Gandhinagar Institute of Science (03)

Academic Regulation & Curriculum

for

Bachelor of Science (06)

in

Biotechnology Programme (117)

Gandhinagar University

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Gujarat

RELEASE DATE

July 2024

(Applicable from 2024 admitted batch)

Preamble

The Department of Microbiology and Biotechnology at Gandhinagar Institute of Science, Gandhinagar University, is dedicated to the advancement of scientific knowledge, innovation, and ethical practices in the field of Biotechnology. Guided by the principles of academic excellence, research orientation, sustainability, and social responsibility, we strive to nurture competent graduates capable of contributing to the rapidly evolving life science sector. The curriculum for the Bachelor of Science in Biotechnology programme has been designed and revised in accordance with the National Education Policy (NEP-2020) guidelines, ensuring a multidisciplinary, skill-oriented, and outcome-based learning approach. The programme emphasizes strong theoretical foundations along with practical, research-based, and experiential learning to meet the contemporary demands of academia, healthcare, agriculture, pharmaceuticals, bioinformatics, environmental sciences, and biotechnology industries. The curriculum incorporates emerging and interdisciplinary areas such as Molecular Biology, Genetic Engineering, Bioinformatics, Immunology, Environmental Biotechnology, Industrial Biotechnology, Plant Tissue Culture, Microbial Technology, and Research Methodology. In alignment with NEP-2020, the programme also integrates Ability Enhancement Courses (AEC), Skill Enhancement Courses (SEC), Value Added Courses (VAC), and Indian Knowledge System (IKS) components to promote holistic education, communication skills, technical competency, ethical awareness, cultural understanding, and employability among students.

Special emphasis has been given to laboratory training, internships, project work, field exposure, innovation, entrepreneurship, environmental consciousness, ethical conduct, and scientific communication. The programme encourages students to actively participate in workshops, seminars, research projects, industrial visits, MOOCs, extension activities, and collaborative learning initiatives to strengthen professional competence and lifelong learning abilities. The curriculum has been structured after considering feedback from academicians, industry experts, alumni, researchers, and other stakeholders to ensure relevance with current scientific advancements, societal needs, and employment opportunities. In pursuit of our vision, the Department remains committed to creating a dynamic academic environment that promotes creativity, critical thinking, interdisciplinary research, and community engagement.

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1. Institutional Vision & Mission

1.1 VISION

Gandhinagar Institute of Science aims to strengthen quality science education and research by fostering innovation, ethical values, and scientific temperament for societal and sustainable development.

1.2 MISSION

• To provide quality education supported by modern infrastructure and an industry- oriented curriculum, while emphasizing ethics and critical thinking.
• To promote an innovative and research-oriented environment that fosters effective problem-solving skills and entrepreneurial development.
• To encourage innovation, entrepreneurship, and scientific ethics for developing responsible and skilled graduates.
• To foster interdisciplinary learning, sustainability, and community engagement for national development.

2. Program Objectives (PO)

PO-1: Grasp of basic and advanced knowledge on various domains of biotechnology.

PO-2: Ability to integrate technologies through an inter-disciplinary learning habit.

PO-3: Demonstrate an independent thinking ability.

PO-4: Ability to communicate effectively.

PO-5: Equipped with laboratory skills in biotechnology.

PO-6: Awareness of the impact of biosolutions in a global, economic, environmental, and societal context.

PO-7: Understanding of professional and ethical responsibility.

PO-8: Ability to design and conduct experiments, as well as to analyze and interpret scientific data.

PO-9: Awareness of contemporary issues that can be mitigated or supported through life science knowhow and biotechnology skills.

PO-10: Recognition of the need for, and an ability to engage in life-long learning.

PO-11: Ability to work in team towards solving broad societal and national issues.

PO-12: Ability to inculcate an attitude of enquiry towards developing innovative ability and enhancing entrepreneurship skills.

3.Program Educational Objectives (PEOs)

PEO-1:

To Understand and inculcate the ability to apply, update, extend and to develop deep knowledge through flexible, research intensive program designed to meet the current demand of academia and industry.

PEO-2:

Demonstrate professional integrity and ethical attitude with awareness of global and national competencies and think about the social entailment of their work, especially its impact on safety, health and environment for sustainable development.

PEO-3:

Participate in individual and team oriented, open ended activities promoting productive thinking to provide opportunities for students to manage and work on multidisciplinary projects through interaction with their peers in industry.

PEO-4:

Apply the acquired practical skills and broad biotechnological training in product, process and inculcate leadership qualities for innovative entrepreneurship to meet the societal demands.

PEO-5:

Graduate will acquire leadership qualities, techno-economic and social considerations, and aptitude for life-long learning, and get introduced to professional ethics and ethos.

4. Program Details

4.1 Program structure & Duration

Duration & Intake: 4 Years & 120 Seats

Semesters: 8

Mode: Full Time

Credit Structure: As per NEP/University norms

Medium of Instruction: English

4.2 Eligibility Criteria for Admission

Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidates must have studied core subjects like Physics, Chemistry and Biology at their Higher Secondary level.

4.3 Admission Procedure

Admission to the B.Sc. Biotechnology program may be granted on the basis of merit obtained in the qualifying examination and/or performance in the Entrance Test, as prescribed by the University from time to time. Candidates seeking admission must have passed the 10+2 examination from a recognized board with science subjects, including Physics, Chemistry, and Biology or equivalent subjects, fulfilling the minimum eligibility criteria specified by the University.

Credit summary for B.Sc Microbiology in MIBT department with effect from 2024

Sl. No.	Course Type	Credit
1.	Core Management Programme Courses (Minor & Major)	120
2.	Interdisciplinary and Multidisciplinary Courses	12
3.	AEC, VAC, SEC	24
4.	Indian Knowledge System (IKS)	4
5.	Internship/Rerearch Project/on the job training (OJT)	16
	Total	**176**

Definition of Credit (as per NEP):

Teaching Component	Credit Definition
1 Hour of Theory (Lecture) per week	1 Credit
2 Hours of Practical/Laboratory Work per week	1 Credit
2 Hours of Field Work/Internship per week	1 Credit = 30 hrs (4 credit = 120 hrs)
2 Hours of Skill/Project Work per week	1 Credit

Range of Credits (as per NEP):

Qualification	Minimum Credits Required
UG Certificate (1 Year)	48 Credits (44 + 4 credit of internship)
UG Diploma (2 Years)	92 Credits (88 + 4 credit of internship)
UG Degree (3 Years)	132 Credits
UG Honours / Honours with Research (4 Years)	176 Credits

Semester-wise Credit Structure (B.Sc. Biotechnology)

Semester	Total Credits
Semester I	22
Semester II	22
Semester III	22
Semester IV	22
Semester V	22
Semester VI	22
Semester VII	22
Semester VIII	22
Grand Total	**176 credits**

5. Curriculum Structure

First Year 1st Semester:

Sr.No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Major	101170101	Introductory Biotechnology	3	-	2	5	4
2	Major	101170102	Cell Biology	3	-	2	5	4
3	Minor	10140103	Fundamental Chemistry-I	3	-	2	5	4
4	Multi / Interdisciplinary	10170105	Astrology-I	4	-	-	4	4
5	Ability Enhancement Course	AEC016	Practical English	2	-	-	2	2
6	Skill Enhancement Course	SEC006	Data Analysis using spreadsheet	2	-	-	2	2
7	Value Added Course	VAC004	Basic Life Support	2	-	-	2	2
Total				19	0	06	25	22

First Year 2nd Semester:

Sr.No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Major	101170201	Animal Biotechnology	3	-	2	5	4
2	Major	101170202	Plant Biotechnology	3	-	2	5	4
3	Minor	10140203	General Chemistry - I	3	-	2	5	4
4	Multi / Interdisciplinary	10170205	Agriculture Business Management	4	-	-	4	4
5	Ability Enhancement Course	AEC015	Personality Development for effective leadership	2	-	-	2	2
6	Skill Enhancement Course	SEC019	Social Media and Management	2	-	-	2	2
7	IKS	IKS0201	Indian Ancient History and Cultural Heritage	2	-	-	2	2
Total				17	0	06	25	22

NCrF Credit Level	Semester	Major (core)	Minor (Elective)	Multi/Inter-disciplinary	AEC	SEC/ Internship	VAC/ IKS	RP/ OJT	Total Credit per sem.	Qualification/ Certificate
First Year	I	8	4	4	2	2 (SEC)	2 (IKS)	-	22	UG Certificate
	II	8	4	4	2	2 (SEC)	2 (VAC)	-	22	
1st Year Total Credits		16	8	8	4	4	4	-	44	
Exit 1: Award of UG certificate in Major course with 44 credits with additional 4 credits of summer Internship in core specific NSQF defined course or continue with major and minor course for next NCrF credit level										

Second Year 3rd Semester:

Sr.No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Major	101170301	Molecular Biology	3	-	2	5	4
2	Major	101170302	Fundamentals of Marine Biology	3	-	2	5	4
3	Major	10170306	Fundamental of Biochemistry	3	-	2	5	4
4	Multi / Interdisciplinary	10170308	Astrology-II	4	-	-	4	4
5	Ability Enhancement Course	AEC010	Functional Grammar and Composition	2	-	-	2	2
6	Skill Enhancement Course	SEC021	Visual Arts	-	-	4	4	2
7	Value Added Course	VAC024	Yoga and Meditation for Wellness	2	-	-	2	2
Total				17	0	10	27	22

Second Year 4th Semester:

Sr.No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Major	101170401	Vaccine Technology	3	-	2	5	4
2	Major	10170405	Immunology - 1	3	-	2	5	4
3	Major	101170402	Cancer Biology	3	-	2	5	4
4	Minor	10140406	Organic Chemistry-II	3	-	2	5	4
5	Ability Enhancement Course	AEC008	Freelancing and content writing	2	-	-	2	2
6	Skill Enhancement Course	SEC023	Organic Farming	2	-	-	2	2
7	IKS	IKS0401	Indian Ancient Science and Philosophy	1	-	2	3	2
Total				17	0	10	27	22

NCrF Credit Level	Semester	Major (core)	Minor (Elective)	Multi/Inter-disciplinary	AEC	SEC/ Internship	VAC/ IKS	RP/ OJT	Total Credit per sem.	Qualification/ Certificate
Second Year	III	12	-	4	2	2 (SEC)	2 (IKS)	-	22	UG Diploma
	IV	12	4	-	2	2 (SEC)	2 (VAC)	-	22	
2nd Year Total Credits		40	12	12	8	8	8	-	88	
Exit 2: Award of UG diploma in Major course with 88 credits with additional 4 credits of summer Internship in core specific NSQF defined course or continue with major and minor course for next NCrF credit level										

Third Year 5th Semester:

Sr.No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Major	101170501	Animal Cell Culture	4	-	-	4	4
2	Major	10170502	Immunology - 2	4	-	-	4	4
3	Major	101170502	BTlaboratory-V	-	-	8	8	4
4	Minor	10170504	rDNA Technology	4	-	-	4	4
5	Minor	10170505	Fermentation Technology	3	-	2	5	4
6	Skill Enhancement Course	SEC022	Public Speaking	2	-	-	2	2
Total				17	0	10	27	22

Third Year 6th Semester:

Sr.No.	**Category**	**Course Code**	**Course Name**	**Contact Hours/Week**				**Credit Points**
				L	T	P	Total	
1	Major	101170601	Genomics & Proteomics	4	-	-	4	4
2	Major	10320402	Biodiversity and Wildlife Conservation	4	-	-	4	4
3	Major	101170602	BTlaboratory-VI	-	-	8	8	4
4	Minor	10170601	Mycology	4	-	-	4	4
5	Ability Enhancement Course	AEC021	Digital Privacy: Understanding and Operational Framework	2	-	-	2	2
6	Internship	101170603	Internship in Major specific course	-	-	8	8	4
Total				14	0	16	30	22

NCrF Credit Level	Semester	Major (core)	Minor (Elective)	Multi/Inter-disciplinary	AEC	SEC/ Internship	VAC/ IKS	RP/ OJT	Total Credit per sem.	Qualification/ Certificate
Third Year	V	12	8	-	-	2 (SEC)	-	-	22	UG Degree
	VI	12	4	-	2	4 (Internship)	-	-	22	
3rd Year Total Credits		64	24	12	10	14	8	-	132	
Award of UG degree in Major course with 132 credits and Internship in core discipline or continue with major and minor course for next NCrF credit level.										

Fourth Year 7th Semester:

Sr.No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Major	11170701	Food and Nutrition Biotechnology	3	-	2	5	4
2	Major	11170702	Bioinstrumentation	3	-	2	5	4
3	Major	11170703	Enzymology	3	-	2	5	4
4	Minor	11170704	Environmental Microbiology	3	-	2	5	4
5	Research Project/On-the-Job Training	1170705	On the Job Training (OJT) (For UG Honors Degree) / Research Project (For UG Honors with Research Degree)	-	-	12	12	6
Total				12	0	20	32	22

Fourth Year 8th Semester:

Sr.No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Major	11170801	Forensic Biotechnology	3	-	2	5	4
2	Major	11170802	Applied Biotechnology	3	-	2	5	4

3	Major	11170803	Biostatistics	3	-	2	5	4
4	Minor	11170804	Microbial Physiology	3	-	2	5	4
5	Research Project/On-the-Job Training	1170805	On the Job Training (OJT) (For UG Honors Degree) / Research Project (For UG Honors with Research Degree)	-	-	-	12	6
Total				12	0	20	32	22

NCrF Credit Level	**Semester**	**Major (core)**	**Minor (Elective)**	**Multi/Inter-disciplinary**	**AEC**	**SEC/ Internship**	**VAC/ IKS**	**RP/ OJT**	**Total Credit per sem.**	**Qualification/ Certificate**
Fourth Year	**VII**	**12**	**4**	**-**	**-**	**-**	**-**	**6 (OJT)**	**22**	**UG Honours Degree**
	VIII	**12**	**4**	**-**	**-**	**-**	**-**	**6 (OJT)**	**22**	
4th Year Total Credits		**88**	**32**	**12**	**10**	**14**	**8**	**12**	**176**	
Award of UG Honours degree in Major course with total 176 credits										

NCrF Credit Level	**Semester**	**Major (core)**	**Minor (Elective)**	**Multi/Inter-disciplinary**	**AEC**	**SEC/ Internship**	**VAC/ IKS**	**RP/ OJT**	**Total Credit per sem.**	**Qualification/ Certificate**
Fourth Year	**VII**	**12**	**8**	**-**	**-**	**-**	**-**	**6 (RP)**	**22**	**UG Honours with Research Degree**
	VIII	**12**	**4**	**-**	**-**	**-**	**-**	**6 (RP)**	**22**	
4th Year Total Credits		**88**	**32**	**12**	**10**	**14**	**8**	**12**	**176**	
Award of UG Honours with Research Degree in Major Course with total 176 credits.										

6. Teaching, Learning & Evaluation

6.1 Teaching Methodology

The program shall adopt:

- Classroom Teaching
- Laboratory Practical and Demonstrations
- Interactive Learning Sessions
- Problem-Based Learning
- Research-Oriented Projects
- Industrial and Laboratory Visits
- Workshops and Hands-on Training
- Internship and Training Programs
- Field Visits and Sample Collection Studies
- AI-based Learning Tools
- Blended Learning Methods
- Assignments, Presentations, and Tutorials

6.2 Attendance Rules

- Minimum 75% attendance shall be mandatory in each course.
- Students below prescribed attendance may not be permitted to appear in examination.
- Additional attendance requirements may apply for practicals, internships, and field work.

6.3 Examination and Evaluation System

6.3.1 Evaluation Components

- The evaluation may consist of Continuous Internal Evaluation (CIE) and End Semester examination (ESE)
- Continuous Internal Evaluation (CIE) may include:
    - Mid-Semester Examination
    - Assignments
    - Presentations
    - Field work
    - Class Test
    - AI Quiz & Viva Voce
    - Dissertation
    - Project work

6.4 Suggested Weightage

- Continuous Internal Evaluation: 50%
- End Semester Examination: 50%

6.5 Passing Standards

- Minimum 45% marks in each component where applicable.
- Minimum 45% aggregate for passing the course/program.
- Separate passing may be required in theory and practical examinations.

6.6 Grading System

The program shall follow Gandhinagar University grading norms.

6.6.1 Grade Table

Grade	Grade Points	From Marks	To Marks
AA	10	80	100
AB	9	75	79
BB	8	70	76
BC	7	65	69
CC	6	60	64
CD	5	55	59
DD	4	50	54
DF	0	0	49

6.7 Dissertation / Project Work

Students shall undertake Research Project or On the job training (OJT).

Requirements may include:

- Proposal Presentation
- Periodic Review
- Final Report Submission
- Viva Voce Examination

The dissertation shall be evaluated by internal and external examiners.

