Gandhinagar Institute of Science (03)

Academic Regulation & Curriculum

for

Bachelor of Science (06)

in

Microbiology Programme (17)

Gandhinagar University

Khatraj-Kalol Road, Moti Bhoyan

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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 Microbiology. The curriculum for the Bachelor of Science in Microbiology 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 along with 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: Microbiology knowledge: Graduates will acquire microbiology specific knowledge including molecular biology, immunology and rDNA technology coupled with hands-on skills and leadership skills for a successful career.

PO-2: Problem analysis: Graduates will be able to analyse, solve and troubleshoot problems in implementation of microbiological protocols.

PO-3: Design/development of solutions: Graduates will develop creative thinking and cooperate with each other to solve problems in the field of microbiology.

PO-4: Conduct investigations of complex problems: Graduates will acquire practical skills – which help in planning and designing protocols to validate hypothesis and execute experimental techniques independently as well as assimilate, analyse and interpret subsequent data.

PO-5: Modern tool usage and communication: Graduates will effectively be able to manage resources and time using ICT and computer enabled devices and accomplish ability to understand and communicate all ideas effectively.

PO-6: Environment sustainability and Ethics: Graduates will get adequate knowledge to use information and implement solutions for environmental protection and remediation. Graduates will be aware of their role and responsibility in handling and use of microbes including genetically modified microorganisms.

PO-7: Lifelong learning: Graduates will carry on to learn and adapt in a world of constantly evolving technology.

3. Program Educational Objectives (PEOs)

PEO-1:

To provide the graduates with knowledge in microbiology and an overview of the processes that employ or deal with microbes that enables them to handle the safe and efficient use of microbiological applications with development of competence on par with global standards and helps the graduates for life-long learning.

PEO-2:

Use current microbial technologies and methods for the drug design and implementation of solution in pharmaceutical industry.

PEO-3:

To train graduates to choose a decent career option either as Entrepreneur or having a high degree of employability; or pursue higher education - by empowering students with basic interpersonal skills, ability to handle critical situations allowing them to be good team members as well as training to excel in competitive examinations.

PEO-4:

To impart a strong sense of social responsibility with awareness of professional and societal ethical values and scope to develop leadership capabilities.

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. Microbiology 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. Microbiology)

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:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
10170103	Major	Introductory Microbiology	4	3	-	2	5
10170104	Major	Basic Bacteriology	4	3	-	2	5
10140103	Minor	Fundamental Chemistry - I	4	3	-	2	5
10170105	Multi / Interdisciplinary	Astrology -I	4	4	-	-	4
AEC016	Ability Enhancement Course	Practical English	2	2	-	-	2
SEC006	Skill Enhancement Course	Data Analysis using Spreadsheet	2	2	-	-	2
VAC004	Value Added Course	Basic Life Support	2	2	-	-	2
			22	19	0	6	25

First Year 2nd Semester:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
10170203	Major	Nutritional Pattern in Microorganisms	4	3	-	2	5
10170204	Major	Food Microbiology	4	3	-	2	5
10140203	Minor	General Chemistry - I	4	3	-	2	5
10170205	Multi / Interdisciplinary	Agriculture Business Managemen	4	4	-	-	4
AEC015	Ability Enhancement Course	Personality Development for effective leadership	2	2	-	-	2

SEC019	Skill Enhancement Course	Social Media and Management	2	2	-	-	2
IKS0201	IKS	Indian Ancient history and cultural heritage	2	2	-	-	2
			22	17	0	06	25

NCrF Credit Level	**Semester**	**Major (core)**	**Minor (Elective)**	**Multi/interdisciplinary**	**AEC**	**SEC/Interdisciplinary**	**VAC/IKS**	**RP/OJT**	**Total credit per sem**	**Qualification/ certificate**
4.5 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 3rdSemester:

Subject Code	**Course Type**	**Subject Name**	**Credit**	**Hours per week**			
				L	**T**	**P**	**Total**
10170304	Major	Soil & Water Microbiology	4	3	-	2	5
10170305	Major	Ecology & Ecosystems	4	3	-	2	5
10170306	Major	Fundamental Biochemistry	4	3	-	2	5
10170308	Multi / Interdisciplinary	Astrology - II	4	4	-	-	4
AEC010	Ability Enhancement Course	Functional Grammar and Composition	2	2	-	-	2

SEC021	Skill Enhancement Course	Visual Arts	2	-	-	4	4
VAC024	Value Added Course	Yoga and Meditation for Wellness	2	2	-	-	2
			22	17	0	10	27

Second Year 4th Semester:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
10170404	Major	Microbial Genetics	4	3	-	2	5
10170405	Major	Immunology - I	4	3	-	2	5
10170406	Major	Virology	4	3	-	2	5
10140406	Minor	Organic Chemistry -II	4	3	-	2	5
AEC 008	Ability Enhancement Course	Freelancing & content writing	2	2	-	-	2
SEC 023	Skill Enhancement Course	Organic Farming	2	2	-	-	2
IKS 0401	IKS	Indian Ancient Science Philosophy	2	1	-	2	3
			22	17		10	27

NCrF Credit Level	Semester	Major (core)	Minor (Elective)	Multi/interdisciplinary	AEC	SEC/Interdisciplinary	VAC/IKS	RP/OJT	Total credit per sem	Qualification / certificate
5.0 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 certificate 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:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
10170501	Major	Advanced Microbial Genetics	4	4	-	-	4
10170502	Major	Immunology - II	4	4	-	-	4
10170503	Major	M laboratory-V	4	-	-	8	8
10170504	Minor	rDNA Technology	4	4	-	-	4
10170505	Minor	IKS-Fermentation Technology	4	3	-	2	5
SEC022	Skill Enhancement Course	Public Speaking	2	2	-	-	2
			22	17		10	27

Third Year 6th Semester:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
10170601	Major	Mycology	4	4	-	-	4
10170602	Major	Industrial Bioprocess Technology	4	4	-	-	4
10170603	Major	M laboratory-VI	4	-	-	8	8
10170604	Minor	Biostatistics & Computer Application	4	4	-	-	4
AEC021	Ability Enhancement Course	Digital Privacy: understanding and operational framework	2	2	-	-	2
10170605	Internship	Internship in Major specific course	4	-	-	8	8
			22	14		16	30

NCrF Credit Level	Semester	Major(core)	Minor (Elective)	Multi/interdisciplinary	AEC	SEC/Interdisciplinary	VAC /IKS	RP /OJT	Total credit per sem	Qualification/ certificate
5.5 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 7thSemester:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
10170701	Major	Environmental Microbiology	4	3	-	2	5
10170702	Major	Bioinstrumentation	4	3	-	2	5
10170703	Major	Enzymology	4	3	-	2	5
10170704	Minor	Food & Nutrition Biotechnology	4	3	-	2	5
10170705	Research Project/On-the-Job Training	On the Job Training (OJT) (For UG Honors Degree) / Research Project (For UG Honors with Research Degree)	6	-	-	12	12
			22	12		20	32

Fourth Year 8th Semester:

Subject Code	Course Type		Credit	Hours per week			
				L	T	P	Total
10170801	Major	Cell Biology	4	3	-	2	5

10170802	Major	Microbial Physiology	4	3	-	2	5
10170803	Major	Biostatistics	4	3	-	2	5
10170804	Minor	Forensic Biotechnology	4	3	-	2	5
10170805	Research Project/On-the-Job Training	On the Job Training (OJT) (For UG Honors Degree) / Research Project (For UG Honors with Research Degree)	6	-	-	12	12
			22	12		20	32

NCrF Credit Level	**Semester**	**Major(core)**	**Minor (Elective)**	**Multi/interdisciplinary**	**AEC**	**SEC/Interdisciplinary**	**VAC /IKS**	**RP/OJT**	**Total credit per sem**	**Qualification/ certificate**
6.0 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/interdisciplinary**	**AEC**	**SEC/Interdisciplinary**	**VAC /IKS**	**RP/OJT**	**Total credit per sem**	**Qualification/ certificate**
6.0	VII	12	4	-	-	-	-	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

7.1 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.

7.2 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

8. 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. Microbiology 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. Microbiology 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. Microbiology program is designed to develop scientifically skilled and industry-ready graduates with strong theoretical knowledge and practical expertise in microbiology, biotechnology, molecular biology, immunology, industrial microbiology, environmental microbiology, food microbiology, and medical microbiology. The program emphasizes laboratory-based learning, research orientation, scientific ethics, and industry relevance aligned with the rapidly growing healthcare, pharmaceutical, biotechnology, food, agriculture, and environmental sectors.

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 microbial culture techniques, staining methods, sterilization practices, biochemical analysis, molecular biology techniques, immunological methods, bioinformatics tools, and laboratory instrumentation relevant to modern biological sciences and industrial applications. Students are also exposed to emerging areas such as genetic engineering, microbial biotechnology, environmental sustainability, vaccine technology, bioinformatics, and artificial intelligence applications in life sciences.

The department actively promotes academic-industry interaction through collaborations with pharmaceutical industries, biotechnology companies, diagnostic laboratories, research institutes, hospitals, food industries, and environmental organizations. Expert lectures, workshops, seminars, live projects, and research activities are regularly organized to provide exposure to current developments and professional practices in microbiology and allied sciences.

The program is designed to prepare graduates for employment, higher education, entrepreneurship, and research opportunities in diverse sectors including healthcare, pharmaceuticals, biotechnology, food technology, agriculture, environmental management, and scientific research. The curriculum also supports progression towards postgraduate studies, competitive examinations, professional certifications, and advanced research in microbiology and related life science disciplines.

9.2 Scope and Career Opportunities

Graduates of the program may work in:

- Pharmaceutical Industries
- Biotechnology Companies
- Clinical and Diagnostic Laboratories
- Hospitals and Healthcare Organizations
- Food and Dairy Industries
- Environmental and Water Testing Laboratories
- Agricultural and Soil Testing Laboratories
- Research and Development Organizations
- Public Health Laboratories
- Quality Control and Quality Assurance Laboratories
- Vaccine and Fermentation Industries
- Government Research Institutes
- Academic and Educational Institutions

9.3 Potential Job Roles

- Microbiologist
- Research Assistant
- Laboratory Technician
- Quality Control Analyst
- Quality Assurance Executive
- Clinical Laboratory Technologist
- Food Microbiologist
- Environmental Microbiologist
- Industrial Microbiologist
- Biotechnologist
- Medical Laboratory Assistant
- Fermentation Technician
- Scientific Assistant
- Public Health Laboratory Technician
- Laboratory Executive

9.4 Higher Study & Professional Opportunities

Students may pursue:

- M.Sc. in Microbiology and Allied Life Sciences
- Ph.D. in related disciplines

- Biotechnology and Molecular Biology Programs
- Clinical Research and Bioinformatics Courses
- Medical Laboratory Technology Programs
- Industrial and Food Microbiology Specializations
- Research Fellowships and Competitive Examinations
- Professional Certification Courses in Biotechnology and Laboratory Sciences
- Entrepreneurship in Healthcare, Diagnostics, and Biotechnology Sectors

10. Collaborative Field Work / Experimental Work

10.1 Microbial Isolation and Culture Techniques Exercise

During a supervised laboratory session, students will collect samples from soil, water, air, or food sources and perform microbial isolation using serial dilution and streak plate techniques. They will prepare culture media, incubate microbial cultures, and record colony morphology observations. Submission shall include laboratory observations, microbial characterization tables.

10.2 Water Quality and Microbial Analysis Report

Students will collect water samples from assigned localities and perform microbiological analysis using standard methods such as total viable count, coliform detection, and biochemical testing. They will compare results with BIS drinking water standards and prepare a structured report including microbial load data, photographs, and public health interpretation.

10.3 Industrial Visit — Pharmaceutical or Biotechnology Industry

Faculty shall arrange a guided visit to a pharmaceutical, biotechnology, or fermentation industry. Students will observe industrial microbiology practices, sterilization systems, quality control procedures, biosafety measures, and production processes. Submission shall include ten annotated photographs and a 500-word industrial observation report.

10.4 Food Microbiology and Contamination Analysis

Students will collect and analyze food samples such as milk, curd, packaged foods, or street food items for microbial contamination using culture and staining techniques. They shall identify probable contamination sources and compare findings with food safety standards. Deliverables include laboratory records, microbial data sheets.

10.5 Hospital or Diagnostic Laboratory Visit

Students will visit a clinical or diagnostic microbiology laboratory to observe specimen collection, microbial diagnostics, sterilization protocols, culture techniques, and biosafety procedures. Students shall prepare a structured observation checklist and submit a 400-word report on laboratory workflow and infection control practices.

10.6 Environmental Microbiology Field Study

Students will conduct field sampling from soil, wastewater, compost, or polluted environments to study microbial diversity and environmental contamination. They will analyze microbial populations and prepare comparative data tables with ecological interpretations. Final submission shall include sample records, photographs, and a environmental assessment report.

10.7 Microscopy and Staining Techniques Laboratory Exercise

In a supervised practical session, students will perform Gram staining, acid-fast staining, and fungal staining techniques on microbial samples. They shall identify microorganisms microscopically and prepare detailed laboratory records with labeled diagrams and interpretations.