7. Rules and Regulations

6.2 **Rules for Promotion**

A student shall be promoted to the next semester as per Gandhinagar University rules subject to fulfilment of academic requirements, minimum attendance and Completion of required credits.

6.3 **Maximum Duration for Completion**

The maximum duration for completing the program shall be 8 years from the date of admission (or as prescribed by the University).

7.3 Internship Guidelines

7.3.1 Students shall undergo mandatory internship/industrial training/field training in:

- Microbiology and Biotechnology Industries
- Pharmaceutical Companies
- Clinical and Diagnostic Laboratories
- Research and Development Laboratories
- Food and Dairy Industries
- Environmental and Water Testing Laboratories
- Hospitals and Healthcare Laboratories
- Agricultural and Soil Microbiology Laboratories
- Public Health and Government Research Institutes
- Quality Control and Quality Assurance Laboratories

7.3.2 Students must submit:

- Internship Report
- Work Diary/Logbook
- Training Completion Certificate
- Presentation/Viva-Voce on Internship Work

7.4 Discipline Rules

Students shall maintain discipline, professional ethics, laboratory ethics, and proper conduct within the institution, during laboratory practicals, field visits, internships, industrial visits, research activities, examinations, and all academic programs. Students are expected to attend classes and practical sessions regularly, follow institutional rules and laboratory safety guidelines, respect faculty members, staff, fellow students, and institutional property, and maintain academic honesty in assignments, projects, practical records, and examinations. Any form of misconduct, ragging, indiscipline, falsification of laboratory data, misuse of laboratory equipment or microbial cultures, use of unfair means in examinations, damage to institutional property, harassment, or behaviour affecting the academic and research environment shall be treated seriously and may result in disciplinary action including warning, suspension, cancellation of examination, withholding of results, or expulsion from the program as per University rules and UGC regulations. Students shall also comply with all biosafety, ethical, environmental, and professional standards prescribed by the institution from time to time.

7.5 Anti-Ragging Policy

The program shall strictly follow:

- UGC Anti-Ragging Regulations
- Anti-Ragging Affidavit requirements
- Institutional disciplinary procedures
- Ragging in any form is strictly prohibited

7.6 Ethical Use of Technology and AI Tools

Students are encouraged to use:

- Microbiology and Bioinformatics Software
- Statistical and Data Analysis Tools
- AI-based Learning Platforms
- Digital Microscopy and Imaging Tools
- Online Scientific Databases and Research Platforms
- Laboratory Information and Documentation Tools

6. Student Support

8.1 Industry Collaboration

The department shall actively promote collaboration with pharmaceutical industries, biotechnology companies, clinical and diagnostic laboratories, food and dairy industries, environmental testing laboratories, research organizations, healthcare institutions, agricultural industries, and government agencies to enhance practical exposure and industry relevance of the B.Sc. Biotechnology program. Such collaborations may include internships, industrial training, laboratory visits, live projects, expert lectures, workshops, research activities, skill development programs, and placement support. The institution may also establish Memoranda of Understanding (MoUs) with industries, research institutes, hospitals, and professional organizations for academic enrichment, technology support, training programs, certification courses, and collaborative initiatives aimed at improving employability, entrepreneurship, innovation, and professional competency among students.

8.2 Research and Consultancy

The department shall encourage faculty members and students to actively engage in research, consultancy, innovation, and applied studies related to microbiology, biotechnology, public health, food microbiology, industrial microbiology, environmental microbiology, agricultural microbiology, molecular biology, and emerging biological technologies. Students may undertake research projects, laboratory-based studies, microbial analysis, environmental monitoring, quality control studies, and data-driven investigations as part of their academic and professional training. The institution may also undertake consultancy assignments for hospitals, industries, food processing units, pharmaceutical companies, environmental agencies, and other organizations in areas such as microbial testing, water and food quality analysis, biosafety practices, industrial fermentation, and laboratory diagnostics. Participation in seminars, conferences, workshops, publications, funded projects, and collaborative research activities shall be encouraged to promote academic excellence, innovation, scientific temperament, and industry-oriented learning.

8.3 Library and Laboratory Facilities

Adequate library, laboratory, and digital learning facilities shall be made available to support effective teaching, practical training, research, and skill development under the B.Sc. Microbiology program. The department shall facilitate access to relevant textbooks, reference books, scientific journals, research publications, e-resources, microbial culture manuals, laboratory protocols, and digital learning platforms related to microbiology, biotechnology, molecular biology, immunology, biochemistry, and allied life sciences. Necessary laboratory infrastructure including microscopes, incubators, autoclaves, laminar airflow systems, culture media preparation facilities, analytical instruments, computing facilities, internet access,

bioinformatics tools, and other technical resources required for practical and project-based learning shall also be provided to enhance scientific knowledge, research capability, laboratory skills, and professional competency among students.

8.4 Student Support and Mentoring

A structured system for student support, academic mentoring, and professional guidance shall be implemented for students enrolled in the B.Sc. Biotechnology program. The department shall facilitate academic counselling, mentoring, career guidance, research support, and skill development activities to assist students in their academic progression and professional growth. Students may also be provided opportunities for interaction with scientists, healthcare professionals, industry experts, and researchers through workshops, seminars, industrial visits, laboratory training, conferences, and extracurricular activities aimed at enhancing employability, scientific aptitude, leadership qualities, communication skills, and overall personality development. Necessary support mechanisms for addressing academic and personal concerns shall also be made available as per institutional policies.

8.5 Placement and Career Development

The department shall promote placement assistance and career development activities for students through industry interaction, professional networking, training programs, internships, and campus engagement initiatives. Efforts shall be made to establish linkages with pharmaceutical industries, biotechnology companies, hospitals, clinical laboratories, food industries, environmental agencies, research organizations, and allied sectors to facilitate internships, industrial exposure, research opportunities, and employment avenues for students. Career development activities such as aptitude training, resume preparation, soft skill development, entrepreneurship guidance, laboratory skill enhancement, certification programs, expert sessions, and placement-oriented workshops may also be organized to improve professional competency, research aptitude, and employability of students.

9. Program Credibility

9.1 Executive Summary

The B.Sc. Biotechnology program is designed to provide students with comprehensive theoretical knowledge and practical laboratory skills in the fields of biotechnology, molecular biology, genetics, microbiology, immunology, biochemistry, bioinformatics, cell biology, genetic engineering, and industrial biotechnology. The curriculum integrates modern biological sciences with technological applications to prepare students for scientific, industrial, healthcare, agricultural, and research-oriented careers.

Every subject in the program is delivered by qualified faculty members and subject experts with academic, research, and industrial experience, ensuring that students gain both conceptual understanding and practical exposure to modern microbiological techniques and applications. Laboratory practicals, research-based assignments, case studies, industrial visits, and internships are integrated throughout the curriculum to strengthen analytical ability, technical competency, and problem-solving skills among students.

The program incorporates training in molecular biology techniques, genetic engineering, recombinant DNA technology, bioinformatics, industrial biotechnology, fermentation technology, immunological techniques, tissue culture, molecular diagnostics, environmental biotechnology, bioprocess technology, and computational biology. Students receive hands-on laboratory exposure in microbiological analysis, DNA and protein isolation, PCR techniques, electrophoresis, chromatography, ELISA, cell culture, biostatistics, and scientific instrumentation handling.

The department focuses on skill-based learning, laboratory training, interdisciplinary education, industrial exposure, research activities, and innovation-driven practices aligned with the National Education Policy (NEP). Workshops, seminars, industrial visits, live projects, internships, and research-oriented activities are regularly organized to expose students to recent advancements and professional practices in biotechnology and allied life science sectors.

The program is designed to prepare graduates for employment, entrepreneurship, higher education, and research opportunities in sectors such as biotechnology industries, pharmaceutical companies, healthcare organizations, agriculture, food technology, environmental management, bioinformatics, industrial fermentation, molecular diagnostics, and scientific research institutions. The curriculum also supports progression toward postgraduate studies, competitive examinations, professional certifications, and advanced research in biotechnology and interdisciplinary sciences.

9.2 Scope and Career Opportunities

Graduates of the program may work in:

- Biotechnology Industries
- Pharmaceutical Industries
- Research and Development Organizations
- Molecular Diagnostic Laboratories
- Clinical and Healthcare Laboratories
- Vaccine and Biopharmaceutical Industries
- Food and Fermentation Industries
- Agricultural Biotechnology Companies
- Environmental Biotechnology and Waste Management Sectors
- Bioinformatics and Computational Biology Organizations
- Quality Control and Quality Assurance Laboratories
- Genetic Engineering and Genomics Laboratories
- Government Research Institutes
- Academic and Educational Institutions
- Healthcare and Public Health Organizations
- Industrial Production and Bioprocessing Units

9.3 Potential Job Roles

- Biotechnologist
- Research Assistant
- Laboratory Technician
- Molecular Biology Technician
- Quality Control Analyst
- Quality Assurance Executive
- Bioinformatics Analyst
- Clinical Research Associate
- Genetic Engineering Assistant
- Fermentation Technician
- Scientific Assistant
- Production Executive
- Medical Laboratory Assistant
- Bioprocess Technician
- Environmental Biotechnology Analyst
- Food Biotechnology Analyst

• Technical Support Executive

• Research Laboratory Associate

9.4 Higher Study and Professional Opportunities

Students may pursue:

• M.Sc. in Biotechnology and Allied Life Sciences

• M.Sc. in Molecular Biology, Genetics, Bioinformatics, or Microbiology

• Ph.D. in Biotechnology and Interdisciplinary Sciences

• Clinical Research and Bioinformatics Programs

• Genetic Engineering and Genomics Courses

• Industrial Biotechnology and Bioprocess Technology Specializations

• Medical Laboratory Technology Programs

• Research Fellowships and Competitive Examinations

• Professional Certification Courses in Biotechnology and Laboratory Sciences

• Entrepreneurship in Biotechnology, Diagnostics, Agriculture, and Healthcare Sectors

10. Collaborative Field Work / Experimental Work

10.1 DNA Isolation and Molecular Biology Exercise

Students will isolate genomic DNA from plant, bacterial, or animal samples using standard laboratory protocols. They will analyze DNA quality using gel electrophoresis and prepare laboratory reports including methodology, observations, and interpretation.

10.2 Recombinant DNA Technology Demonstration

Students will perform basic recombinant DNA experiments involving restriction digestion, ligation, and plasmid analysis under supervised laboratory conditions. Deliverables shall include laboratory records and interpretation of molecular results.

10.3 Industrial Visit — Biotechnology or Pharmaceutical Industry

Faculty shall arrange guided industrial visits to biotechnology companies, pharmaceutical industries, vaccine production units, or research organizations. Students will observe industrial biotechnology processes, fermentation systems, quality control practices, biosafety measures, and product development techniques. Submission shall include an industrial observation report and annotated photographs.

10.4 Fermentation Technology and Bioprocess Exercise

Students will study microbial fermentation processes using bacterial or yeast cultures for the production of enzymes, alcohol, organic acids, or bioproducts. Students shall monitor pH, temperature, microbial growth, and product formation during fermentation and prepare technical reports.

10.5 Clinical and Diagnostic Laboratory Visit

Students will visit molecular diagnostic or clinical laboratories to observe PCR-based diagnostics, ELISA techniques, specimen handling, sterilization procedures, and biosafety protocols. Students shall prepare structured reports on laboratory workflow and diagnostic applications.

10.6 Environmental Biotechnology Field Study

Students will conduct environmental sampling from soil, wastewater, compost, or polluted environments to study bioremediation and microbial diversity. Students shall analyze environmental samples and prepare comparative reports with ecological interpretation.

10.7 Tissue Culture and Plant Biotechnology Exercise

Students will learn basic plant tissue culture techniques including media preparation, sterilization, inoculation, and culture maintenance under aseptic conditions. Laboratory records and growth observations shall be submitted.

10.8 Protein Analysis and Biochemical Techniques

Students will perform protein estimation, enzyme assays, chromatography, and electrophoresis techniques in biotechnology laboratories. Students shall prepare data sheets and interpret biochemical observations.

10.9 Bioinformatics and Database Exploration Exercise

Students will use biological databases such as NCBI, EMBL, PDB, and UniProt to retrieve gene and protein sequences. They will perform sequence alignment and basic computational analysis using bioinformatics tools. Submission shall include screenshots, sequence data, and analytical reports.

10.10 Immunology and Diagnostic Techniques Exercise

Students will perform immunological techniques such as ELISA, blood grouping, antigen-antibody reactions, and rapid diagnostic assays. Students shall prepare detailed laboratory reports and result interpretations.

10.11 Industrial Bioprocess and Downstream Processing Exercise

Students will study industrial bioprocessing and downstream purification methods including filtration, centrifugation, precipitation, and chromatography. Deliverables include technical observations and process reports.

10.12 Biosafety and Laboratory Audit Exercise

Students will evaluate laboratory facilities using biosafety guidelines to assess sterilization procedures, waste management systems, chemical handling, and personal protective measures. Students shall prepare structured biosafety audit reports with recommendations.

10.13 Mandatory Industry Internship (4–8 Weeks)

Students shall complete mandatory internships in biotechnology companies, pharmaceutical industries, research institutes, molecular diagnostic laboratories, food industries, hospitals, or environmental biotechnology organizations. Internship activities may include laboratory assistance, molecular analysis, documentation, quality control, bioprocess monitoring, or research work. Deliverables shall include internship reports, work diaries, and supervisor evaluation certificates.

10.14 Research Project and Dissertation

Students shall undertake independent or group research projects related to biotechnology, molecular biology, industrial biotechnology, medical biotechnology, environmental biotechnology, bioinformatics, or genetic engineering. The project shall include proposal preparation, literature review, experimentation, data analysis, and report writing. Final submission shall include dissertation and viva voce presentation.

10.15 Scientific Seminar and Poster Presentation

Students shall prepare and present scientific seminars or posters on emerging biotechnology topics such as CRISPR technology, vaccine development, stem cell therapy, synthetic biology, bioinformatics, personalized medicine, industrial bioprocessing, and environmental sustainability. Evaluation shall be based on scientific understanding, analytical skills, and presentation quality.

10.16 Portfolio Presentation and Exit Viva

The Portfolio Presentation and Exit Viva shall serve as the final capstone assessment of the program. Students shall compile laboratory records, internship reports, research projects, field studies, seminar presentations, and skill certifications into a professional portfolio. Students shall deliver presentations before a faculty panel followed by viva voce examinations assessing scientific understanding, laboratory competency, research aptitude, and professional readiness.

11. Market Survey

The Biotechnology course is studied as it is an interdisciplinary field that combines biological sciences with modern technology to improve human life and solve real-world problems. The course provides detailed knowledge of subjects such as microbiology, genetics, molecular biology, cell biology, biochemistry, immunology, bioinformatics, Vaccine development and genetic engineering. Through theoretical learning and practical laboratory training, students develop technical skills in handling microorganisms, molecular techniques, fermentation technology, tissue culture, and analytical methods that are widely used in scientific research and industries.

One of the major reasons students choose B.Sc. Biotechnology is the growing importance of biotechnology in healthcare and medicine. Biotechnology plays a key role in the development of vaccines, antibiotics, diagnostic kits, gene therapies, and recombinant products used for treating diseases. The field also contributes significantly to agriculture through the development of biofertilizers, biopesticides, disease-resistant crops, and sustainable farming methods. In environmental science, biotechnology helps in waste management, bioremediation, water treatment, and pollution control using microorganisms and biological processes.

The course is also important because it opens a wide range of career opportunities in research institutions, pharmaceutical industries, food and dairy industries, agriculture sectors, hospitals, forensic laboratories, environmental organizations, and biotechnology companies. Students can work as research assistants, microbiologists, laboratory technicians, quality control analysts, biotechnologists, or pursue higher studies such as M.Sc., Ph.D., or specialized research programs. The increasing advancement in areas like microbial biotechnology, genomics, proteomics, bioinformatics, and industrial biotechnology has created a high demand for skilled biotechnology professionals globally. The departmental action plan is focused towards Curriculum enhancement, skill development programs, industrial collaborations, research activities, seminars, and professional training.

In addition, the course helps students develop scientific thinking, problem-solving abilities, analytical skills, and research aptitude. Practical exposure through laboratory work, industrial visits, seminars, and research projects prepares students for both academic and industrial environments. Biotechnology is considered one of the most rapidly developing scientific fields

because it contributes to innovations in medicine, food production, environmental sustainability, and industrial development. Therefore, studying B.Sc. Biotechnology provides students with both knowledge and practical expertise to contribute to scientific progress and societal development.

12. Review and Revision of Regulation

The University reserves the right to interpret, modify, revise, amend, or update any provision, rule, regulation, curriculum structure, evaluation pattern, academic requirement, or operational guideline related to the program from time to time in accordance with university regulations, statutory requirements, industry developments, and academic needs.