10.8 Comparative Study of Fermented Products

Students will prepare and analyze fermented food products such as curd, bread, idli batter, or fermented beverages to study microbial activity and fermentation processes. They will document preparation methods, microbial observations, and biochemical changes during fermentation.

10.9 Molecular Biology and DNA Isolation Exercise

Students will isolate genomic DNA from bacterial or plant samples using standard laboratory protocols. They will assess DNA quality using spectrophotometric or gel electrophoresis methods and prepare a structured laboratory report with methodology, observations, and interpretation.

10.10 Bioinformatics and Database Exploration Exercise

Students will use online biological databases such as NCBI, PDB, and EMBL to retrieve microbial gene or protein sequences. They will perform sequence alignment and basic bioinformatics analysis using software tools. Submission shall include screenshots, sequence data, and interpretive report.

10.11 Industrial Fermentation Laboratory Exercise

Students will study fermentation processes using yeast or bacterial cultures for production of products such as alcohol, organic acids, or enzymes. They shall monitor growth conditions, pH changes, and product formation during fermentation. Deliverables include laboratory observations and a technical report.

10.12 Biosafety and Laboratory Audit Exercise

Students will inspect laboratory facilities using biosafety guidelines to evaluate sterilization practices, waste disposal methods, chemical handling, and personal protective measures. They shall prepare a structured biosafety audit report with recommendations for laboratory improvement.

10.13 Mandatory Industry Internship (4–8 Weeks)

Students shall complete a mandatory internship in pharmaceutical industries, biotechnology companies, diagnostic laboratories, food industries, environmental laboratories, hospitals, or research institutes. Internship activities may include laboratory assistance, microbial analysis,

documentation, quality control, or research work. Deliverables shall include a structured internship report, laboratory work diary, and supervisor evaluation certificate.

10.14 Research Project and Dissertation

Students shall undertake an independent or group research project related to microbiology, biotechnology, environmental microbiology, food microbiology, industrial microbiology, or public health. The project shall include proposal preparation, literature review, experimentation, data analysis, and report writing. Final submission shall include a dissertation and viva voce presentation before a faculty panel.

10.15 Scientific Seminar and Poster Presentation

Students shall prepare and present scientific seminars or posters on emerging microbiological topics such as antimicrobial resistance, vaccine technology, microbial biotechnology, environmental sustainability, or infectious diseases. Evaluation shall be based on scientific content, presentation skills, and analytical understanding.

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, project reports, internship work, field studies, and seminar presentations into a professional portfolio. Students shall deliver a presentation before a faculty panel followed by a viva voce examination assessing practical knowledge, laboratory competency, scientific understanding, and professional readiness.

11. Market Survey

The B.Sc. Microbiology course is studied because microbiology is a rapidly growing branch of life sciences that focuses on the study of microorganisms such as bacteria, viruses, fungi, algae, and protozoa, along with their role in human health, industry, agriculture, and the environment. The course combines theoretical knowledge with practical laboratory training to help students understand microbial physiology, genetics, immunology, medical microbiology, industrial microbiology, environmental microbiology, and molecular biology. Students gain technical expertise in microbiological techniques, microbial culture handling, staining methods, sterilization, fermentation technology, microbial analysis, and molecular diagnostic methods used in research laboratories and industries.

One of the major reasons students choose B.Sc. Microbiology is the increasing importance of microorganisms in healthcare and disease management. Microbiology plays a vital role in the diagnosis, prevention, and treatment of infectious diseases. Microbiologists contribute significantly to the development of antibiotics, vaccines, probiotics, diagnostic kits, and antimicrobial therapies. After the global impact of infectious diseases and pandemics, the demand for trained microbiology professionals has increased in hospitals, pharmaceutical industries, diagnostic laboratories, and public health organizations. The field also supports research in immunology, virology, microbial genetics, and antimicrobial resistance, which are among the most important emerging areas in modern healthcare systems.

The course also has strong industrial and environmental relevance. In industrial microbiology, microorganisms are used for the production of antibiotics, enzymes, organic acids, fermented foods, beverages, biofuels, and biopharmaceutical products. In food and dairy industries, microbiologists ensure food safety, quality control, preservation, and fermentation processes. Environmental microbiology contributes to waste management, sewage treatment, bioremediation, and pollution control through microbial processes. Agricultural microbiology supports sustainable farming through biofertilizers, biopesticides, and soil microbial management. These applications have created a continuous demand for microbiology graduates in industrial and environmental sectors.

The B.Sc. Microbiology course also provides wide career opportunities in research institutions, pharmaceutical companies, hospitals, food and dairy industries, water testing laboratories, forensic laboratories, public health organizations, biotechnology industries, and environmental agencies. Graduates can work as microbiologists, laboratory technicians, quality control analysts,

research assistants, medical laboratory professionals, food safety officers, or production executives in microbiology-related industries. Students may also pursue higher education such as M.Sc. Microbiology, Medical Microbiology, Industrial Microbiology, Biotechnology, Molecular Biology, Public Health, or Ph.D. programs for research and academic careers.

The increasing advancement in areas such as molecular diagnostics, vaccine technology, microbial genomics, industrial fermentation, environmental sustainability, and infectious disease research has significantly enhanced the scope of microbiology at national and international levels. Industries today require skilled professionals with laboratory expertise, analytical ability, problem-solving skills, and research aptitude. Therefore, the departmental action plan focuses on curriculum enrichment, laboratory skill development, research activities, industrial collaborations, internships, seminars, workshops, field visits, and professional training programs to bridge the gap between academics and industry requirements.

In addition, the course develops scientific temperament, critical thinking, analytical skills, teamwork, and research-oriented learning among students. Practical exposure through laboratory experiments, microbial analysis, industrial training, research projects, and scientific presentations helps students gain confidence and technical competency. As microbiology contributes directly to healthcare, food security, environmental sustainability, agriculture, and industrial development, B.Sc. Microbiology has emerged as one of the most significant and career-oriented programs in the field of biological sciences. Therefore, studying B.Sc. Microbiology provides students with strong academic knowledge, practical laboratory expertise, and diverse career opportunities to contribute effectively toward scientific advancement and societal welfare.

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.
Semester-1

Subject Code: 10170103	**Subject Title: Introductory Microbiology**
Pre-requisite: 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.	

Course Objective: (1) To explain the History, Scopes, Branches and Basics of microbiology.
(2) To explain the habitats and impart the knowledge regarding the pure culture techniques.
(3) Clear the concepts of cultivating various microorganisms on different types of media.
(4) To explore the preservation techniques for maintaining routine cultures.
(5) To impart information regarding various national and international culture collection centers.
(6) To train the students in staining techniques and clear the concepts of Microscopy.

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	**History and Scope of Microbiology:** Development of microbiology as a discipline, Spontaneous generation vs. biogenesis, Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Role of microorganisms in fermentation, Germ theory of disease. Development of various microbiological techniques and golden era of microbiology. Development in the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman. Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.	15	33%

	Branches and Scopes in Microbiology.		
2	**Habitats of Microorganisms:** Soil, Water, Air and others. **Pure culture Techniques and Cultivation:** Pure culture Techniques: Definition of Pure culture and Axenic culture, Mix culture, Methods for Pure culture techniques: Striking, Spreading, Serial Dilutions, Pour Plate methods. Cultivation of Anaerobic Bacteria. **Culture Media:** Principles of Media Formulation, Media Ingredients, Types of Media: Natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media, Sterilization. **Culture Collection Centers.** **Preservation Techniques:** Preservation of industrially important organism: Principle, methods and quality control.	15	34%
3	**Techniques used to study microorganisms:** **Microscopy:** Principles of Microscopy, magnification and resolving power, Light microscopy: Simple and compound microscope, bright field and dark field microscopy, Principles and applications of phase contrast, fluorescent and Electron microscopy. **Staining:** **Dyes and stains:** Definition, acidic, basic dyes and leuco compounds. **Smear:** Fixation, use of mordents, intensifiers and decolorizers Mechanism of staining. **Types of staining:** Simple and differential staining.	15	33%

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

1. Comprehend historical developments/branches and scopes in the field of Microbiology.
2. Comprehend various habitats of microorganisms.
3. Prepare Media in Laboratory and learn the basic skills of isolation and cultivation of microorganisms in laboratory.
4. Preserve Microbial cultures on various media.
5. Explain principles and working pattern of Microscopes.
6. Learn aspects of staining techniques, various dyes and smear preparation.

List of Text Books:

1. Dr. C. B. Powar and Dr. H. F. Daginawala, (2010), General Microbiology Volume-I. 2nd edn. Himalaya Publishing House.
2. Dr. C. B. Powar and Dr. H. F. Daginawala, (2010), General Microbiology Volume-II. 2nd edn. Himalaya Publishing House.
3. Pelczar Jr, M J, Chan E C S, Krieg N R, (2023), Microbiology: An Application Based Approach, 5th edn. McGraw-Hill Book Company, NY.

List of Reference Books:

1. Atlas R M, (2015), Principles of Microbiology, 2nd Edition, McGraw Hill education, Mumbai.

2. Ingraham J. L. and Ingraham C. A. Introduction to Microbiology: Thomson Brooks/Cole.
3. Microbiology: an introduction- Tortora, G.J., Funke, B.R. and Case, C.L.
4. Stanier, R.Y., Ingraham J. L., Wheelis, M. L. (1999). General Microbiology,5th Edition, Palgrave Macmillan.

Open e-Resource:

- Swayam Portal: General Microbiology - Course (swayam2.ac.in)
- OpenStax: Microbiology – OpenStax
- https://microbenotes.com/
- https://www.microbiologybook.org

List of Suggested Experiments

1. Awareness and knowledge of Lab apparatus. Dos and Don'ts-Criteria to be followed – Lab Discipline – Biosafety, Washing, Cleaning and preparation of glassware for sterilization. Disposal of laboratory waste and cultures. Preparation of standard solutions. Good Laboratory Practices. Good Documentation Practices.
2. Study of principles and working of laboratory instruments: Light microscope, Autoclave, Hot air oven, Incubator, Water-bath, Laminar Air Flow chamber, Rotary shaker, pH meter, Spectrophotometer/Colorimeter, Centrifuge, Refrigerator, Colony counter.
3. Basic Microbe handling techniques:
    a. How to inoculate Needles and wire loops
    b. Preparing suspensions
    c. Inoculating/transferring cultures
    d. Handling petri plates
    e. Incubating petri dishes, slants and broths
    f. Preparing smear
    g. Preparing serial dilutions
4. Study of Hay infusion.
5. **Staining of Bacteria:**
   Simple staining:
   Positive staining, Negative staining.
   Differential staining:
   Gram staining.
6. Preparation of Nutrient media: Nutrient agar and Nutrient broth.
7. pH adjustment of media by use of pH strip and pH meter.
8. Isolation and cultivation methods for bacteria from water, soil, curd and surface of table.
   Cultivation methods for bacteria:
    a. Broth culture
    b. Agar slope/slant culture
    c. Agar plate method
        i. Streak plate method

ii. Pour plate method
iii. Spread plate method
iv. Serial Dilution method

d. Cultivation of Anaerobic Bacteria.

9. Preservation Techniques:
    a. Periodic sub culturing and storage at refrigeration temperature
    b. Preservation in soil (fungi/Azotobacter)
10. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.

Gandhinagar Institute of Science
B.Sc.
Semester 1

Subject Code: 10170104	**Subject Title: Basic Bacteriology**
Pre-requisite: 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.	

Course Objective: (1) To impart the knowledge of Basic bacteriology, internal organs of bacteria, their structures and functions.
(2) To explore the classification scheme and taxonomy of Microorganisms.

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	**Overview of Bacteriology-I:** Cell size, shape and arrangement of bacteria, glycocalyx, capsule, flagella, endo-flagella, fimbriae and pili. **Cell-wall:** Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), spheroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. **Cell Membrane:** Structure, function and chemical composition of bacterial and archaeal cell membranes. **Cytoplasm:** Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.	15	33%
2	**Overview of Bacteriology-II:**	15	33%

	Nucleus: Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization Nucleolus. **Protein Sorting and Transport:** Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus Lysosomes.		
3	**Bacterial Systematics and Taxonomy:** Bacterial Systematics- Introduction to taxonomy, nomenclature and systematic Types of classification Taxonomic ranks Techniques for determining microbial taxonomy and phylogeny, Phylogenetic trees, Evolution of three domains of life.	15	34%

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

1. Comprehend size, shapes and arrangement of bacterial cells.
2. Comprehend detailed internal structure of Bacterial cell.
3. Understand classification system of Bacteria and its Taxonomical bifurcation.

List of Text Books:

1. Dr. C. B. Powar and Dr. H. F. Daginawala, (2010), General Microbiology Volume-I. 2nd edn. Himalaya Publishing House.
2. Dr. C. B. Powar and Dr. H. F. Daginawala, (2010), General Microbiology Volume-II. 2nd edn. Himalaya Publishing House.
3. Pelczar Jr, M J, Chan E C S, Krieg N R, (2023), Microbiology: An Application Based Approach, 5th edn. McGraw-Hill Book Company, NY.

List of Reference Books:

1. Atlas R M, (2015), Principles of Microbiology, 2nd Edition, McGraw Hill education, Mumbai.
2. Ingraham J. L. and Ingraham C. A. Introduction to Microbiology: Thomson Brooks/Cole.
3. Microbiology: an introduction- Tortora, G.J., Funke, B.R. and Case, C.L.
4. Stanier, R.Y., Ingraham J. L., Wheelis, M. L. (1999). General Microbiology,5th Edition, Palgrave Macmillan.