In case of any ambiguity or dispute regarding interpretation of any provision of this manual, the decision of the University/Competent Authority shall be final and binding on all stakeholders. Any amendments, additions, or revisions approved by the appropriate academic or statutory bodies of the University shall automatically become applicable to the program.

Gandhinagar Institute of Science
B.Sc. Biotechnology
Sem-1

Subject Code: 11170101	**Subject Title: Introductory Biotechnology**
Prerequisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidates must have studied core subjects like Chemistry and Biology at their Higher Secondary level.	

Course Objective:

- To explain the origin and discoveries in biotechnology.
- To understand the basis of biotechnology.
- To explore the application of biotechnology in various sectors.
- The objectives of these courses are to provide hands-on training in basic experiments of cell biology.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to biotechnology** Origin and definitions, history of biotechnology ancient, classical and modern, major scientific discoveries in biotechnology, an interdisciplinary activity-strain choice, mass culture, optimization of cell responses, process of operations, product recovery.	15	33%
2	**Biotechnology and its application** Applications of biotechnology in Agriculture, medicine, environment, veterinary sciences, food industry, chemical industry, pharmaceutical industry forensic science; Bioremediation and waste treatment biotechnology.	15	34%
3	**Emerging fields of biotechnology** Nanobiotechnology, bioinformatics, pharmacogenomics, regenerative medicine, therapeutic proteins, bio-robotics, biosensors; Brief account	15	33%

	of safety guidelines and risk assessment in biotechnology; Ethical issues related to biotechnology.		

Course Outcome: After completion of this course, student will be able to

CO1: Understand the basics of biotechnology, its history and recent discoveries.

CO2: Gain insight about the various fields involved with biotechnology, understand the role of biotechnologist in various public and private sectors.

CO3: Explore the emerging fields of biotechnology for future biotechnologists.

CO4: Gain knowledge about the safety and ethics of biotechnology.

List of Textbooks:

- Biotechnology by B D Singh.
- H. D. Kumar, Modern Concepts of Biotechnology, Vikas Publishing House, New Delhi.
- P.K. Gupta, Biotechnology and Genomics, Rastogi Publications, Meerut.

List of Reference Books:

- Biotechnology Fundamentals and Application by S. S. Purohit Ex-Head, P.G. Department of Botany Dungar College, Bikaner.
- Biotechnology: Progress and Application by Saif Hameed.
- Hulse JH. Biotechnologies: Past history, present state and future prospects. Trends Food Sci Technol.
- Seidman& Moore, Basic Laboratory Methods for Biotechnology.
- Wohlgemuth R. Industrial biotechnology – past, present and future. New Biotechnology.

Open e-Resource:

- Swayam Portal: General Biotechnology - Course (swayam3.ac.in)
- https://nptel.ac.in/courses/102103045

List of Suggested Experiments:

- Basic operations in laboratory
- Documentation: The Lab Notebook & Lab Report
- Biotechnology Laboratory Security & Safety
- Lab Equipment & Reagent Orientation
- Math Skills for the Laboratory
- Basic tools in the biotechnology laboratory
- Calibrating Lab Instruments
- Preparing solutions

Gandhinagar Institute of Science
B.Sc. Biotechnology
Sem-1

Subject Code: 11170102	**Subject Title: Cell biology**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Chemistry and Biology at their Higher Secondary level.	

Course Objective:

- To understand differentiation between prokaryotic and eukaryotic cells and their functional compartmentalization.
- To introduce a knowledge of different cell organelles and their function.
- To understand the extracellular matrix and cytoskeleton structure which helps in locomotion and structural support
- The objectives of this course are to provide hands-on training in basic experiments of cell biology.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Cell and structural organization of Membrane** **Cell**: Introduction and classification of organisms by cell structure, compartmentalization of eukaryotic cells, cell fractionation. **Cell Membrane and Permeability**: Structural organization of cell membrane and Fluid-Mosaic model, Lipid composition, Protein components and basic functions, Membrane carbohydrates and their role transport.	15	33%
2	**Structural Organization and function of Cell organelles** Nucleus: Structure and function, Nuclear envelop, Pore complex; Golgi complex: Structure, biogenesis and functions including role in protein secretion; Endoplasmic reticulum: Structure, function including role in protein segregation; Mitochondria and chloroplast: Structure and	15	33%

	function, Genomes, biogenesis; Ribosomes: Structures and function including role in protein synthesis; Lysosomes, Vacuoles, peroxisomes, Structure and functions.		
3	**Cytoskeleton and Extracellular matrix** Basic functions of cytoskeleton, Structure and organization of actin filaments, intermediate filaments, microtubules. Assembly, organization and movement of cilia and flagella, components of Extracellular Matrix, their organization and their interaction with cells.	15	34%

Course Outcome: After completion of this course, student will be able to

CO1: Concept of cell and cell membrane.
CO2: Gain insight into different cell organelles origin, structure and function.
CO3: Acquiring an understanding of mechanism of motility in different organism.
CO4: Gain knowledge about the cell function and its interaction with extracellular matrix.

List of Text Books:

- Cell Biology, Genetics, Molecular Biology: Evolution and Ecology P S Verma and V K Agarwal, S Chand publications, 2004.

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List of Reference Books:

- Cell and Molecular Biology‘8th Edition by E.D.P. De Robertis.
- Cell Biology 2nd Edition, by Seong S. Han, Ruth Ashley, Gary Hann Rastogi publications.
- Essentials of Cell and Molecular Biology: by de Robertis E. D. P. and E. M. F., Holt Saunder's
- G. M. Cooper. 1997. The Cell and Molecular approach. ASM Press. Ed.
- Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons.
- The Physiology and Biochemistry of Prokaryotes, by White, D (2000) Oxford University Press, Oxford. International Edition (new edition).

Open e-Resource:

- Swayam Portal: General Microbiology - Course (swayam2.ac.in)
- OpenStax: Microbiology - OpenStax.

List of Suggested Experiments:

- Study the effect of temperature and organic solvents on semi permeable membrane.
- Demonstration of dialysis.
- Study of plasmolysis and de-plasmolysis.
- Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
- Study of structure of any Prokaryotic and Eukaryotic cell.
- To learn the skills of cell disruption methods.
- Staining and visualization of animal and plant cell and organelles
- Cell division in onion root tip/ insect gonads.
- Preparation of Nuclear, Mitochondrial & cytoplasmic fractions

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-1

Subject Code: 10140103	**Subject Title:** Fundamental Chemistry-1 (Theory)
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective: (1) They will gain proficiency in logical deduction skills through written problems and laboratory work.

(2) They will identify problems and generate hypotheses, develop and implement experimental methods to test their hypotheses, and analyze and interpret the resulting data.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	70	30	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Fundamentals of Organic Chemistry** **Basic Concepts of Organic Chemistry,** Tetravalent carbon atom, Hybridization, Functional groups, Nomenclature of organic molecules, Types of bonds, Fission of bond, Inductive effect, Electrometric effect, Resonance Effect, Hyper conjugation.	10	23%
2	**Fundamentals of Inorganic Chemistry** **Periodic table and properties**: Periodic Table, Ionization Energy, Electron affinity, Atomic Size and Electronegativity. **Chemical Bonds:** The Lewis Theory, Sidgwick- Powell Theory, Valence Shell Electron Pair Repulsion (VSEPR) Theory, Valence Bond Theory (VBT), Hybridization, Molecular Orbital Theory (MOT).	11	27%
3	**Fundamentals of Physical Chemistry** **Chemical thermodynamics**: System and surroundings, heat and work, internal energy, first law of thermodynamics, entropy and enthalpy, temperature dependence of entropy and enthalpy, exothermic and endothermic reactions, Hess's law, Gibbs free energy, second law of thermodynamics, heat capacities, reversible and irreversible systems.	11	27%
4	**Fundamentals of Stereochemistry** Definition, Importance, Geometrical isomerism, cis-trans and E/Z nomenclature Optical isomerism – optical activity, plane polarized light, enantiomers, chirality, specific molar rotation. **Stereoisomerism with two chiral centers:** Diastereomers, Mesoisomers, Resolution of racemic modification.	10	23%

	Projection diagrams of stereoisomers: Fischer, Newman and Sawhorse projections.		

Course Outcome: After completion of this course, student will be able to

- Foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries as well as stereochemistry.
- Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
- Skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- Clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.
- Explore new areas of research in both chemistry and allied fields of science and technology.
- Appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
- Explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
- Function as a member of an interdisciplinary problem-solving team.

List of Text Books:

1. Physical Chemistry for the life sciences by Peter Atkins, Oxford University Press.
2. Essential of Physical Chemistry by Bahl, Bahl, and Tuli, S. Chand and Co.
3. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
4. Stereochemistry Conformation and Mechanism 7th Edition by P.S. Kalsi; New Age International (P) Ltd.

List of Reference Books:

1. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. P.W. Atkins: Physical Chemistry, Oxford University Press.
3. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
4. James E. Huheey *et al*.: Inorganic Chemistry: Principles of Structure and reactivity.
5. Ashutosh Kar Advanced Inorganic Chemistry Vol: I and II CBS Publishers.

List of Suggested Experiments

1. Titrimetric Analysis:
   i. Calibration and handling of apparatus.
   ii. Preparation of solutions of titrants of different Molarity/Normality.

2. Acid-Base Titrations: Principles of acid-base titrations to be discussed.

   i. Estimation of sodium carbonate using standardized HCl.
   ii. Estimation of carbonate and hydroxide present together in a mixture.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc.

Semester-1

Subject Code: 10170105	**Subject Title:** Astrology-1
Pre-requisite:	

Course Objective:

1. To introduce the basic principles, origin, development, and key texts of astrology.
2. To understand the astrological view of the universe and its applications in various fields.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Astrology** Introduction Origin Development of Astrology	10	23%
2	**Elements of Astrology** Siddantha Samhitha Hora	11	27%
3	**Concept of Universe** Word Solar family Earth	11	27%
4	**Applications of Astrology** Social Environmental Health and Education	10	23%

Course Outcome: After completion of this course, students will be able to

1. Understand the origin, development, and core elements of astrology, including key texts like Siddantha, Samhitha, and Hora.
2. Describe the astrological universe and the roles of the solar family and Earth.
3. Identify and analyze essential astrology components and terminology.
4. Evaluate astrology's applications in social, environmental, health, and education fields.

Textbooks

1. "Brihat Samhita" by Varahamihira
2. "Surya Siddhanta" (Translation by Ebenezer Burgess or modern Indian authors)
3. "Brihat Parashara Hora Shastra" by Maharishi Parashara
4. "Essentials of Astrology" by Komilla Sutton

Reference Books

1. "Light on Life: An Introduction to the Astrology of India" by Hart de Fouw & Robert Svoboda
2. "Astrology and Science" by B.V. Raman
3. "Phaladeepika" by Mantreswara
4. "Indian Astrology" by B.V. Raman

Gandhinagar Institute of Science
B.Sc. Biotechnology
Sem-2

Subject Code: 11170201	**Subject Title: Animal Biotechnology**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidates must have studied core subjects like Chemistry and Biology at their Higher Secondary level.	

Course Objective:

- The objectives of this course are to provide hands-on training in basic experiments of animal biotechnology.
- To introduce students to the principles, practices and application of animal biotechnology.
- To impart knowledge regarding evolution patterns, behavior and physiology of animals.
- To make students understand the reproductive mechanism of animals.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Animal Evolution:** Concept of Evolution: Origin of Life, Variations, Mutations, Isolation, Species and Speciation, Darwin's Natural Selection Theory, Mimicry, Population Genetics and Evolution. **Animal Behavior:** Introduction of Ethology, Branches, History, Significance, Patterns of Behavior, Study of Behavior, Genetics of Behavior, Reproductive Behavior.	15	34%

2	**Animal Physiology:** Tissues, Organs and Systems, Feeding and Digestion, Absorption, Metabolism, Respiration, The Blood and Circulatory System, Excretion, Muscle Contraction, Nervous System, Endocrine Glands.	15	33%
3	**Animal Reproduction:** Reproduction in selected vertebrates and invertebrates.	15	33%

Course Outcome: After completion of this course, student will be able to

CO1: Concept of evolution

CO2: Various aspects of animal behavior.

CO3: Animal physiology associated with various body systems

CO4: Process of reproduction in selected vertebrates and invertebrates

List of Text Books:

- Textbook of Invertebrates by RL Kotpal, Rastogi Publication, Meerut.
- Textbook of Vertebrates, RL Kotpal, Rastogi Publications, Meerut.
- A Textbook of Animal Physiology by AK Berry, Emkay Publications, Delhi.

List of Reference Books:

- Chordate Zoology, PS Dhami and JK Dhami, S Chand & Co., Delhi.
- Invertebrate Zoology, Jordan and Verma, S Chand & Company, Delhi
- Instant notes in Animal Biology by Richard D Jurd. Vivi Books Pvt Ltd, New Delhi.
- Evolution and Behavior by Reena Mathur, SP Singh and BS Tomar 1st Ed., 2013 Rastogi Publication, Meerut.
- Evolutionary Biology by BS Tomar and SP Singh. 9th Ed. 2013-14, Rastogi Publications, Meerut.
- Animal Physiology by VK Agarwal and PS Verma. Reprint Edition: (2012), S Chand &Co., Delhi.
- Animal Physiology by KA Goel and KV Sastry, 6th Ed 2012-13, Rastogi Publications, Meerut.
- Animal Physiology and Biochemistry by KV Sastry, 2nd Ed. 2012-13, Rastogi Publications, Meerut.
- Instant notes in Animal Biology by Richard D Jurd. Vivi Books Pvt Ltd, New Delhi.
- A Manual of Practical Zoology: Invertebrates, By: V.K. Aggarwal, Dr. P. S. Verma. S Chand and Co.
- Practical Zoology Invertebrates by Dr. S. S. Lal, 2013, Rastogi Publications.
- A Manual of Practical Zoology Chordates byDr. P. S. Verma, S Chand and Co.

- Practical Zoology vertebrates by SS Lal, Rastogi Publications.

Open e-Resource:

- Animal Physiology - Course (nptel.ac.in)
- Best Animal Courses Online with Certificates [2024] | Coursera
- https://alison.com/course/introduction-to-animal-science
- Online Learning | Animal Science (ncsu.edu)
- https://www.educations.com/animal-science/distance-learning
- 1.full note - lecture notes - Institute of Agriculture and Animal Science (IAAS) Principles and - Studocu

List of Suggested Experiments:

- Learning operation of light microscope
- Exploring animal diversity and behavior through census methods.
- Observing fossil specimens, connecting links and museum specimens, distinguishing single celled animals of economic importance through permanent slides.
- Preparation of animal cell culture media.
- Preparation of suspension cultures from animal tissue.
- Enumeration of cells in culture by hemocytometer
- Preparation of glycerol stocks.

Gandhinagar Institute of Science
B.Sc. Biotechnology
Sem-2

Subject Code: 101170202	**Subject Title: Plant Biotechnology**
1. **Pre-requisite:** Student should have basic knowledge about plant biology subjects like, plant Tissue culture, Cell differentiation and its applications.	

Course Objective:

- Comprehensive Knowledge of Plant Tissue Culture.
- Proficiency in Laboratory Techniques.
- Practical Skills in Micropropagation.
- Application of Plant Biotechnological Methods.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Plant Tissue Culture and history:** Introduction and History of Plant Tissue Culture, Overview of the development and significance of plant tissue culture techniques, Laboratory Requirements and General Techniques: Essential laboratory setup and equipment, Standard procedures and protocols in plant tissue culture. **Tissue Culture Media:** Types of media used, including Murashige and Skoog (MS) and Gamborg media, Preparation methods and the role of different media constituents, Utilization of natural extracts in media	15	34%
2	**Cellular Differentiation and Totipotency:** Concepts of cellular differentiation and the totipotent nature of plant cells, Introduction to Micropropagation: Basics of micropropagation, Advantages and limitations of micropropagation techniques. **Micropropagation Techniques:** Direct organogenesis and its applications, Indirect organogenesis and its uses in plant culture	15	33%
3	**Molecular Tools for Crop Improvement:** Overview of molecular tools and their role in enhancing crop traits	15	33%

	Biotechnological Approaches: Methods for improving plant disease resistance through biotechnology, Strategies for enhancing abiotic stress tolerance in plants using biotechnological approaches.		

Course Outcome: After completion of this course, student will be able to

CO1: Understand the basics of plant Biotechnology and Plant tissue Culture.
CO2: Analyze the media formulation for Propagation of Plant *In-vitro*.
CO3: Understand concept of cellular differentiation and totipotency.
CO4: Apply Biotechnology concepts to the real-world scenario.