Open e-Resource:

- Swayam Portal: General Microbiology - Course (swayam2.ac.in)
- OpenStax: Microbiology – OpenStax
- https://microbenotes.com/
- https://www.microbiologybook.org

List of Suggested Experiments

1. Preparation of different media:
   - **a.** Selective Media: Rose Bengal agar,
   - **b.** Differential Media: McConkey agar, EMB agar, McConkey broth, Triple sugar ion agar,

   c. Enrichment Media: Selenite Broth, Glucose Yeast Extract agar,
   d. Natural Media: Soil Extract Agar Medium
2. Cell wall staining by Dyar's method
3. Capsule staining by Hiss's method
4. Granule staining by Albert's method
5. Endospore staining by Dorner's method
6. Acid fast staining
7. Spirochaetes staining by Fontana's method
8. Motility by hanging drop method.
9. Study of permanent slides of different groups of Bacteria:

   Prokaryotes:

   Bacteria: Cocci, Short rods, Bacilli, Spirochetes, Curved bacteria, Filamentous bacteria – Actinomycetes
10. Microscopic Measurements - Micrometry

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc.

Semester-1

Subject Code: 10140103	**Subject Title:** Fundamental Chemistry-I
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	-	02	04	50	50	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.	10	23%

	Stereoisomerism with two chiral centers: Diastereomers, Mesoisomers, Resolution of racemic modification. **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. /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 Institute of Science

B.Sc. Microbiology

Semester 2

Subject Code: 10170204	**Subject Title: Food Microbiology**
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 and he/she may have complete Certificate Course (First Year, B.Sc.) with Basic Microbiology and Chemistry subjects.	

Course Objective:

(1) This course is intended to teach the students the relationship of micro-organisms with food and dairy products.

(2) To obtain the knowledge about important genera of microorganisms associated with food and their characteristics.

(3) To learn various techniques for enumeration and control of microorganisms in food.

(4) To gain the essential knowledge and applications of various techniques (traditional to advanced) for preserving food.

(5) To understand the role of different microorganisms in food spoilage, food fermentation and food-borne 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	**Microbiology of Food:** Basic concepts and scope of food and dairy microbiology. Foods as a substrate for microorganisms. Composition and nutritive values in food. Study of primary sources of microorganisms in foods and their mode of transmission. Effect of intrinsic (pH, moisture content) and	15	34%

	extrinsic (temperature and relative humidity) factors on microbial growth in various foods. **Food preservation:** Methods of food Preservation Comparison of shelf life of pasteurized, UHT milk, raw milk both at low and room temperature. Aseptic packaging – layers of tetra packs and comparison of shelf life of such packaged fruit juices. Study of specimens of various canned foods (vegetables, fruits, pickles etc.) and treatments given to them for preservation. Food preservation: Physical, chemical and biological methods.		
2	**Microbial spoilage of various foods:** Principles, Biochemical reactions influencing food quality, Study of milk, vegetables, fruits, bread, meat and egg samples. **Food intoxications:** *Staphylococcus aureus, Clostridium botulinum* and mycotoxins. **Food infections:** *Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica, Listeria monocytogenes* and *Campylobacter jejuni*.	15	33%
3	**Fermented Foods, Beverages and Dairy products Fermented foods:** Dosa, Idli, Sauerkraut, Soy sauce and Tampeh; Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi, buttermilk and cheese. Probiotics/Prebiotics: Health benefits, types of microorganisms used, probiotic foods available in market. Beverages and fermentation process: wine and beer.	15	33%

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

1. Define the fundamental concepts and scope of food and dairy microbiology.
2. Explain the principles of food preservation and methods to slow microbial growth.
3. Recognize the characteristics of important pathogens and spoilage microorganisms in food.
4. Examine the food borne diseases in the human body.
5. Prepare the various fermented food products with the help of starter cultures.
6. Explain food sanitization process, control and inspection.

List of Text Books:

- Pelczar Jr, M J, Chan E C S., Krieg N R, (1986) Microbiology, 5th edn, McGraw-Hill Book Company, NY.
- Frazier WC and Westhoff DC. (2005). Food Microbiology. 5th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.

List of Reference Books:

- Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.

- Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
- Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
- Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
- Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
- Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

Open e-Resource:

- https://www.onlinebiologynotes.com/
- https://microbiologynotes.org/
- https://www.easybiologyclass.com/
- https://microbiologyinfo.com/
- https://thebiologynotes.com/
- http://asm.org/articles/2020/december/virtual-resources-to-teach-microiology-techniques

List of Suggested Experiments

1. Methylene Blue Reduction Test of milk samples (MBRT).
2. Isolation and characterization of spoilage microorganisms from vegetable/fruit/milk-milk products.
3. Preparation of Yoghurt/curd/probiotic curd/probiotic lassi using pure culture.
4. Standard plate count from vegetables and fruit juices, milk-milk products, soft drink (Any available in Market).

Gandhinagar Institute of Science
B.Sc.
Semester 1

Subject Code: 10170104	**Subject Title: Basic Bacteriology**
Pre-requisite: 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.	

Course Objective: (1) To impart the knowledge of Basic bacteriology, internal organs of bacteria, their structures and functions.
(2) To explore the classification scheme and taxonomy of Microorganisms.

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	**Overview of Bacteriology-I:** Cell size, shape and arrangement of bacteria, glycocalyx, capsule, flagella, endo-flagella, fimbriae and pili. **Cell-wall:** Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), spheroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. **Cell Membrane:** Structure, function and chemical composition of bacterial and archaeal cell membranes. **Cytoplasm:** Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.	15	33%
2	**Overview of Bacteriology-II:**	15	33%

	Nucleus: Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization Nucleolus. **Protein Sorting and Transport:** Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus Lysosomes.		
3	**Bacterial Systematics and Taxonomy:** Bacterial Systematics- Introduction to taxonomy, nomenclature and systematic Types of classification Taxonomic ranks Techniques for determining microbial taxonomy and phylogeny, Phylogenetic trees, Evolution of three domains of life.	15	34%

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

1. Comprehend size, shapes and arrangement of bacterial cells.
2. Comprehend detailed internal structure of Bacterial cell.
3. Understand classification system of Bacteria and its Taxonomical bifurcation.

List of Text Books:

1. Dr. C. B. Powar and Dr. H. F. Daginawala, (2010), General Microbiology Volume-I. 2nd edn. Himalaya Publishing House.
2. Dr. C. B. Powar and Dr. H. F. Daginawala, (2010), General Microbiology Volume-II. 2nd edn. Himalaya Publishing House.
3. Pelczar Jr, M J, Chan E C S, Krieg N R, (2023), Microbiology: An Application Based Approach, 5th edn. McGraw-Hill Book Company, NY.