List of Text Books:

- Pandey, S. N., Trivedi, P. S. and Misra S. P. 2005. A Textbook of Botany Vol. I and II, Vikas Publishing House Pvt. Ltd.
- Text Book for Degree Students: Pteridophytes by Vasishta Sinha, S. Chand Publishers Delhi. 11.
- Text Book for Degree Students: Bryophytes by Vasishta Sinha, S. Chand Publishers Delhi.

List of Reference Books:

1. S.S. Bhojwani and M.K. Razdan, "Plant Tissue Culture: Theory and Practice", Elsevier Science, 1996.
2. H.S. Chawla, "Plant Biotechnology", Taylor and Fransis, 2010.
3. B.D. Singh, "Plant Biotechnology", MedTech Science Press, 2022.

Open e-Resource:

- https://onlinecourses.swayam2.ac.in/cec19_bt09/preview
- https://elearning.icar.gov.in/DisplayUG_ECoursesContent.aspx?CourseCode=!i9!ePIku/Cy/eJzcitMkQ==
- https://www.hortcourses.com/courses/botany-i-plant-physiology-and-taxonomy-255.aspx
- https://www.online.colostate.edu/courses/BZ/BZ440.dot
- https://www.udemy.com/course/plant-anatomy-systematics-and taxonomy/?couponCode=IND21PM
- https://www.eshiksha.mp.gov.in/mpdhe/course/view.php?id=335

List of Suggested Experiments:

- **Study of various tools:** Laboratory design, Laminar Air Flow, Autoclave, pH meter, Oven, Digital balance, Study of Artificial seeds through chart/Photograph, Study of cell and its organelles with the help of electron micrographs.

- **Cell Biology:** Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum, Demonstration of the phenomenon of protoplasmic streaming in

Hydrilla leaf, Measurement of cell size by the technique of micrometry, Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).

- **Demo Experiments for Plant Physiology:** Diffusion- Safranin or Potassium permanganate in water, ImbibitionDemonstration of Endosmosis, Exosmosis in grapes, Osmosis- Potato osmoscope, Plasmolysis- Tradescantia leaf, Transpiration- Four Leaf experiment.

- **Study of Algae:** Spirogyra: Mounting- Thallus, conjugation types, P.S. - Thallus and conjugations Nostoc: Mounting- Colony, P.S. – Colony.

- **Study of Fungi:** Mucor: Specimen- Bread/ Roti with Mucor, Mounting- Reproductive structure- spores, sporangia, PS- Mucor sporangia, Zygospores Agaricus: Specimen- - Plant body, Mounting- Reproductive structures, Basidiospores, PS- L.S of Stroma.

- **Study of Bryophytes-Riccia:** Specimen – Thallus (Gametophyte), P. Slides – Thallus v.t.s., thallus with Antheridia and Archegonia, Mounting: Sporophyte and Spore structure.

- **Study of Pteridophytes- Nephrolepis:** Specimen-Sporophytic plant, Mounting- Ramenta, Sori with sporangia arrangement, PS- Prothallus with Antheridia and Archegonia; T.S. leaflet passing through sorus.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-2

Subject Code: 10140203	**Subject Title:** General Chemistry-1 (Theory)
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) The main objective of the course is to develop the basic understanding of the chemistry.

(2) Students will gain the advance theories and methodologies to solving the problems in classroom and laboratory.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	70	30	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Periodic Properties of Element** Periodicity of Elements: Brief discussion of the following properties of elements, with reference to s- & p-block and the trends shown: (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic and ionic radii	11	27%
2	**Fundamental of Organic Reactions** Intramolecular forces (dipol-dipol interaction, Vander Waals forces) Electromeric effect, Inductive effect, Resonance effect, Hyper conjugation.	11	27%
3	**Liquid States** Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapor pressure, surface tension, coefficient of viscosity, friccohesity, their determination. Effect of various pollutants and solutes on surface tension and viscosity of water as a valuable resource. Explanation of cleansing action of detergents.	10	23%
4	**Basic concepts of Qualitative and Quantitative Analysis** Introduction, Solubility product principle, Common ion effect, Separation of cations of each groups and separation of anions (acid radicals),	10	23%

	Introduction of volumetric titration based on normality and morality of the solution, Conditions for volumetric analysis and types of titrimetric analysis.		

Course Outcome: After completion of this course, student will be able to

- This course will help to develop a solid foundation in the principles and applications of modern chemical and scientific ideas in the field of chemistry.
- Fundamental understanding of plan, conduct, and accurately record and analyze scientific experiments as well as their outcomes.
- Capable to applying analytical reasoning, critical thinking, and problem-solving skills to scientific issues.
- Effectively convey scientific findings to both scientists and the general audience in oral, written, and electronic mediums.
- Investigate novel chemistry-related and related scientific and technological domains.
- Recognize the significance of chemistry in society and utilize this to guide ethical behavior in matters involving chemists, such as knowledge of chemical handling safety, environmental concerns, and important societal issues involving energy, health, and medicine.
- Justify the importance of chemistry in solving social, economic, and environmental issues.
- Participate in multidisciplinary teams to solve problems.

List of text books:

1. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
2. Physical Chemistry for the life sciences by Peter Atkins, Oxford University Press.
3. Essential of Physical Chemistry by Bahl, Bahl, and Tuli, S. Chand and Co.

List of Reference Books:

1. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. P.W. Atkins: Physical Chemistry, Oxford University Press.
3. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
4. James E. Huheey *et al.*: Inorganic Chemistry: Principles of Structure and reactivity.
5. Cotton and Wilkinson. Advanced Inorganic Chemistry 3rd Ed. Wiley.

List of Suggested Experiments

1. Iodo/Iodimetric Titrations

   (i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).

   (ii) Estimation of antimony in tartar-emetic iodimetrically

2. Paper chromatographic separation of following metal ions:

   (i) Ni (II) and Co (II)

3. Inorganic preparations
4. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group

GANDHINAGAR
UNIVERSITY

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. /B.A.

Semester-2

Subject Code: 10170205	**Subject Title: Agriculture Business Management**
Pre-requisite: Candidate must have achieved regular 10+2 degree from any recognized Board.	

Course Objective: (1) To expose learners to the environment in which the agri-business is conducted.

(2) Focus will be on understanding micro and macro environmental forces and their impact on agri-business.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	Agri-business: Meaning, definition, history and scope of agri-business (Input, Farm Product Sectors). Importance of agri-business in the Indian economy. Changing dimension of agricultural business. Agri-business Management-distinctive features, nature and components.	15	25%
2	Structure of Agriculture - Linkages among sub-sectors of the Agribusiness sector; economic reforms and Indian agriculture; impact of liberalization, privatization and Globalization on Agri business sector. Emerging trends in production, processing, marketing and exports; policy controls and Regulations relating to the industrial sector with specific reference to agro-industries.	15	25%
3	Role of agriculture in Indian economy; problems and policy changes relating to farm Supplies, farm production, agro processing, agricultural marketing, agricultural finance etc. in the country. Demand and Supply: Definition, Meaning, Laws, Factor affecting, Types, Determinants. Elasticity: Definition, Types Natural Resource Economics.	15	25%

4	Agricultural Economics: Meaning, Definition, Scope and Importance of Agricultural Economics Basic Concepts: Goods, Services, Utility, Value, Price, Wealth, and Welfare, Consumption Wants: Meaning, Characteristics, Classification of Wants, Importance.	15	25%

Course Outcome: After completion of this course, student will be able to

1. Understand the fundamentals of management with reference to agribusiness.
2. Acquaint with various functional areas of agribusiness.
3. Study the managerial functions and its applications with reference to agribusiness.
4. Learn the concepts and process of Planning and Organizing.
5. Provides knowledge about the Staffing, Directing and Control.

List of Reference Books:

1. Freddie L. Barnard, Jay T. Akridge, Frank J. Dooley, Agribusiness Management (Environmental and Agricultural Economics), 2010.
2. John B. Penson, Oral Capps, C. Parr Rosson, Richard T. Woodward, Introduction to Agricultural Economics, Pearson, 2019.
3. W.J. Obst, R. Graham & G. Christie, Financial Management in Agribusiness, Scientific Publishers, 2010.

Gandhinagar University
UG/PG
Semester-II

Subject Code: IKS0201	Subject Title: Indian Ancient History and Cultural Heritage

Course Objective:

- Foster an appreciation for the composite nature of Indian history, culture and heritage.
- Instill a sense of love and belonging among learners, contributing to nation-building efforts.
- Provide an overview of various components of cultural heritage, including fairs, festivals, dances, art, architecture, and historical landmarks, which are crucial for a deeper understanding of history.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
01	0	2	02	0	25/ Project	25/ Project		50

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Credit**
1	**Indian Ancient History:** Introduction of Ancient India. Harappan Civilization. Rigvedic & Later Vedic Period. India in the 6th Century B.C. Persian and Greek invasions and its impact. Mauryan and Gupta Periods. Post – Mauryan. Brief History of the Sanskrit literature: The Vedas, The Brahmanas and Upanishads & Sutras, Epics: Ramayana and Mahabharata & Puranas.	15	1
2	**Indian Cultural Heritage:** Ethnic Indian Cultural Construct – Fairs & Festivals and their historical background. Indian dances as Cultural Heritage. Indian Architecture: Temples, Stupas, Caves, Chaityas. Medieval Architecture and Colonial Architecture. Social culture in India- Vedic culture. Ancient period- varna and jati, family and marriage in India, position of women in ancient India, Contemporary period; caste system and communalism.	15	1

Course Outcome: After completion of this course, students will be able to

- Demonstrate knowledge of the key events, periods, and figures that have shaped Indian history from ancient to modern times, including their impact on the socio-political and economic landscape.
- Analyze the rich cultural heritage of India, including art, architecture, literature, and philosophy, while recognizing the contributions of various communities to India's pluralistic society.

List of Text Books:

1. An advanced history of India – causes and decline of Guptas by B.C. Majumdar and others, 1967, Macmillan.
2. Ancient India by R.C. Majumdar, 1977, Motilal Banarasi Das.
3. History of Ancient India by Rama sankar Tripati, 1942, Motilal Banarasi Das.
4. History and culture of India to 1000 A.D. by H.V. Srinivasa Murthy, 1980, S. Chand and Co.
5. History of South India by K.A. Nilakanta Sastry 1976, Oxford University Press.
6. History of Ancient India by Krishnaswamy Aiyangar, 1980, Seema Publishers.
7. Ancient India by V.D. Mahajan, 1985, S.Chand and Company.
8. Advance History of India by K.A. Nilakantasastry and C.S.Srinivasachari, 1980, Allied Publishers.
9. Ancient Indian History and Civilization by Silendranath Sen, 1988, Wiley Eastern.
10. Lothal and Indus Civilizations by S.R.Rao, 1972, Asia Publishers, Madras

Gandhinagar Institute of Science
Bachelor of Science - Biotechnology
Semester-III

Subject Code: 101170301	Subject Title: Molecular Biology

Pre-requisite:

- Basic understanding of Cell Biology (structure and function of organelles)
- Knowledge of Biomolecules (DNA, RNA, proteins)
- Familiarity with **Genetics** and Mendelian principles
- Elementary concepts in **Biochemistry** (enzymes, metabolism)

Course Objective:

- To understand the molecular mechanisms of genetic information storage, transmission, and expression.
- To explore the processes of DNA replication, repair, transcription, translation, and gene regulation.
- To examine the experimental techniques used in studying nucleic acids and gene expression.
- To relate molecular biology to Biotechnological applications and genetic engineering.
- To develop laboratory skills related to DNA/RNA analysis and gene function studies.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Molecular Basis of Genetic Material:** Overview of **Mendelian Experiments**: Laws of Segregation and Independent Assortment, Extension of Mendelian genetics: incomplete dominance, co-dominance, multiple alleles, gene interactions, DNA as genetic material: Griffith, Avery, Hershey–Chase experiments, Structure of DNA and RNA (Watson & Crick model, types of RNA), Denaturation, renaturation, and hybridization of DNA, DNA topology: supercoiling, linking number, Types of genomes: prokaryotic vs. eukaryotic, mitochondrial and chloroplast DNA, Replication of DNA	15	34%
2	**Gene expression and regulation:** 1. Fundamentals: A. Central Dogma: The flow of genetic information B. Structure of the protein coding gene	15	33%

	2. Transcription: A. Initiation: Role of Promoter, RNA polymerase, Sigma factor B. Elongation C. Termination: Rho independent and Rho dependent D. Intron, Exon, Cistron and Polycistronic mRNA 3. Genetic code: Triplet nature, Polarity, Degeneracy, Wobble phenomenon, near universality. 4. Translation: A. Initiation: role of initiation factors, 70 S initiation complex B. Elongation: binding of AA-tRNA to A site, peptide bond formation, translocation C. Termination: role of release factors. 5. Regulation of gene expression: A. Negative inducible control of lactose operon B. Catabolite repression and positive control of lactose operon C. Negative repressible control of tryptophan operon		
3	**DNA Mutation, Repair and Molecular Biology Techniques:** Mutation and its Types; Transposable elements; DNA repair and its mechanisms DNA and RNA isolation and quantification, Agarose gel electrophoresis, Polymerase Chain Reaction (PCR) – principle and applications, RT-PCR, Types of blotting, Introduction to Cloning-vectors (Plasmids, Phage, Cosmid) and cloning techniques. Applications of molecular Biology (Medical, Agricultural, Environmental and Industrial)	15	33%

Course Outcome: After completion of this course, student will be able to

CO1: The basic concepts and importance of molecular biology and how nucleic acids were proved to be the genetic material.
CO2: The DNA and RNA structure was well as genome organization.
CO3: The mechanism of replication, recombination and repair.
CO4: How RNA and Protein Synthesis takes place.
CO5: How gene expression is regulated.

List of Text Books:

• Alberts, B. et al. – Molecular Biology of the Cell, Garland Science.
• Lodish, H. et al. – Molecular Cell Biology, W.H. Freeman.
• Prescott, Harley, and Klein's Microbiology, J. M. Willey, L. M. Sherwood, C. J. Woolverton, 7th Edition (2008), McGraw Hill Higher Education- USA.
• Principles of Microbiology, R. M. Atlas, 2nd Edition (Indian Edition) (2015), McGraw Hill Education (India) Private Limited –New Delh

List of Reference Books:

• Essential of Molecular Biology by David Freifelder, 2015.
• DNA Science by David A. Micklos, 2007.

• Genes XI by Benjamin Lewin, 2012.
• Genomes 3 by TA Brown, 2006.
• Molecular Biology of the Cell by Bruce Alberts, 2008.
• Principles of Genome Analysis by SB Primose, 2002.
• Stanier RY, Ingraham JL, Wheelis ML and Painter PR (2005) General Microbiology 5th edition,
• Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene,6th edition, Cold Spring Harbour Lab. Press, Pearson Publication, ecker WM, Kleinsmith LJ.

Open e-Resource:

• NCBI Molecular Biology Resources – https://www.ncbi.nlm.nih.gov
• YourGenome.org (Sanger Institute) – https://www.yourgenome.org
• Cold Spring Harbor Molecular Biology Resources – https://www.cshl.edu
• MIT OpenCourseWare (Biology) – https://ocw.mit.edu
• iBiology Video Lectures – https://www.ibiology.org

List of Suggested Experiments:

1. Isolation of Genomic DNA from bacterial/plant cells
2. Quantification of DNA/RNA using spectrophotometer (A260/A280 ratio)
3. Agarose Gel Electrophoresis for DNA separation
4. Restriction Digestion of DNA and analysis by gel electrophoresis
5. Polymerase Chain Reaction (PCR) – amplification of a target DNA segment
6. Preparation of Competent Cells and bacterial transformation (simulation if needed)
7. Demonstration of Southern, Northern or Western blotting (simulation/video-based)
8. Observation of DNA denaturation-renaturation cur

Gandhinagar Institute of Science
Bachelor of Science – Biotechnology
Semester-III

Subject Code: 101170302	Subject Title: Fundamentals of Marine Biology
Pre-requisite: Students should have a basic understanding of biology, including ecology and animal diversity, before studying Fundamentals of Marine Biology.	

Course Objective:

- To introduce students to the physical, chemical, and biological characteristics of marine environments.
- To provide knowledge of marine biodiversity and adaptations of organisms to oceanic conditions.
- To understand ecological interactions and energy flow within marine ecosystems.
- To examine human impacts on marine life and explore strategies for marine conservation and sustainable use.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Marine Biology:** Definition, scope, and importance of marine biology, Historical development and major discoveries in marine science, Characteristics of marine ecosystems, Classification of marine environments: pelagic, benthic, neritic, oceanic, intertidal zones; Physical and chemical properties of seawater (temperature, salinity, pH, oxygen, nutrients). **Marine Biodiversity and Adaptations:** Classification of marine organisms: plankton, nekton, benthos; Marine microbes: bacteria, archaea, and phytoplankton; Major marine phyla: Porifera, Cnidaria, Mollusca, Arthropoda, Echinodermata, Chordata; Adaptations in marine organisms: pressure, salinity, light, and locomotion; Coral reefs and their biodiversity.	15	34%
2	**Marine Ecology and Ecosystem Dynamics:** Trophic levels and food chains in the marine environment; Nutrient cycles (carbon, nitrogen, and phosphorus cycles in oceans).	15	33%

	Primary productivity in marine ecosystems: Symbiotic relationships (mutualism, commensalism, parasitism); Impact of ocean currents, upwelling, and thermohaline circulation on marine life; Culture of marine organisms (Brackish Water Fishes - Mullet, Milkfish, Etroplus/ Culture of Shrimps/Culture of Edible Oysters/Pearl Oyster Culture/Culture of Edible Mussels).		
3	**Human Impact and Marine Conservation:** Marine pollution: oil spills, plastics, heavy metals, eutrophication; Climate change and ocean acidification; Overfishing and its ecological impact; Marine protected areas (MPAs) and biodiversity conservation; Laws and organizations: UNCLOS, IUCN, MARPOL, NOAA, WWF (marine programs).	15	33%

Course Outcome: After completion of this course, student will be able to

CO1: Describe the physical, chemical, and biological features of marine ecosystems.
CO2: Identify and classify various marine organisms and explain their structural and functional adaptations.
CO3: Analyze ecological relationships and nutrient cycles within marine environments.
CO4: Evaluate the impact of human activities on marine ecosystems and propose conservation strategies.

List of Reference Books:

- Aquaculture Biotechnology, First edition, 2012, Eds. Garth L. Fletcher and Mathew L Rise, Wiley-Blackwell publication.
- Aquaculture Biotechnology, V. Ramachandran, 2013, Black Prints
- Aquaculture –Principles and Practices, 1990 – TVR Pillay, Fishing Nets Books.
- Bhakuni, D.S., and Rawat, D.S., (Eds.), 2005, Bioactive Marine Natural Products, Springer, Anamya Publications, New Delhi.
- Introduction to the Biology of Marine Life by John Morrissey & James Sumich.
- Jefford, Rinehart, Sheld, 1988, Pharmaceuitcals and the Sea,. Technomic Publishing Co., AG Pensylvana, USAMarine Biology: Function, Biodiversity, Ecology by Jeffrey S. Levinton.
- Marine Biology – An ecological approach, 1988 – James W. Nybken, Harper Collins publication
- Marine Ecology: Processes, Systems, and Impacts by Michel Kaiser et al.

Open e-Resource:

- https://onlinecourses.swayam2.ac.in/cec23_bt22/preview?utm
- https://archive.nptel.ac.in/courses/120/108/120108002/?utm

List of Suggested Experiments:

- Estimation of Salinity and pH of Seawater.
- Determination of Dissolved Oxygen (DO) in Seawater.
- Identification of Marine Organisms (Charts/Models/Preserved Specimens).
- Study of Marine Food Web using Case Examples.
- Coral Reef Identification Using Charts or Videos.
- Simulation/Demonstration of Ocean Acidification.

Gandhinagar Institute of Science
B.Sc. Semester III

Subject Code: 10170306	**Subject Title:** Fundamental of Biochemistry
Prerequisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidates must have studied core subjects like Chemistry and Biology at their Higher Secondary level and he/she may have completed a Certificate Course (First Year, B.Sc.) with Basic Microbiology and Chemistry subjects.	

Course Objective:

1. To introduce the students about basic knowledge of biomolecules like Protein, Carbohydrates, Lipids, their interaction and bonding.
2. To impart knowledge regarding significance & various applications of biomolecules.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credit**	**Theory**		**Practical**		**Total**
				University Assessment	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	
3	**0**	**2**	**4**	**50**	**50**	**25**	**25**	**150**

Subject Contents			
Sr. No	**Topics**	**Total hours**	**Weight (%)**
1	**Basic bioenergetics & Thermodynamics** ● Chemical bonds and Stabilizing interactions: Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, Free radical reaction, Isomerization, oxidation-reduction reactions. ● Structure and properties of water ● pH and buffer: pH and buffer and buffering against pH changes in biological systems. ● Energy flow: Basic introduction to laws of thermodynamics, Gibb's free energy and chemical potential, Enthalpy & Entropy and relation between them.	**10**	**20 %**
2	**Energy metabolism** ● Energy rich compounds: Phosphoenolpyruvate, 1,3-Bisphosphoglycerate, Thioesters, ATP. ● Introduction to metabolism, Methods of studying intermediary metabolism ATP (Structure, generation, & role. ● Modes of ATP generation in bacteria Oxidative phosphorylation - ETC - components and organization.	**10**	**20 %**

	● Mechanism of Oxidative phosphorylation, ATP synthase Fermentation and substrate level phosphorylation Bacterial photophosphorylation		
3	**Carbohydrate, Lipid & fatty acid** ● Introduction to carbohydrate, classification, properties of monosaccharide, osazone formation, mutarotation. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen), bacterial cell wall polysaccharide, Glycoprotein's and their biological functions. ● **Lipid:** Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Introduction to lipid micelles, monolayers and bilayers. Biological function of lipid. ● Fatty acid, - Introduction, Nomenclature and classification of fatty acid Essential and non-essential fatty acids.	**12**	**30 %**
4	**Amino acids and protein**. ● Introduction to amino acid, structure, classification of protein based on polarity. Properties (physical, chemical) Titration of amino acid. ● Essential and non-essential amino acid. Amino and sequencing (EDMan and Sangar method). ● Protein Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond – Structure of peptide bond. Denaturation – renaturation of protein, properties of protein. ● Introduction to lipoprotein, glycoprotein and nucleoprotein. Biological function of protein (Protein structure) Protein structure - Primary, secondary / tertiary and quaternary, Ramchandran plot, β – turns and motif.	**13**	**30 %**

Course Outcome: After completion of this course, student will be able to

1) Fundamental concept of Biochemistry & Thermodynamics
2) Significance and mode of energy generation
3) Biomolecules, their types and their role
4) Students will be able to appear and qualify for competitive exams like NET, GSET, and GATE. They will be skilled enough to join any research institute, Biopharma industry or even start ventures of their own.

Open e-resource

● Swayam Portal: General Microbiology - Course (swayam2.ac.in)
● OpenStax: Microbiology – OpenStax
● https://www.microbenotes.com
● https://pll.harvard.edu/course/principles-biochemistry-1
● https://www.futurelearn.com/courses/biochemistry

- https://www.edx.org/learn/biochemistry

List of Textbooks:

· "Lehninger Principles of Biochemistry", David L. Nelson & Michael M. Cox. 4th edition, W.H. Freeman & Co.

· "Microbiology", by Prescott, L.M. Harley, J.P. Klein, D.A.," International edition", 5th edition, 2003, McGraw– Hill Publications, New York.

List of Reference Books:

- Bering, Charles L. "Biochemistry (Zubay, Geoffrey)." 4th Edition, (1989).
- Carl Branden, Carl Ivar, and John Tooze. "Introduction to Protein Structure: Second Edition, Garland Science, (2012).
- Creighton, Thomas E. Proteins: Structures and Molecular Properties. Macmillan, 1993.
- Dr. C. B. Powar and Dr. H. F. Daginawala, (2010), General Microbiology Volume-I. 2nd edn. Himalaya Publishing House.
- Fundamentals of biochemistry- Life at the molecular level By: Voet, Voet and Pratt, Second edition, 2006.
- "Principles of Microbiology", by Atlas R.M., 1st edition, 1995, Mosby–YearBook Inc. St. Louis, Missouri.
- Stanier, R.Y., Ingraham J. L., Wheelis, M. L. (1999). General Microbiology,5th Edition, Palgrave Macmillan.
- U. Satyanarayan & U. Chakrapani, "Biochemistry", Forth Edition. (2013).
- Wilson, Jerry L. "Biochemistry - Stryer, Lubert)". 1988.

List of Suggested Practical

1. Preparation of different standard solutions.
2. Qualitative analysis of Carbohydrates.
3. Qualitative analysis of Proteins.
4. Estimation of reducing & non reducing sugar using Cole's method.
5. Estimation of sugar by Nelson Somogyi method.
6. Estimation of amino-acid using ninhydrin method.
7. Estimation of protein using Folin lowry method.
8. Quantitative analysis of Lipid by Bligh and Dyer's method.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc.

Semester-III

Subject Code: 10170308	**Subject Title:** Astrology-II
Pre-requisite:	

Course Objective:

1. **To study the traits and scientific aspects of planets, signs, houses, and aspects with critical thinking.**
2. **To build skills in natal chart reading using concepts from prediction, psychology, and neuroscience.**

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Planets** Introduction Characteristics Scientific aspects	10	23%
2	**The Zodiac: Understanding the 12 Signs** Introduction Characteristics Relative analysis with Science	11	27%
3	**Houses and Aspects** Introduction Characteristics Critical Thinking & Skepticism	11	27%
4	**Reading a Natal Chart** Introduction Characteristics Prediction, Psychology and Neuroscience	10	23%

Course Outcome: After completion of this course, students will be able to

1. Understand the traits and scientific aspects of planets, signs, houses, and aspects.
2. Analyze zodiac signs from both traditional and scientific viewpoints.
3. Use critical thinking to evaluate houses and other astrological concepts.

4. Interpret natal charts using astrology, psychology, and neuroscience.

Textbooks

1. "Planets in Transit" by Robert Hand
2. "The Only Astrology Book You'll Ever Need" by Joanna Martine Woolfolk
3. "Astrology for the Soul" by Jan Spiller

Reference Books

1. "Cosmos and Psyche" by Richard Tarnas
2. "Aspects in Astrology" by Sue Tompkins
3. "The Inner Sky" by Steven Forrest
4. "Psychological Astrology: A Synthesis of Jungian Psychology and Astrology" by Karen Hamaker-Zondag
5. "Houses: Temples of the Sky" by Deborah Houlding

Gandhinagar Institute of Science
Bachelor of Science – Biotechnology
Semester-IV

Subject Code: 101170401	Subject Title: Vaccine Technology
Pre-requisite: Students should have a foundational understanding of microbiology, immunology, molecular biology, and genetic engineering techniques before taking the Vaccine Technology course.	

Course Objective:

- To understand the principles of immunology and their application in vaccine development.
- To explore various types of vaccines, including traditional and modern technologies.
- To study the processes involved in vaccine design, production, testing, and regulation.
- To analyze the role of vaccines in public health and emerging strategies for combating infectious diseases.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Basics of Immunology and Vaccinology:** Introduction to Immunity, Types of immunity: Innate and Adaptive, Cells and organs of the immune system, Antigen, antibody, epitopes, adjuvants; Principles of Vaccination, Active and passive immunization, Herd immunity and booster doses, History and development of vaccines (Edward Jenner to mRNA vaccines) **Antigen-Antibody Interaction:** Structure and Types of antibodies (IgG, IgM, etc.), Antigen Types and Determinants; Monoclonal vs Polyclonal Antibodies, Hybridoma technology for monoclonal antibody production; Advantages and applications in vaccines and therapeutics.	15	34%
2	**Types of Vaccines and Production Technology:** Types of Vaccines, Live attenuated vaccines, Inactivated (killed) vaccines, Toxoid vaccines, Subunit and conjugate vaccines, Recombinant vector vaccines, DNA and mRNA vaccines **Vaccine Development Process:** Antigen selection, Expression systems (bacterial, yeast, mammalian), Purification and formulation of vaccines, Role of adjuvants and stabilizers; Quality Control and Safety, Preclinical testing,	15	33%

	Clinical trial phases (I–III), Regulatory approvals (DCGI, WHO, FDA overview).		
3	**Applications and Emerging Trends:** Vaccines in Public Health, Immunization programs (UIP, WHO-EPI), Pediatric and adult vaccination schedules in India, Eradication of diseases through vaccines (e.g., polio, smallpox). **Vaccine Storage and Delivery:** Cold chain management, Routes of administration (oral, intramuscular, intradermal), Needle-free technologies and nasal sprays. **Modern Vaccine Strategies:** mRNA vaccines (COVID-19 vaccine covishield and covaxin); Reverse vaccinology and synthetic biology in vaccine design; Challenges in vaccine development for diseases like HIV, TB, malaria.	15	33%

Course Outcome: After completion of this course, student will be able to

CO1: Understand the fundamental concepts of immunology and the mechanism of vaccine-induced immunity.

CO2: Describe various types of traditional and modern vaccines along with their methods of development and production.

CO3: Analyze the role of vaccines in disease prevention, public health, and immunization programs.

CO4: Apply knowledge of vaccine storage, delivery, and emerging technologies in addressing global health challenges.

List of Text Books:

- "Immunology" by Kuby, Kindt, Osborne, and Goldsby, *Publisher:* W. H. Freeman and Company
- "Plotkin's Vaccines" by Stanley A. Plotkin, Walter A. Orenstein, Paul A. Offi, *Publisher:* Elsevier.
- "Vaccines: A Biography" by Stanley A. Plotkin, *Publisher:* Academic Press.

List of Reference Books:

- **Vaccinology: Principles and Practice, Editors:** W. John W. Morrow, Matthew L. Albert, Michel De Wilde, **Publisher:** Wiley-Blackwell
- **Vaccine Development and Manufacturing, Author:** Emily P. Wen, Ronald Ellis, Narayanan Subbarao, **Publisher:** Wiley

Open e-Resource:

- https://archive.nptel.ac.in/courses/102/105/102105083/?utm
- https://onlinecourses.nptel.ac.in/noc25_bt58/preview?utm

List of Suggested Experiments:

- Perform Blood Grouping using Agglutination Reaction.
- Ouchterlony Double Immunodiffusion Test.
- Estimation of Antibody Titer in Serum using Indirect ELISA.
- Demonstration of Inactivated Bacterial Vaccine Preparation.
- Widal Test for Detection of Typhoid Antibodies.

Gandhinagar Institute of Science
B. Sc. Microbiology/Biotechnology
Semester IV

Subject Code: 10170405	**Subject Title: Immunology-I**
Prerequisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Chemistry and Biology at their Higher Secondary level and he/she may have complete Certificate Course (First Year, B.Sc.) with Basic Microbiology and Chemistry subjects.	

Course Objective:

1. To introduce the students about basic knowledge of Immunity, its types and immune response via different mechanisms, immune disorders and diagnostic techniques.

2. The course also includes the methodology and technical aspects to provide comprehensive knowledge of the subject.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credit**	**Theory**		**Practical**		**Total**
				University Assessment	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	
03	**-**	**02**	**04**	**50**	**50**	**25**	**25**	**150**

Sr. No.	**Topic**	**Total Hours**	**Weight %**
1	**Introduction to Immunology** Concept of Innate and Adaptive Immunity **Innate immunity**: species, racial and individual **Acquired immunity**: Active and Passive, natural and artificial **Nonspecific and specific immunity** **Contribution of following scientists** to the development of field of Immunology-Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jene, Rodney Porter and Susumu Tonegawa **Immune cells** Composition of the Human blood: Types of white blood cells Stem cells	**11**	**25 %**

	Types of Lymphocytes: T cells and B cells, NK cell, **Antigens Presenting cells**: Macrophage, Neutrophil, Dendritic cell **Immune Organs**: Bone marrow, Thymus, Lymph node, Spleen, GALT, MALT, CALT		
2	**Antigens** Concepts of antigen, immunogen, hapten, epitope Physico-chemical and biological properties of antigen Adjuvant and its types, Types of antigens, bacterial antigens **Antibodies** Concept of antibody, immunoglobulin, myeloma protein Basic structure of antibody **Classes of antibody:** Physico-chemical and biological properties, Antigenic determinants on antibodies (Isotypic, Allotypic, idiotypic) **Antibody diversity** **Monoclonal antibodies:** Production using hybridoma technology and its applications	**11**	**25%**
3	**GENERAL IMMUNE RESPONSE:** Concept and basic functions **Humoral (Plasma and memory cells) and cell mediated** immune response (Self MHC restriction, T cell activation, Co-stimulatory signals). Killing mechanisms by CTL and NK cells. Introduction to tolerance. **Characteristics of IR:** Discrimination, diversity, specificity, memory and transferability Primary and Secondary immune response **Mechanism of antigen-antibody reactions:** zone phenomenon and lattice formation **Principles, types and applications of an in vitro antigen-antibody reactions:** Precipitation reaction, Agglutination reaction, complement fixation reaction, Immunofluorescence **Advanced antigen-antibody reactions:** Enzyme linked immunosorbent assay (ELISA) ELISpot, Radio immunoassay (RIA), Radio-Allergo-Sorbent test (RAST), Flowcytometry, Western blot, Skin test	**11**	**25%**
4	**Immune disorders** Immune disorders: hyper and hypo functioning of immune system Hypersensitivity and its types Autoimmunity and autoimmune disorders Immunodeficiency- Chediak-Higashi syndrome, Leukocyte adhesion deficiency Tumor immunity immunosuppression **Transplantation and graft rejection.**	**12**	**25 %**

	Prophylactic Immunization: Principles of vaccination, Types of Vaccines, Schedule of Vaccination, Hazards of Vaccination		

Course Outcome: After completion of this course, student will be able to

CO 1. This course is designed to enable students to acquire understanding of the structure of immune system, its functions, cells and organs involved in immunity.
CO 2. This course will give insight about different types of antibodies, their interaction, production and types of immune response.
CO 3. It helps them to get knowledge of various immunoreactions and immunodiagnostic techniques.
CO 4. The awareness of the immune system will help them for further work in the field of vaccine.