List of Reference Books:

1. Atlas R M, (2015), Principles of Microbiology, 2nd Edition, McGraw Hill education, Mumbai.
2. Ingraham J. L. and Ingraham C. A. Introduction to Microbiology: Thomson Brooks/Cole.
3. Microbiology: an introduction- Tortora, G.J., Funke, B.R. and Case, C.L.
4. Stanier, R.Y., Ingraham J. L., Wheelis, M. L. (1999). General Microbiology,5th Edition, Palgrave Macmillan.

Open e-Resource:

- Swayam Portal: General Microbiology - Course (swayam2.ac.in)
- OpenStax: Microbiology – OpenStax
- https://microbenotes.com/
- https://www.microbiologybook.org

List of Suggested Experiments

1. Preparation of different media:
   - **a.** Selective Media: Rose Bengal agar,
   - **b.** Differential Media: McConkey agar, EMB agar, McConkey broth, Triple sugar ion agar,

   c. Enrichment Media: Selenite Broth, Glucose Yeast Extract agar,
   d. Natural Media: Soil Extract Agar Medium
2. Cell wall staining by Dyar's method
3. Capsule staining by Hiss's method
4. Granule staining by Albert's method
5. Endospore staining by Dorner's method
6. Acid fast staining
7. Spirochaetes staining by Fontana's method
8. Motility by hanging drop method.
9. Study of permanent slides of different groups of Bacteria:

   Prokaryotes:

   Bacteria: Cocci, Short rods, Bacilli, Spirochetes, Curved bacteria, Filamentous bacteria – Actinomycetes
10. Microscopic Measurements - Micrometry

Gandhinagar Institute of Science
B.Sc. Microbiology
Semester 2

Subject Code: 10170203	**Subject Title: Nutritional Pattern in Microorganisms**
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 and he/she may have complete Certificate Course (First Year, B.Sc.) with Basic Microbiology and Chemistry subjects.	

Course Objective:

(1) To make the students to understand the physiology of microbes in detail.
(2) To make students aware about the nutritional pattern of microbes and their mode of nutrition uptake.
(3) To make students learn about basics of enzymes and other biomolecules.
(4) To teach student Microbial Growth pattern.

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	**Microbial Nutrition and Growth supporting conditions:** **Culture media: Types of culture media:** Routine and specialized media; Selective media, differential media, enriched media, enrichment media, enumeration media, assay media and maintenance media. **Modes of nutritional uptake: a.** Entry of nutrition in the cell, passive diffusion, facilitated diffusion and active transport **b.** Utilization of nutrients that cannot enter the cell**.** **Classification** of bacteria on the basis of growth supporting environmental factors such as oxygen, temperature, pH, osmotic pressure, salt and hydro static pressure.	15	33%

2	**Microbial growth:** **Methods of reproduction in bacteria and new cell formation:** **Microbial Growth:** a. Introduction to growth rate, generation time b. Criteria for growth measurement: Cell mass and cell number, methods of c. their measurement d. Normal growth curve of bacteria e. Continuous growth and synchronous growth.	15	33%
3	**Enzymes:** **General introduction: a.** Physical and chemical properties **b.** Structure of enzymes: Prosthetic group, apoenzyme, coenzymes, cofactors **c.** Localization of enzymes: Extra cellular and intra-cellular **d.** Nomenclature and classification of enzymes, lUB system of enzyme classification. **Enzyme action: a.** Active sites of enzymes **b.** Mechanism of enzyme action **c.** Factors affecting enzyme activity **d.** Inhibition of enzyme activity: Competitive and non-competitive.	15	34%

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

1. Understand the concept of Nutrition of the Bacteria and develop an understanding of growth and various parameters affecting to the growth also get the information about how bacterial cell uptake nutrition from the media, Students will understand Classification of bacteria on the basis of different parameters.
2. Students will Gain knowledge about the properties of enzymes and how it works& what is the structure of enzyme, Role of enzymes in Microbial cell also students can learn about what factors will affect the optimum activity of enzymes and how enzymes can inhibit their over acting activity
3. Also, by this paper learning students will aware profoundly about how bacteria and other Microbial cell can reproduce, how new cell formation process will occur, what is growth, how growth can be measured, how was the life cycle of bacteria, what are different types of growth.
4. Basic understanding of bio-molecules and their role in metabolism.

List of Text Books:

- Microbial physiology (4th ed.) Moat, A.G., Foster, J, W., and Spector, M. P. Wiley, Liss. New York; 2002.
- Pelczar Jr, M J, Chan E C S, Krieg N R, (2023), Microbiology: An Application Based Approach, 5th edn. McGraw-Hill Book Company, NY.

List of Reference Books:

- Bacterial Metabolism. (2nd ed.) Gerhardt, G. Springer, 1986.
- Bacterial Physiology and Metabolism. Sokatch, J. R. (2014). Academic Press, New York.
- Biochemistry and Physiology of microorganisms (3rd ed.) David White. Oxford University Press; 2007.
- Black J G, (2015) Microbiology: Principles and Explorations, 9th edn, John Wiley and Sons, Inc. NY.
- Brock's Biology Microorganisms (14th ed.) Madigan, M.T., Martinko, J. M., Bender, K.S., Buckley, D.H., Stahl, D. A., Benjamin Cummings.

- Ingraham J L, and Ingraham, C L, (2000) Introduction to Microbiology, 2nd edn, Brooks/Cole, Singapore.
- Lehninger's Principles of Biochemistry. (8th ed.) Nelson, D.L. & Cox, M. M. W. H. Freeman & Co. NY; 2021.