References

1. Prescott, Harley, and Klein's Microbiology, J. M. Willey, L. M. Sherwood, C. J. Woolverton,7th Edition (2008), McGraw Hill Higher Education- USA
2. R. M. Atlas, Principles of Microbiology, 2nd Edition (Indian Edition) (2015), McGraw Hill Education (India) Private Limited –New Delhi
3. Baker F J, Silverton, R E, Pallister C J, Baker and Silverton's Introduction to Medical Laboratory Technology, 7th edition (1998), Butterworths-Heinemann, Oxford, UK
4. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition. W.H. Freeman and company, New York.
5. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
6. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology, Saunders Publication, Philadelphia.
7. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). *Roitt's essential immunology*. John Wiley & Sons.
8. Peakman M, and Vergani D. (1993). Basic and Clinical Immunology. Churchill Livingstone Publishers, Edinberg

Open e-Resource

https://onlinecourses.swayam2.ac.in/cec24_bt09/preview
https://www.immunopaedia.org.za/immunology/
https://pll.harvard.edu/course/hmx-immunology
https://www.coursera.org/courses?query=immunology
https://onlinecourses.nptel.ac.in/noc21_bt49/preview
https://alison.com/course/introduction-to-immunology-revised

List of Suggested Practical

1. Separate serum from the blood sample (demonstration).
2. Study of agglutination reaction: Widal test by slide agglutination, Dreyer's technique & double dilution method.
3. Study of precipitation reaction: Rapid plasma regain (RPR) method.
4. Detection of HBsAg using ELISA test.
5. Determination of human blood group: ABO and Rh systems.
6. Estimation of hemoglobin by Sahli's acid hematin method.
7. Total count of erythrocytes (RBC).
8. Total count of leucocytes (WBC).
9. Differential count of leucocytes by Field's method
10. Bleeding time
11. Clotting time
12. Immunodiffusion techniques.
13. Immunoelectrophoresis.

Gandhinagar Institute of Science
Bachelor of Science - Microbiology/ Biotechnology/ Food Nutrition and Dietetics
Semester-4

Subject Code: 101170402	**Subject Title: Cancer Biology**
Pre-requisite: Candidate must have studied core subjects like Chemistry and Biology at their Higher Secondary level and he/she may have knowledge of with Basic Microbiology and Chemistry subjects.	

Course Objective:

- This Cancer Biology course provides students an understanding of the disease processes involved in malignancy and the scientific rationale for therapeutic options.
- Students will be trained in scientific research methods and learn the techniques used in cell and molecular biology and pathology.
- Students will study the biology of disease, tumor biology, immunology, molecular oncology, hematological malignancy, plus diagnostic and therapeutic techniques for cancer.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction:** Cell types (prokaryotes/ eukaryotes), cell organelles, cell wall, cell membrane, cytoplasmic organelles, structure of nuclear envelope, nuclear pore, complex, transport across envelope, regulation of nuclear import. **Protein trafficking:** Targeting proteins to endoplasmic reticulum, signal recognition particle, signal recognition particle receptor, protein folding and processing in ER, protein export from ER, Protein sorting and export from golgi apparatus; SNARE hypothesis; Protein import into Mitochondria, Import and sorting of chloroplast protein.	11	25%
2	**Cytoskeleton:** Structure and organization of cell skeleton; Microfilaments and Microtubule-structure and assembly, actins, myosin muscle contraction, cilia, flagella-structure and function.	11	25%
3	**Cell signaling:** Cell-cell interaction, modes of cell signaling, steroid hormone receptors, peptide hormones and growth factor, plant hormones, G-protein	11	25%

	coupled receptors; receptor –protein tyrosine kinase, c- AMP pathway of signal transduction; c GMP, phospholipids and calcium ions, MAP kinase pathway, JAK – STAT pathway, Integrin signaling, Hedgehog and Wnt pathways.		
4	**Cell division and cancer biology Cell Cycle:** Interphase and M phase (mitosis and meiosis), Cell cycle regulation, checkpoints in cell cycle; regulators of cell cycle, Apoptosis: intrinsic and extrinsic pathways. Cancer biology: types of cancer; development of cancer, cells; Oncogenes, protooncogenes, function of oncogene products, tumor suppressor genes, function of tumor suppression gene products, role of oncogene and tumor suppressor gene in development, molecular diagnosis of cancer.	12	25%

Course Outcome: After completion of this course, student will be able to

CO1: Identify the main cellular mechanisms leading to initiation and progression of cancer growth. Describe the characteristics of cancer cells that explain high mortality rate.
CO2: Define the role of oncogenes and mutations in cancer and explain why several types of cancer have heritable traits and family history.
CO3: Discuss the cellular signaling pathways that are deregulated in tumor cells compared to normal cells.
CO4: Define the main factors contributing to metastatic growth. Identify the role of stem-like cells, their properties and contribution to tumor progression. List and describe the main factors controlling the evolution of cancer cell populations.
CO5: Develop a solid understanding of the main methods used in the modern studies of cellular and molecular mechanisms of cancer.

List of Text Books and Reference Books:

- Cell and molecular biology by Gerald Karp
- Cell biology by Pollard and Earnshaw
- Molecular Biology by Lodish, Darnell and Baltimore
- Molecular Biology of the gene by Watson et al 4th ed.
- Molecular Cell Biology by Bruce Albert

Open e-Resource:

- Best Cancer Biology Courses Online with Certificates [2024] | Coursera
- Cancer Biology Certificate Course - BioGrademy
- Cancer Biology Specialization [3 courses] (Johns Hopkins) | Coursera
- Free Course: Introduction to the Biology of Cancer from Johns Hopkins University | Class Central
- Cancer Biology Certification Course — BioTecNika Store

List of Suggested Experiments:

1. Microscopic examination of cell division and stages.
2. Qualitative estimation of cell wall properties by histo-chemical staining.
3. Isolation and separation of cell organelles and their assay.
4. Preparation of Minimal Essential Growth media.
5. Preparation of Hank's Balanced Media

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-4

Subject Code: 10140406	**Subject Title:** Organic Chemistry-2
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective: (1) They will gain proficiency in logical deduction skills through written problems and laboratory work.

(2) They will identify problems and generate hypotheses, develop and implement experimental methods to test their hypotheses, and analyze and interpret the resulting data.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Alcohol:** Preparation, Pinacol-Pinacolone rearrangement. Phenols: Preparation and properties; Acidity and affecting factors, Ring substitutionreactions, Reimer– Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements and their mechanism.	10	23%
2	**Carbonyl Compounds:** Nucleophilic additions, Nucleophilic addition-elimination reactions, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, Friedel-Crafts reaction.	11	27%
3	**Carboxylic acids:** General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength, hydroxy acids and unsaturated acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides	11	27%
4	**Carbohydrates** Saccharides, structure of Glucose, Fructose, (+) maltose, (+) cellobiose, (+) lactose and (+) sucrose. Synthesis of carbohydrates, Physical and Chemical Properties of Carbohydrates.	10	23%

Course Outcome: After completion of this course, student will be able to

- Understanding major concepts and different aspects of organic chemistry.
- Understanding and defining various topics of organic chemistry in broader sense like: basic principles, reaction mechanism, stereochemistry, nomenclature, estimation and purification of organic compounds.
- Understanding an overview of application of organic chemistry.
- Applying chromatographic method of separation and qualitative analysis functional groups in organic compounds.
- Evaluating distribution co-efficient of a compounds between two immiscible solvents.
- Function as a member of an interdisciplinary problem-solving team.

List of Text Books:

1. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
2. Chandra, R.; Singh, S.; Singh, A. (2019), Basic Organic Chemistry, Arcler Press.

List of Reference Books:

1. Finar, I. L. Organic Chemistry (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Eliel, E. L.; Wilen, S. H. (1994) Stereochemistry of Organic Compounds; Wiley: London.
3. Singh, S.P.; Prakash, O. (2017), Reaction Mechanism in organic chemistry, Laxmi Publications.
4. Stereochemistry Conformation and Mechanism 7th Edition by P.S. Kalsi; New Age International (P) Ltd.

List of Suggested Experiments (Max. 12)

Short organic preparation and their purification: Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product.

Preparation of organic compounds

1. Glucosazone from dextrose or fructose
2. Tribromoaniline from aniline.
3. β-Naphthylbenzoate
4. m-Dinitrobenzene from nitrobenzene
5. Phthalic anhydride from phthalic acid by sublimation
6. Acetanilide from aniline
7. p-Bromoacetanilide from acetanilide
8. Iodoform from acetone

Gandhinagar University
UG/PG
Semester- IV

Subject Code: IKS0401	Subject Title: Indian ancient Science and Philosophy

Course Objective:

- Foster an appreciation for the composite nature of Indian history, culture and heritage.
- Instill a sense of love and belonging among learners, contributing to nation-building efforts.
- Provide an overview of various components of cultural heritage, including fairs, festivals, dances, art, architecture, and historical landmarks, which are crucial for a deeper understanding of history.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
01	0	2	02	0	25/ Project	25/ Project		50

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Credit**
1	**Ancient Science And Technology In India:** Development of science in ancient India (Astronomy, Mathematics, Medicine, Metallurgy, Chemistry) **Scientists of Ancient India and their contribution:** Mathematics & astronomy (Baudhayan, Aryabhatta, Brahmgupta, Bhaskaracharya, Mahaviracharya) Science (Kanad, Varahamihira, Nagarjuna) Medical science in ancient india (Susruta, Charak, Yoga & Patanjali)	15	1
2	**Indian Philosophical Systems:** Characteristics of Indian Philosophy, Pramanas, General Introduction to Indian Philosophical systems, i.e. Orthodox and Heterodox. Tenet of Nyaya philosophy, Principles of Vaisesika. Indian preaching on dharma, artha and Society- Bhagavadgita, Arthasastra, Gurukula systems, Nalanda, Takṣasila,	15	1

Course Outcome: After completion of this course, students will be able to

- Develop the ability to critically examine ancient sciences of India and narratives to understand the science and technology in ancient India.
- Develop a comprehensive understanding of the key characteristics of Indian philosophical systems.

List of Text Books:

1. An advanced history of India by B.C Majumdar & others, 1967, Macmillan
2. Ancient India by R.C. Majumdar, 1977, Motilal Banarsidas
3. History of Ancient India by Ram Shankar Tripati, 1942, Motilal Banarsidas
4. History and culture of India to 1000 A.D. by H.V. Srinivasamurthy, 1980, S.Chand & Co.
5. Advance history of India by K.A. NIlakanta Sastry & C.S. Srinivasachari, 1980, Allied Publications.
6. Ashoka, V.A. Smith, 1970, Oxford University Press.
7. Society, Religion & Art of Kushana India, Kanchan Chakraberti, 1930, Bagchi & Co.,
8. Ancient India by Romila Thapar, 2002, Oxford University Press, Delhi
9. Understanding Harappan civilization by Shereen Ratnagarh, Tulika Publication, Delhi

Gandhinagar Institute of Science
B.Sc. Biotechnology
Sem-V

Subject Code: 101170501	**Subject Title: Animal Cell Culture**
1. **Pre-requisite:** Students should have a basic knowledge of **cell biology, Microbiology, and laboratory sterilization techniques** is required to understand animal tissue culture.	

Course Objective:

- To understand the principles and concepts of animal tissue culture techniques.
- To learn the design of cell culture laboratories and aseptic handling methods.
- To study the establishment, maintenance, and preservation of animal cell cultures and Transgenic animals.
- To understand the applications of animal cell culture in biotechnology, medicine, and research.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Animal Tissue Culture** History and development of animal cell culture, Scope and importance of animal tissue culture in Biotechnology, Basic principles of animal cell and tissue culture, Structure and characteristics of animal cells in culture, Types of animal cell culture: primary culture, secondary culture, continuous cell lines, Advantages and limitations of animal cell culture. Media for culturing cells and tissues - Chemically defined and serum free media for cell culture; Sterilization of various equipment's and apparatus; Subculture and propagation; Cloning and selection; Cell separation and Characterization.	15	25%

2	**Cell Culture Methods and Maintenance** Animal cell culture; types and methods - Development of cell lines; Development and Maintenance. Establishment of primary cell culture, Cell lines and cell strain development, Subculturing (passaging) techniques, Cell growth curve and factors affecting cell growth, Cell counting methods (haemocytometer, viability tests using trypan blue), Cryopreservation and revival of animal cells, Contamination in cell culture (bacterial, fungal, mycoplasma) and its prevention. Preservation and Characterization of animal cells , Scaling up of animal cell cultures – Cell culture as source of valuable products-Protein production by genetically engineered mammalian cell lines, Stem cells and their applications.	15	25%
3	**Transgenic Animals** Concepts of transgenic animal technology - Various strategies for the production of transgenic animals and their importance in biotechnology; pronuclear microinjection, embryonic stem cells and somatic cell nuclear transfer in the production of transgenic animals. - Transgenic animals as bioreactors for producing pharmaceutically important compounds and therapeutics etc. Role of gene knock out and gene knock in mice model for studying human genetic disorder.	15	25%
4	**Applications of Animal Tissue Culture** Vaccine production, Monoclonal antibody production (hybridoma technology), Production of recombinant proteins, Drug screening and toxicity testing, Cancer research and stem cell studies, Tissue engineering and regenerative medicine, Role of animal cell culture in gene therapy and biotechnology research.	15	25%

Course Outcome: After completion of this course, student will be able to

CO1: Understand the fundamental concepts and types of animal cell cultures**.**
CO2: Demonstrate knowledge of laboratory equipment and aseptic techniques used in cell culture**.**
CO3: Understand methods for cell maintenance, subculturing, cryopreservation and concepts of transgenic animals.
CO4: Describe the applications of animal tissue culture in vaccine production, drug testing, and biotechnology research**.**

List of Text Books:

- Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications – by **R. Ian Freshney**.
- Animal Cell Culture: A Practical Approach – edited by **J. R. W. Masters**.

List of Reference Books:

1. Freshney, R. I. – *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*.
2. Butler, M. – *Animal Cell Culture and Technology*.
3. Masters, J. R. W. – *Animal Cell Culture: Practical Approach*.
4. Kalyan Kumar De – *An Introduction to Animal Tissue Culture*.

Open e-Resource:

- https://archive.nptel.ac.in/courses/102/105/102105083/?utm
- https://onlinecourses.nptel.ac.in/noc25_bt58/preview?utm

Gandhinagar Institute of Science
Bachelor of Science –
Biotechnology

Semester-V

Subject Code: 10170502	Subject Title: Immunology-II
Prerequisite: Candidate must have Basic knowledge of Cell biology, Microbiology, and fundamental concepts of the immune system including innate and adaptive immunity.	

Course Objective:

- To introduce the students about basic knowledge of Immunity, its types and immune response via different mechanisms, immune disorders and diagnostic techniques.
- The course also includes the methodology and technical aspects to provide comprehensive knowledge of the subject.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture	Tutorial	Practical	Credit	Theory		Practical		Total
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
04	-	-	04	50	50	-	-	100

Sr. No.	Topic	Total Hours	Weight %
	Non-Specific Host Defense Mechanisms: Phagocytosis, Complement, Inflammation, Cytokines Acute Phase Proteins, Cells, Tissues & Organs of the Immune System. **Specific Immune Responses:** Antigens, Haptens, Cluster of Differentiation Molecules, Humoral & Cell Mediated Immunity. Recognition of Foreignness. T Cell Biology - T Cell receptors, Types of T Cells, T Cell Activation. B Cell Biology- B Cell Receptors, B cell Activation.	15	25%
2	**Specific Immune Responses: II** Antibodies - Classes of Immunoglobulins. Antigen-Antibody Reactions: General Features, Measurement of Antigen & Antibody. Serological Reactions: Precipitation Reactions, Definition, Mechanism - Zone Phenomenon & Lattice Hypothesis. Applications- Precipitation in Liquid Medium. Agglutination reactions- Definition, Applications-Slide agglutination test. Tube agglutination test, Passive agglutination test. Primary & Secondary Antibody response. Diversity of Antibodies.	15	25%

3	**Complement system:** Components of the Complement system. Activation pathways (Classical, Alternative and Lectin pathways). - Immune Response: Primary and secondary immune response. Generation of humoral immune response (plasma and memory cells). Generation of cell mediated immune response (Self MHC restriction, T cell activation, Co-stimulatory signals). Killing Mechanisms by CTL and NK cells. **Introduction to tolerance.** - Characteristics of immune response: Discrimination, diversity, specificity, memory and transferability.	**15**	**25%**
4	**Vaccines:** Introduction to vaccines, live attenuated vaccines, killed vaccines, subunit vaccines; conjugate vaccines, toxoid as vaccines, recombinant vaccines, polyvalent vaccines, large scale production of vaccines **Immunotechnology and stem cell technology:** Immunodiagnostics, hybridoma technology, monoclonal antibodies, antibody engineering, large scale manufacture of antibodies, stem cell immunology	**15**	**25 %**

Course Outcome: After completion of this course, student will be able to

CO 1. Understand and explain the structure, function, and coordination of non-specific and specific host defense mechanisms.