Open e-Resource:

- https://www.onlinebiologynotes.com/
- https://microbiologynotes.org/
- https://www.easybiologyclass.com/
- https://microbiologyinfo.com/
- https://thebiologynotes.com/

List of Suggested Experiments

1. **Study of different types of media:**
   A. Selective media: Rose Bengal agar medium B. Differential medium: MacConkey's agar medium, EMB agar medium, Triple sugar iron agar medium C. Enrichment media: Selenite broth D. Enriched media: Blood agar medium, Glucose yeast extract agar medium E. Natural media: Soil extract agar medium.
2. **Qualitative analysis of biomolecules:**
   A. Carbohydrates: Iodine test, Molisch's test, Benedict's test, Barfoed's test, Bial's test
   B. Protein: Biuret test, Ehrlich's test, Glyoxilic acid test and Xanthoproteic test.
3. **Study of effect of Environmental factors on growth of bacteria:**
   A. Study the effect of heavy metal on the growth of bacteria.
   B. Study the effect of temperature on the growth of the bacteria.
   C. Study the effect of pH on the growth of the bacteria.
   D. Study the effect of osmotic pressure on the growth of the bacteria.
   E. Study the effect of UV light on the growth of the bacteria.
4. **Study of Biochemical reactions:**
   A. Based on Carbon source i. Oxidative and fermentative breakdown of glucose ii. Fermentation of Sugars: Glucose, Xylose, Mannitol, Lactose, Maltose and Sucrose iii. Glucose breaks down products: Methyl red test and Voges Proskauer's test iv. Citrate utilization test v. Starch utilization test vi. Lipid utilization test.
   B. Based on Nitrogen source i. Indole production test ii. H_2S production test iii. Urea utilization test iv. Casein hydrolysis test v. Gelatin Hydrolysis test vi. Deamination test vii. Ammonia production test viii. Nitrate reduction test.
   C. Other tests i. Catalase test ii. Dehydrogenase test iii. Oxidase test.
5. Methylene Blue Reduction Test of milk samples (MBRT).
6. Isolation and characterization of spoilage microorganisms from vegetable/fruit/milk-milk products.
7. Preparation of Yoghurt/curd/probiotic curd/probiotic lassi using pure culture.
8. Standard plate count from vegetables and fruit juices, milk-milk products, soft drink (Any available in Market).

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

Subject Code: 10170304	**Subject Title: Soil & Water Microbiology**
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:

- To teach students regarding the basics of soils and microbiology related to soil including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.
- Understand basic requirements of clean water.
- Understand the industrial process, water utilization and wastewater generation.
- Have knowledge on selection of treatment methods for drinking water, sewage water and industrial wastewater.
- Understand, inspect, and resolve operational problems of common effluent treatment plants.
- Imply Physio chemical and biological treatment methods for recovery, reuse, and disposal of all types of water. Also, they should be able to search the ways of minimizing wastewater.
- 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	**-**	**02**	**04**	**50**	**50**	**25**	**25**	**150**

Sr. No.	Topic	Total Hours	Weight %
1	**Soil:** Definition, composition, structure and characteristic features of soil, soil as a substrate for microbial growth, Biotic and Abiotic factors in soil development. **Soil biota:** Occurrence, characteristic features of microorganisms present in soil; types of organisms in different soils. **Microbial interactions:** Symbiosis, Synergism, Commensalism, Ammensalism, Predation and Parasitism**.** **Methods of studying soil microorganisms:** Culture dependent and independent methods, buried slide technique and soil respiration technique. **Interaction between plant roots and microorganisms:** Mycorrhizal associations- structure, characteristics mechanism and their role in Agriculture and Forestry.	**11**	**25%**
2	**Introduction to biogeochemical transformations in soil:** Mineralization and immobilization of elements **Rotation of elements in nature** A. **Nitrogen Cycle**- ammonification, nitrification and denitrification, utilization of various nitrogen sources. Symbiotic and asymbiotic nitrogen fixation B. **Sulphur Cycle-** source of Sulphur, Sulphur oxidizing and reducing microorganisms (Role of *Thiobacillus sp*. and *Desulfovibrio sp*.), Sulphate and Sulphur reduction process, H2S formation, role of *Thiobacillus* in soil reclamation. C**. Carbon Cycle-** Significance of carbon cycle, Fundamentals of biodegradation, Factors affecting biodegradation, co-metabolism and biotransformation, D. **Iron Cycle-** microbial transformation of Iron, Siderophores and antimicrobials. E. **Phosphorous Cycle-** source of organic and inorganic phosphates in soil and elsewhere, mineralization of inorganic phosphates, factors affecting phosphate solubilization and mechanism. Role and importance of Phosphate solubilizing bacteria. **Soil fertility**: Biofertilizers	**12**	**25%**
3	**General:** Hydrologic cycle, factors affecting kinds of microorganisms found in aquatic environments and nutrient cycles in aquatic environments. **Microbiology of drinking water:** Sources, contamination and characterization **Nuisance organisms in drinking water:** Slime forming bacteria, Iron and Sulfur bacteria and Algae, water borne diseases. **Microbial indicators of faecal pollution in drinking water:** Coliforms as indicator, Methods for differentiation: IMViC test and Elevated temperature test, Microbial indicators other than coliforms.	**11**	**25%**

4	**Bacteriological examination of drinking water:** Sampling, Quantitative analysis, Standard Plate Count, Qualitative analysis: Multiple tube fermentation method (presumptive, confirmed and completed test), MPN, Membrane filtration technique, defined substrate test, P-A (Presence-Absence) test. **Microbiology of wastewater**: Types of waste water, Chemical and Microbiological characteristics of waste water. **Methods of wastewater treatment**: Primary treatment and secondary treatment. − Principles and role of microorganisms in septic tank, Imhoff tank, trickling filters, activated sludge process, oxidation ponds. Advanced treatment and final treatment. BOD, COD and TOD as indicators of untreated waste water, Pollution problems due to disposal of untreated wastewater.	**11**	**25%**

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

CO1: Understand the composition of soil and determination of microbial diversity. Explain the diversity of microbes and biogeochemical cycles and their significance.

CO2: Know the mechanism involved in biodegradation of soil organic matter / organic waste and crop residues (Agricultural waste). Learn a firm foundation and knowledge of sources, characterization process and microbial aspects of water.

CO3: Define and reason about fundamental concepts of water and wastewater treatment.

CO4: Design and conduct experiments and the ability to analyse the data, interpret results and draw conclusions related to water-borne diseases and precautions to be followed.

CO5: 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.

List of Textbooks:

Pelczar Jr, M J, Chan E C S., Krieg N R, (1986) Microbiology, 5th edn, McGraw-Hill. Book Company, NY.

List of Reference Books:

- Agrios GN (2006) Plant Pathology, 5th ed., Academic press.
- Alexander M, (1977), Soil Microbiology, 2nd Edition Krieger Publ. Co. Melbourne, FL.
- Atlas R M, (1977), Principles of Microbiology, 2nd Edition, Wm. C. Brown Publ. Iowa USA
- Coyne MS (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
- Dubey RC and Maheshwari DK (2013). Textbook of Microbiology. S. Chand Publishers.
- "Handbook of microbiological media", by Atlas, R. M., 1993, CRC Press, Inc. Florida.1.
- "Laboratory exercises in Microbiology", by Harlcy Prescott, 2002, 6th edition, The MaCraw-Hill.
- Modi HA (2013). Soil Microbiology, Aavishkar Publishers, Jaipur.
- Pelczar Jr. MJ, Chan ECS & Krieg NR (2001). Microbiology. Indian ed., McGraw-Hill.