CO 2. Describe the biology of antigens, antibodies, T cells, B cells, and their roles in humoral and cell-mediated immunity, immune tolerance, and recognition of foreignness, along with the characteristics of immune responses.

CO 3. Analyze and apply knowledge of antigen-antibody interactions, serological reactions, complement activation pathways, and primary and secondary immune responses in the context of diagnostics and disease mechanisms.

CO 4. valuate various vaccine types, immunotechnology tools, and stem cell applications for immunological research and large-scale production of biologicals.

References

- Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology, Saunders Publication, Philadelphia.
- Advanced Immunology (1991) Male D., Champion B. Cooke A. and Owen M. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition. W.H. Freeman and company, New York.
- Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). *Roitt's essential immunology*. John Wiley & Sons.
- Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (Year). *Roitt's essential immunology* (Edition). Publisher.
- Lydyard, P., Whelan, A., & Fanger, M. (2003). *Immunology* (3rd ed.). Garland Science.
- Peakman M, and Vergani D. (1993). Basic and Clinical Immunology. Churchill Livingstone Publishers, Edinberg
- Principle and practice of Immunoassay (IInd ed.) Christopher P. Price and David J.
- Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Open e-Resource

https://onlinecourses.swayam2.ac.in/cec24_bt09/preview
https://www.immunopaedia.org.za/immunology/
https://pll.harvard.edu/course/hmx-immunology
https://www.coursera.org/courses?query=immunology
https://onlinecourses.nptel.ac.in/noc21_bt49/preview
https://alison.com/course/introduction-to-immunology-revised

GANDHINAGAR UNIVERSITY

Gandhinagar Institute of Science
Bachelor of Science –
Biotechnology

Semester-V

Subject Code: 101170502	**Subject Title: BTLaboratory - V**
Pre-requisite: Students should have basic knowledge of **Cell Biology, Microbiology, and fundamental immunology concepts** to understand animal cell culture and immunological techniques.	

Course Objective:

- To introduce students to the principles and laboratory practices of Animal Cell Culture techniques.
- To develop skills in cell counting, viability testing, and maintenance of cell lines.
- To train students in immunological techniques for antigen–antibody detection and analysis.
- To provide hands-on experience in advanced techniques such as transfection, cryopreservation, and Western blotting.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-	08	04	-	-	50	50	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	Preparation and Filter sterilization of Animal tissue culture medium.	8 hours per week	Equal weightage to each experiment.
2	Chicken embryo fibroblasts culture.		
3	Quantification of cells by haemocytometer.		
4	Quantification of viable and non-viable cells by trypan blue dye exclusion method.		
5	Identification of leukocyte subsets and total count.		
6	Blood leukocyte culture.		
7	Isolation of lac— mutants of Escherichia coli using UV radiations as mutagen.		

8	Isolation of pigment less mutant of Serratia marcescens using UV radiations as mutagen.
9	Isolation of streptomycin resistant mutants of *Escherichia coli* by gradient plate method.
10	Isolation of drug/biochemical mutants of *E.coli* by replica plating technique.
11	Isolation of DNA
12	Slide and tube agglutination tests (e.g., Widal test for Salmonella antibodies).
13	Precipitation reaction: Ouchterlony double diffusion or radial immunodiffusion.
14	Western blotting (demonstration or interpretation of pre-run blot for antigen detection).

Course Outcome: After completion of this course, student will be able to

CO1: Prepare and sterilize animal cell culture media and maintain aseptic conditions in the laboratory.
CO2: Perform cell quantification and viability assays using haemocytometer and trypan blue staining.
CO3: Conduct basic animal cell culture techniques including leukocyte culture and fibroblast culture.
CO4: Apply immunological assays such as agglutination, precipitation, and Western blotting for antigen detection.
CO5: Demonstrate techniques like cryopreservation, revival of cell lines, and transfection in laboratory conditions.

List of Text Books:

- Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications – R. Ian Freshney.
- Essential Cell Culture Protocols – John M. Davis (Ed.).

List of Reference Books:

1. Basic Cell Culture Protocols – Cheryl D. Helgason & Cindy L. Miller.
2. Immunology: A Short Course – Richard Coico & Geoffrey Sunshine.
3. Kuby Immunology – Thomas J. Kindt, Richard Goldsby, Barbara Osborne.
4. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson & John Walker.

Open e-Resource:

- MycoBank Database – https://www.mycobank.org
- Fungal Biology Course – NPTEL – https://nptel.ac.in
- Tree of Life Web Project (Fungi section) – http://tolweb.org/Fungi
- https://nptel.ac.in – NPTEL Courses on Industrial Biotechnology

- https://www.ebi.ac.uk – European Bioinformatics Institute
- https://www.fda.gov – U.S. Food and Drug Administration

Gandhinagar Institute of Science
Bachelor of Science –
Biotechnology

Semester-VI

Subject Code: 10170504	Subject Title: rDNA Technology
Pre-requisite: Students should have • Basic knowledge of Molecular Biology • Understanding of Biochemistry and Genetics • Familiarity with Microbiology and Cell Biology • Laboratory skills in DNA extraction and electrophoresis	

Course Objective: This course aims:

- To understand the fundamental principles of gene cloning and recombinant DNA techniques.
- To gain knowledge of vectors, host systems, and gene manipulation strategies.
- To familiarize students with modern tools like PCR, CRISPR, and bioinformatics in rDNA research.
- To apply recombinant DNA methodologies in diagnostics, therapeutics, agriculture, and industry.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Basics of Recombinant DNA Technology** • Historical perspective and milestones • Restriction enzymes and other DNA modifying enzymes • Cloning strategies: cohesive-end ligation, blunt-end ligation, linkers and adaptors • Types of DNA: genomic, plasmid, and cDNA • Isolation and purification of nucleic acids	15	25%

2	**Vectors and Host Systems** • Characteristics of ideal vectors • Cloning vectors: plasmids (pBR322, pUC), bacteriophages (λ), cosmids, BACs, YACs • Expression vectors and shuttle vectors • Host organisms: *E. coli*, yeast, insect cells, mammalian cells, and plant systems • Selection, screening, and expression of recombinant clones	15	25%
3	**Tools and Techniques in rDNA Technology** • Polymerase Chain Reaction (PCR) and its variants • Blotting techniques: Southern, Northern, Western • DNA sequencing methods: Sanger and NGS overview • Site-directed mutagenesis • Gene libraries: Genomic and cDNA libraries • Use of reporter genes and fusion proteins	15	25%
4	**Applications and Ethical Aspects** • Genetically Modified Organisms (GMOs) • Applications in agriculture, pharmaceuticals, diagnostics, and industry • Gene therapy and recombinant vaccines • Biosafety levels and containment strategies • Ethical, legal, and social implications (ELSI) of rDNA technology • Regulatory bodies: rDNA guidelines (DBT, NIH, WHO, etc.)	15	25%

Course Outcome: After completion of this course, student will be able to

CO1: Explain the principles and workflow of recombinant DNA technology.
CO2: Select appropriate vectors, host systems, and tools for genetic engineering tasks.
CO3: Design and troubleshoot gene cloning and expression experiments.
CO4: Evaluate the applications and risks of GMOs in various sectors.
CO5: Apply knowledge of rDNA tools in real-world research and industrial settings.

List of Text Books:

- "Gene Cloning and DNA Analysis" – T.A. Brown.
- "Molecular Cloning: A Laboratory Manual" – Joseph Sambrook, David W. Russell.
- "Principles of Gene Manipulation and Genomics" – Sandy Primrose, Richard Twyman.

List of Reference Books:

- "Molecular Biology of the Gene" – James D. Watson et al.
- "Molecular Biotechnology: Principles and Applications of Recombinant DNA" – Bernard R. Glick, Jack J. Pasternak.
- "Recombinant DNA" – James D. Watson, Amy A. Caudy, Richard M. Myers.

Open e-Resource:

- NCBI Bookshelf – https://www.ncbi.nlm.nih.gov/books
- MIT Open Course Ware – Molecular Biology – https://ocw.mit.edu
- Coursera – Recombinant DNA Technology Courses – https://www.coursera.org
- edX – Molecular Biology Programs – https://www.edx.org
- IISER Pune/NPTEL Courses on Genetic Engineering – https://nptel.ac.in

Gandhinagar Institute of Science
Bachelor of Science - Microbiology
Semester-V

Subject Code: 10170505 (IKS)	Subject Title: Fermentation Technology
Pre-requisite: Students should have basic knowledge of Microbiology. Students should have understanding of microbial metabolism and growth kinetics.	

Course Objective: This course aims to:

- Introduce students to the basic principles and types of fermentation.
- Familiarize with the components and functioning of fermenters.
- Understand media formulation, sterilization, and operational modes of fermentation.
- Explore various industrial applications of fermentation technology.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Fermentation** Definition and scope of fermentation, Types: solid-state vs submerged fermentation, Microorganisms used in fermentation, Screening and strain improvement, Inoculum preparation and scale-up.	11	25%
2	**Fermenter Design and Operation** Basic structure and parts of a fermenter, Types of bioreactors: stirred tank, airlift, packed bed, Aeration and agitation: mechanisms and control, Sensors and control systems: pH, temperature, DO, foam, Sterilization of fermenter and media	11	25%
3	**Fermentation Process and Media** Media formulation: carbon and nitrogen sources, Additives: precursors, inducers, inhibitors, Batch, fed-batch, and continuous processes, Downstream processing: cell harvesting, extraction, purification, Product recovery and yield estimation.	11	25%
4	**Industrial Applications of Fermentation** • Microbial production of:	12	25%

	○Alcohol (ethanol) ○Organic acids (citric acid) ○Antibiotics (penicillin) ○Enzymes (amylase, protease) ○Dairy products (yogurt, cheese) • Fermentation using agro-industrial waste		

Course Outcome: After completion of this course, student will be able to

CO1: Explain the principles of microbial fermentation and its types. *(Understand)*

CO2: Describe fermenter design, aeration, and process control. *(Apply)*

CO3: Formulate suitable fermentation media and sterilization procedures. *(Apply)*

CO4: Discuss industrial production processes of important microbial products. *(Analyze)*

CO5: Perform basic fermentation techniques in the laboratory. *(Apply)*

List of Text Books:

- Casida, L. E. (2007). *Industrial Microbiology*. New Age International.
- Crueger, W., & Crueger, A. (2017). *Biotechnology: A Textbook of Industrial Microbiology*. Panima Publishing.
- Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of Fermentation Technology*. Elsevier.

List of Reference Books:

- Joshi, V. K., & Pandey, A. (Eds.). *Biotechnology: Food Fermentation* Vol I & II.
- Moo-Young, M. (Ed.). *Comprehensive Biotechnology*. Pergamon Press.
- Peppler, H. J. (Ed.). *Microbial Technology* Vol I & II. Academic Press.

Open e-Resource:

- **NPTEL Courses:** Fermentation Biotechnology – IIT Kharagpur
- **eGyanKosh (IGNOU):** Modules on food and industrial microbiology
- **YouTube Channels:** Amrita Virtual Lab, MIT OCW (Biological Engineering)

List of Suggested Experiments:

1. Preparation of fermentation media and sterilization (glucose, molasses, jaggery-based).
2. Amylase production using *Bacillus subtilis.*
3. Alcohol fermentation using *yeast.*
4. Effect of pH and temperature on fermentation yield.
5. Determination of ethanol concentration using distillation + dichromate method.

Gandhinagar Institute of Science
B.Sc. Biotechnology
Sem-VI

Subject Code: 101170601	**Subject Title: Genomics and Proteomics**
1. **Pre-requisite:** Students should have a basic understanding of **Molecular Biology, Genetics, and Bioinformatics** is required to study genomics and proteomics.	

Course Objective:

- To understand the **concepts and principles of genomics and genome organization**.
- To study **genome sequencing technologies and functional genomics approaches**.
- To understand the **techniques used for protein analysis in proteomics**.
- To explore the **applications of genomics and proteomics in Biotechnology, medicine, and agriculture**.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Genomics** Introduction to Genomics, types of Genomics, epigenomics, structural, epigenomics and mutational Genomics. Genome analysis: genome complexity (cot curve), repetitive and unique sequences, C-value paradox, Genome mapping (FISH, restriction mapping), molecular markers used in genetic mapping (RAPD, AFLP, STS, EST).	15	25%
2	**Functional Genomics and Genome Analysis** Genome sequencing, Introduction to DNA sequencing, methods of DNA sequencing (Maxam & Gilbert, Sanger and NGS- Illumina). Metagenomics: 16S rRNA typing/sequencing. Whole genome sequence: genome assembly and annotation. Human Genome Project.	15	25%

	Global gene expression analysis: cDNA-Microarrays and oligonucleotide arrays: Technique of cDNA Micro array, Micro array design, Data representation and applications. Expression sequence tags (ESTs) and their significance. MiRNAs and siRNAs: biogenesis and function. Serial analysis of gene expression (SAGE), SAGE data analysis, role of SAGE in gene discovery		
3	**Introduction to Proteomics** Proteomics: Introduction, strategies in analysis of proteome: Pulldown of interacting partners of a protein, Tandem-Affinity purification (TAP) and Immunoprecipitation. Identification of proteins by mass spectrometry, 2D-Gel electrophoresis, trypsin digestion, liquid chromatography (LC) for separation of peptides and mass spectrometry (MALDI-MS and ESI-MS). Analysis: Peptide mass finger printing.	15	25%
4	**Applications of Genomics and Proteomics** Applications of genomics and proteomics in disease diagnosis, drug discovery, Agriculture and biomarker identification, Clinical proteomics and personalized medicine, Integration of genomics and proteomics in systems biology.	15	25%

Course Outcome: After completion of this course, student will be able to

CO1: Explain the structure, organization, and sequencing of genomes.
CO2: Describe functional genomics techniques such as microarrays and transcriptomics.
CO3: Understand protein analysis techniques including electrophoresis and mass spectrometry.
CO4: Discuss the applications of genomics and proteomics in disease diagnosis, drug discovery, and Biotechnology research.

List of Text Books:

- Genomics and Cloning (East-West Press, 2004) – Kumar, HD.
- Introduction to Bioinformatics (Oxford University Press, Second edition, 2007) – Arthur M Lesk.
- Bioinformatics concepts, Skills and Applications (CBS Publishers & Distributors, Second edition, 2007) – Rastogi, SC., Namita, M and Parag, R. Biochemistry (John Wiley & Sons, 2011) – Donald Voet and Judith Voet.
- Proteomics (Kluwer Academic Publishers, 2002) – Timothy, P.

List of Reference Books:

- Benjamin Lewin, (2006).Genes IX. Johns and BartlettPublisher.
- Primrose, S.B. (1987). Modern Biotechnology (2nd ed.). BlackwellPublishing.
- Glick, B.R., Pasternak, J.J., & Patten, C.L.(2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA (4thed.).

- Sambrook & Russell (3rd ed.). (1989). Molecular Cloning: A Laboratory Manual (Vols. 1to3). Cold Spring Harbor Laboratory Press
- Primrose, S.B., Twyman, R.M. & Old, R.W. (2001). Principles of Gene Manipulation (6th ed.). Blackwell Science.
- Snustad, D.P., &Simmons, M.J. (2009). Principles of Genetics (5th ed.). John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., & Spencer, C.A. (2009). Concepts of Genetics (9th ed.). Benjamin Cummings.
- Russell, P. J. (2009). iGenetics- A Molecular Approach (3rd ed.). Benjamin Cummings.
- Glick, B.R., & Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. Washington: ASMPress.

Open e-Resource:

- https://archive.nptel.ac.in/courses/102/105/102105083/?utm
- https://onlinecourses.nptel.ac.in/noc25_bt58/preview?utm

Gandhinagar Institute of Science
B.Sc. Biotechnology
Sem-VI

Subject Code: 10320402	**Subject Title: Biodiversity and Wildlife Conservation**
Pre-requisite: Students should have basic knowledge of **ecology, environmental science, and the diversity of plants and animals** to understand concepts of biodiversity and wildlife conservation.	

Course Objective:

- To understand about the biodiversity and its value.
- To gain knowledge about different threat species of plant and animal.
- To acquire knowledge about wildlife and its depletion.
- To learn about wildlife conservation.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	Biodiversity: Definition and its significance; Level of biodiversity: Genetic, species and ecosystem; Biogeographic Classification Of India; Value Of Biodiversity: Consumptive, Productive Use, Social, Ethical, Aesthetic And Option Values; Biodiversity At Global, National And Local Levels;India As A Mega Diversity Nation; Hotspots Of Biodiversity	8	25%
2	Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Categories of Wildlife: IUCN Red data categories - Extinct, Extinct in wild, Critically endangered, Endangered, Vulnerable, Near	12	25%

	threatened, Least concerned, Data deficient, Not evaluated. IUCN Red data book. Keystone species, Flagship species, Umbrella species. Priority species, Indicator species. Endangered and Endemic species of India: Common Plant species; Common Animal species; Conservation of biodiversity: in-situ and ex-situ. Community conserved areas – *Devarakadu* and *Pavitra Vana*. Role of BSI and ZSI in conservation.		
3	Wildlife: Definition, significance Biogeographical zones of India. Significant wildlife of India. Causes for wildlife depletion – HIPPO (Habitat destruction, Invasive species, Pollution, Population (human overpopulation), Overharvesting by hunting and fishing. Forest fires and wildlife depletion. Effects of depletion of wildlife – Ecological, Economic Socio-cultural. Urban wildlife. Human-wildlife conflict and management.	10	25%
4	Wildlife conservation: Need for conservation of wildlife. History of wildlife conservation in India. Biosphere reserves, National parks, Wildlife sanctuaries, wildlife reserves, protected areas, privately owned wildlife reserves &, Single species/single habitat-based conservation areas, Area of special scientific interest (ASSI). People and conservation: Traditional knowledge, Traditions and cultures, Women and people's participation in managing protected areas. Role of NGOs in conservation. Conservation Institutions – Bird Life International, GEF, IUCN, UNEP, WCS, WWF; BNHS, WTI.	15	25%

Course Outcome: After completion of this course, student will be able to

CO1: Gain knowledge about biodiversity at global, national and local levels.
CO2: Gain insight about the biodiversity threat and different species under this category.
CO3: Acquiring an understanding about wildlife significance and its depletion.
CO4: Understand about the conservation techniques and various institutions for conservation.

List of Text Books:

Gadgil, M., & Guha, R. (1993). This Fissured Land: An Ecological History of India. Univ. of California Press.
Grumbine, R. Edward, and Pandit, M.K. (2013). Threats from India's Himalaya dams. Science, 339: 36-37.
Herbert H. T. Prins, Jan Geu Grootenhuis and Thomas T. Dolan. (2000). Wildlife Conservation by Sustainable Use. Springer publication.

List of Reference Books:

Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). (2013). Conservation Biology: Voices from the Tropics. John Wiley & Sons.
Thapar, V. (1998). Land of the Tiger: A Natural History of the Indian Subcontinent.

E.P. Gee. (2002). The Wild Life of India. HarperCollins India
Goutam Kumar Saha , Subhendu Mazumdar. (2017). Wildlife Biology: An Indian Perspective, PHI Learning Pvt. Ltd. India
Jedediah F. Brodie, Eric S. Post, and Daniel F. Doak. (2012). Wildlife Conservation in a Changing Climate. The University of Chicago Press.
Manfredo, Michael J. (2008). Who Cares About Wildlife?. Springer publication.
Morrison, M.L., Block, W.M., Strickland, M.D., Collier, B.A., Peterson, M.J. (2008). Wildlife Study Design, Springer publication.
Nagendra, H., & Mundoli, S. (2019). Cities and canopies: trees in Indian cities.Penguin Random House India Private Limited.
Underkoffler, Susan C, Adams, Hayley R. (Eds.). (2021). Wildlife Biodiversity Conservation - Multidisciplinary and Forensic Approaches, Springer publication.

Open e-Resource:

- https://onlinecourses.nptel.ac.in/noc23_hs155/preview
- https://dspmuranchi.ac.in/pdf/Blog/satyapriya52dspmucomS12.pdf

Gandhinagar Institute of Science
Bachelor of Science –
Biotechnology

Semester-VI

Subject Code: 101170602	Subject Title: BTLaboratory - VI
Pre-requisite: Students should have **basic knowledge of ecology, Microbiology, molecular biology, and bioinformatics along with fundamental laboratory skills** to perform field, wet-lab, and computational experiments.	

Course Objective:

- To provide practical knowledge of ecological field techniques for studying community structure, biomass estimation, and ecosystem characteristics.
- To train students in soil analysis and environmental assessment including physical and chemical properties of soil.
- To develop skills in microbial isolation, culture techniques, and identification of fungi and microorganisms from environmental samples.
- To introduce students to molecular biology techniques such as DNA isolation, PCR, electrophoresis, primer design, and protein analysis using SDS-PAGE.
- To familiarize students with bioinformatics tools and databases for genome analysis, sequence alignment, and protein structure visualization.
- To develop the ability to identify economically important plants, animals, and museum specimens and prepare field reports from biodiversity conservation sites.
-

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
-	-	08	04	-	-	50	50	100

Subject Contents			
Sr.No.	**Topic**	**Total Hours**	**Weight (%)**
1	Description of community structure by using the quadrates.	Approx 08 hours per week	Equal weightage to each experiment.
2	Estimation of total biomass and herbage yield by harvest method.		
3	Description of zonation in a pond and stratification in a forest		
4	Experiments related to soil-Garden soil experiments to make texture, Capillary Water, Field Capacity, Witting coefficient, pH of the soil, Chemistry of the soil (NO_3, PO_4 & SO_4)		

5	Identification and inventory of important crop plants and economic plants.		
6	Culture of bacteria from water and soil samples.		
7	Estimation of protein content using plant or/ animal tissues using Lowry et al.		
8	Study and identification of museum specimen (Birds, Mammals); Field Report on the Management tour:- To National Park, Biosphere Reserve Sanctuary, Protected Area and Captive Breeding Program.		
9	Web based servers and software for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, Protein Data Bank.		
10	NCBI Database study-BLAST and FASTA.		
11	Multiple sequence alignments using Clustal Omega.		
12	Selected Model Organisms specific Genomes and Databases.		
13	SDS-PAGE electrophoresis.		
14	Primer Design for PCR.		

15	Isolation of Genomic DNA.		
16	Agarose Electrophoresis.		
17	Polymerase Chain Reaction (PCR).		
18	Visualization and analysis of 3D protein structures using PyMOL.		
19	Isolation of fungi from soil and air (using Potato Dextrose Agar).		
20	Lactophenol cotton blue staining of fungal hyphae and spores.		
21	Identification of common fungi**:** *Rhizopus*, *Mucor*, *Penicillium*, *Aspergillus*, *Fusarium*, etc.		
22	Slide culture technique for studying fungal morphology.		

Course Outcome: After completion of this course, student will be able to

CO1: Apply ecological field methods to analyze vegetation structure, biomass, and ecosystem zonation.
CO2: Evaluate soil properties including texture, water holding capacity, pH, and nutrient composition.
CO3: Isolate and identify microorganisms and fungi from environmental samples using standard microbiological techniques.
CO4: Perform molecular biology experiments including DNA extraction, PCR amplification, and gel electrophoresis.
CO5: Use bioinformatics databases and tools such as genome browsers, BLAST, FASTA, and multiple sequence alignment programs.
CO6**:** Interpret protein structures and molecular data using visualization tools and prepare scientific reports from field and laboratory studies.

List of Text Books:

- "Fundamentals of Ecology", by Odum, E. P., and Barrett, G. W., 2005, Brooks/Cole Publishing, USA.
- "Molecular Biology of the Gene", by Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2014, Pearson Education, USA.
- "Microbiology: A Laboratory Manual", by Cappuccino, J. G., and Sherman, N., 2014, Pearson Education, New York.
- "Introduction to Bioinformatics", by Lesk, A. M., 2014, Oxford University Press, Oxford.
- "Practical Biochemistry", by Wilson, K., and Walker, J., 2010, Cambridge University Press, Cambridge.

List of Reference Books:

- "Fundamentals of Soil Science", by Foth, H. D., 1990, John Wiley & Sons, New York.
- "An Introduction to Practical Biochemistry", by Plummer, D. T., 2001, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- "Molecular Cloning: A Laboratory Manual", by Sambrook, J., and Russell, D. W., 2001, Cold Spring Harbor Laboratory Press, New York.
- "Bioinformatics: Sequence and Genome Analysis", by Mount, D. W., 2004, Cold Spring Harbor Laboratory Press, New York.
- "Illustrated Genera of Imperfect Fungi", by Barnett, H. L., and Hunter, B. B., 1998, APS Press, Minnesota.
- "Biodiversity", by Wilson, E. O., 1992, National Academy Press, Washington D.C.

Open e-Resource:

- MycoBank Database – https://www.mycobank.org
- Fungal Biology Course – NPTEL – https://nptel.ac.in
- Tree of Life Web Project (Fungi section) – http://tolweb.org/Fungi
- https://nptel.ac.in – NPTEL Courses on Industrial Biotechnology
- https://www.ebi.ac.uk – European Bioinformatics Institute
- https://www.fda.gov – U.S. Food and Drug Administration

Gandhinagar Institute of Science
Bachelor of Science –
Biotechnology

Semester-VI

Subject Code: 10170601	Subject Title: Mycology
Pre-requisite: Students should have opted undergraduate degree level with knowledge of Microbiology, Cell Biology, and Biochemistry. • Should have basic understanding of microbial taxonomy and physiology. • Familiarity with lab techniques including staining, culturing, and microscopy.	

Course Objective: This course aims:

- To understand the diversity, classification, and biology of fungi.
- To study fungal structure, reproduction, life cycles, and ecological roles.
- To explore fungal interactions with plants, animals, and humans.
- To examine the industrial, agricultural, environmental, and clinical significance of fungi.
- To gain hands-on experience in fungal isolation, identification, and cultivation.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Fungi and Fungal Classification** General characteristics and significance of fungi, History and scope of mycology, Classification: traditional (Ainsworth) and modern molecular approaches, Overview of fungal groups: Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota, Deuteromycete, Structure and function of fungal cell components (cell wall, hyphae, spores, etc.).	15	25%
2	**Fungal Physiology, Growth, and Reproduction** Nutrition: saprophytic, parasitic, symbiotic fungi, Fungal metabolism: carbon, nitrogen, and secondary metabolism, Asexual and sexual reproduction; spore types and dispersal mechanisms, Fungal life cycles (Rhizopus, Penicillium, Saccharomyces, Ustilago, Puccinia), Environmental factors affecting fungal growth.	15	25%

3	**Fungi in Environment, Agriculture, and Industry** Fungi in ecosystem functioning: decomposers and nutrient cycling,	15	25%
	Mycorrhizae and their role in plant health, Plant pathogenic fungi and disease control strategies, Industrially important fungi: production of enzymes, antibiotics, organic acids, and fermented foods, Biocontrol agents and fungi in bioremediation.		
4	**Medical Mycology and Mycotoxins** Human fungal diseases: superficial, subcutaneous, systemic mycoses, Opportunistic mycoses: *Candida*, *Aspergillus*, *Cryptococcus*, *Mucor,* Antifungal agents and mechanisms of action, Mycotoxins (aflatoxins, ochratoxins, ergot alkaloids): sources, effects, and detection, Laboratory diagnosis of fungal infections.	15	25%

Course Outcome: After completion of this course, student will be able to

CO1: Describe fungal diversity, structure, and reproductive strategies.
CO2: Analyze the ecological and economic roles of fungi.
CO3: Identify agriculturally and industrially significant fungi and their uses.
CO4: Diagnose common fungal diseases and explain antifungal treatment mechanisms.
CO5: Perform standard mycological techniques for fungal cultivation and identification.

List of Text Books:

1. Alexopoulos, Mims & Black – *Introductory Mycology*, John Wiley & Sons.
2. Deacon, J.W. – *Fungal Biology*, Wiley-Blackwell.
3. Webster, J. & Weber, R. – *Introduction to Fungi*, Cambridge University Press.

List of Reference Books:

1. Talaro & Chess – *Foundations in Microbiology*, McGraw Hill
2. Aneja, K.R. – *Experiments in Microbiology, Plant Pathology and Biotechnology*
3. Moore, Robson & Trinci – *21st Century Guidebook to Fungi*

Open e-Resource:

- MycoBank Database – https://www.mycobank.org
- Fungal Biology Course – NPTEL – https://nptel.ac.in
- Tree of Life Web Project (Fungi section) – http://tolweb.org/Fungi
- Centers for Disease Control – Fungal Diseases – https://www.cdc.gov/fungal
- Coursera / edX Courses on Fungal Biology and Medical Mycology

A. Ability Enhancement Courses (AEC)

Sl. No	Course Name	Course Code
1	Business Communication – Blended with ICSI	AEC001
2	Communication and Presentation for Technical Professionals (IEEE)	AEC002
3	Conversational Hindi (Modern Indian Language)	AEC003
4	Corporate Grooming and Business Etiquettes	AEC004
5	Digital Privacy: Understanding and Operational Framework (IEEE)	AEC005
6	Digital Transformation: Game Changing Opportunities (IEEE)	AEC006
7	Economics & Business Environment Blended with ICSI	AEC007
8	Freelancing and Content Writing	AEC008
9	French	AEC009
10	Functional Grammar and Composition	AEC010
11	German	AEC011
12	Gujarati	AEC012
13	Marathi	AEC013
14	Mass Communication and Journalistic Writing	AEC014
15	Personality Development for Effective Leadership	AEC015
16	Practical English	AEC016
17	Punjabi	AEC017
18	Spanish	AEC018
19	Radio Jocky	AEC019
20	Ethics for Engineers, Patents, Copyrights and IPR	AEC020
21	Digital Privacy: Understanding and Operational Framework	AEC021
22	Environmental Studies	AEC022

B. Skill Enhancement Courses (SEC)

Sl. No	Course Name	Course Code
1	Animation & Graphics Design	SEC001
2	Aptitude and Logical Reasoning Blended with ICSI	SEC002
3	AutoCAD and Basic Drafting	SEC003
4	Business Administration	SEC004
5	Current Affairs and Quantitative Aptitude Blended with ICSI	SEC005
6	Data Analysis using Spreadsheet	SEC006
7	Digital Marketing	SEC007
8	Eco-Engineering: Designing for the Future	SEC008
9	Engineering Mastery: Tools and Techniques	SEC009
10	Event Management	SEC010
11	ICT Skills for Leadership	SEC011
12	Innovation & Entrepreneurship	SEC012
13	Interpersonal Skills – Blended with ICSI	SEC013
14	Introduction of Cyber Security (IEEE)	SEC014
15	Office Automation Tools	SEC015
16	Performing Arts (Dance, Music, Drama)	SEC016
17	Personal Financial Planning	SEC017
18	Practical Workshop Training	SEC018
19	Social Media Management	SEC019
20	Tally Accounting	SEC020
21	Visual Arts	SEC021
22	Public Speaking	SEC022
23	Organic Farming	SEC023
24	Web Development Framework	SEC024
25	Cyber Crime	SEC025
26	Cyber Security	SEC026
27	Agri-Business Law	SEC027

C. Value Addition Courses (VAC)

Sl. No.	Course Name	Course Code
1	Anti-ragging – Blended with IEEE	VAC001
2	Art of Living for Wellness	VAC002
3	Awareness of Cyber Crime and Ethical Hacking	VAC003
4	Basic Life Support (BLS)	VAC004
5	Community Development	VAC005
6	Economics & Social Development	VAC006
7	Emotional Intelligence	VAC007
8	Environmental Studies	VAC008
9	Ethics and Values in Ancient Indian Tradition	VAC009
10	Gandhian Studies	VAC010
11	Indian Economy and Planning	VAC011
12	Indian Geography and Environmental Ecology	VAC012
13	Indian History and Cultural Heritage	VAC013
14	Integrated Personality Development Course	VAC014
15	Life Lessons from Bhagvad Gita	VAC015
16	Life Skills	VAC016
17	National Cadet Corps (NCC)	VAC017
18	National Service Scheme (NSS)	VAC018
19	Prevention of Sexual Harassment	VAC019
20	Psychology	VAC020
21	Stress and Time Management	VAC021
22	Sustainable Development and Environmental Studies	VAC022
23	Universal Human Values	VAC023
24	Yoga and Meditation for Wellness	VAC024