List of Suggested Practical

1. Enumeration of organisms from soil (Standard plate count).
2. Isolation and cultivation of symbiotic and non-symbiotic nitrogen fixing bacteria, Actinomycetes and Fungi (Mucor, Rhizophus, Aspergillus and Penicillium) from soil.
3. Preparation of Natural media: Soil extract agar medium
4. Study microflora of different types of soil.
5. Microbial Examination of Water (SPC)
6. Qualitative analysis of Soil and water by presumptive, confirmed and completed test.
7. MPN test for detection of coliforms.
8. Determination of BOD of water.
9. Determination of COD of water.
10. Determination of TOC of water.

Open e-Resource:

- https://www.onlinebiologynotes.com/
- https://microbiologynotes.org
- https://www.easybiologyclass.com/
- https://microbiologyinfo.com/
- https://thebiologynotes.com/
- http://asm.org/articles/2020/december/virtual-resources-to-teach-microiology-techniques

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Microbiology / Biotechnology

SEMESTER-3

Subject Code: 10170305	**Subject Title:** Ecology and Ecosystem
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) This paper will introduce to the students the basic understanding of ecosystem and its structural and functional aspects.

(2) It will explore the interconnectedness among all the biotic and abiotic components of environment and the dynamic nature of the ecological processes in maintaining equilibrium in nature.

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	Basic concepts and definitions: ecology, ecosystems, resistance and resilience; autecology; synecology; major terrestrial biomes, Biogeochemical cycles and sedimentary cycle, role of mycorrhizae; decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies.	11	25%
2	Concept of population and meta-population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent; limits to population growth; deterministic and stochastic models of population dynamics; rudreal, competitive and stress-tolerance strategies.	12	25%
3	Types of ecosystem: forest, grassland, lentic, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; ecosystem boundary; ecosystem function; ecosystem metabolism; primary production and models of energy flow; secondary production and trophic efficiency	11	25%
4	Ecosystem connections: food chain, food web; detritus pathway of energy flow and decomposition processes; ecological efficiencies; ecological	11	25%

	pyramids: pyramids of number, biomass, and energy, ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake.		

Course Outcomes:

- Develop an appreciation of the modern scope of scientific inquiry in the field of Ecology.
- Become familiar with the variety of ways that organisms interact with both the physical and the biological environment.
- Develop an understanding of the differences in the structure and function of different types of ecosystems.
- Learn techniques of data analysis as well as methods of presenting scientific information in figures and tables.
- Develop an appreciation of the natural world through direct experience with local ecosystems.

List of Text Books:

1. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications.
2. Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. The Ecology of Plants. Sinaue associates incorporated.

List of Reference Books

1. Loreau, M. & Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
2. Groom. B. & Jenkins. M. 2000.Global Biodiversity: Earth's Living Resources in the 21st Century. World Conservation Press, Cambridge, UK.
3. Sawyer, C. N. and Mc Carty, P. L. (1978). Chemistry for Environmental Engineering. Mc Graw – Hill International.
4. Saxena M M. (1990). Environmental Analysis: Water, Soil and Air. Edition, Publisher, Agro Botanical Pub.
5. Standard Methods for Examination of Water and Wastewater. (2017). APHA – WEF.
6. Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publication.

List of Suggested Experiments

1. Determination of moisture content in soil sample.
2. Estimation of Chlorides – Argentometric method
3. Estimation of Dissolved Oxygen – Modified Winkler's method
4. Determination of the chemical oxygen demand (COD) of given water sample
5. Determination of biochemical oxygen demand (BOD) of given water sample
6. Determination of Electrical Conductance – Conductivity meter method
7. Estimation of Sulphates – Barium chloride method
8. Estimation of Turbidity – Nephelometric method

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

Subject Code: 10170306	**Subject Title:** Fundamental Biochemistry
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 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 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 Text Books:

- "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
B.Sc. Microbiology
Sem-4

Subject Code: 10170404	**Subject Title: Microbial Genetics**
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 and he/she may have completed a Certificate Course (First Year, B.Sc.) with Basic Microbiology and Chemistry subjects.	

Course Objective:

- To gain a thorough understanding of the basic principles of molecular biology.
- To understand the tools of DNA technology.
- To impart knowledge regarding structure of the prokaryotic genetic material, know the replication and repair mechanisms as well as the organizational variability they present and the relationship between these mechanisms and the cell cycle.
- To give insight to students about the mutations; their types and consequences; they shall know about the different repair mechanisms present in the prokaryotic system.

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	**Genetic material and its replication:** **1. Nature of Genetic material:** **A. Understanding of terms:** Chromosome, Nucleoid, Plasmid, Genome, Genetic material, Gene, Genotype, Phenotype, Replicon. **B. Experimental proof for DNA as genetic material:** Work of Griffith; Avery, McCarty and MacLeod; Hershey and Chase. **2. Structure of DNA:** A. The elucidation of DNA structure B. Watson-Crick's model of DNA **3. Replication of DNA:**	11	33%

	A. Semi conservative nature, Meselson and Stahl's experiment. B. Molecular mechanism: Strand separation, Synthesis of RNA primer, Formation of leading strand and lagging strands, Removal of primer, Joining of Okazaki Fragments, Proof reading activity of DNA polymerase. C. Patterns of DNA replication: Cairn's (Ø) model and Rolling Circle Mechanism (σ model).		
2	**Gene expression and regulation:** **1. Fundamentals:** A. Central Dogma: The flow of genetic information B. Structure of the protein coding gene **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	11	34%
3	**Mutation and DNA repair:** **1. Types of mutation:** A. Spontaneous mutations (i) Experimental proof for spontaneous nature of mutation: work of Joshua and E. Leaderberg (ii) Transition, Transversion, Insertion, Deletion, Development of AP sites B. Induced mutations (i) Chemical mutagenesis by 5-bromouracil, methyl-nitrosoguanidine and acridine orange (ii) Physical mutagenesis by UV radiations (iii) Biological mutagenesis by phage Mu **2. Transposable elements: Properties, Insertion Sequences (IS), Tn elements, Transposon mutagenesis** **3. Effects of mutation in protein coding gene** A. Forward mutations: silent, missense, nonsense, frame shift B. Reverse mutation: true reversion C. Suppressor mutation: intragenic and extragenic **4. Classes of bacterial mutants:** Morphological, conditional, biochemical (nutritional) and resistant mutants	11	33%

	5. DNA repair mechanisms A. Direct: Photo-reactivation repair B. Indirect: Excision (base and nucleotide) repair, Mismatch repair C. SOS repair system.		
4	**Gene transfer among bacteria:** **1. Fundamentals:** Zygote, Allele, Recombination, Horizontal and Vertical gene transfer, Production and fate of merozygote. **2. Bacterial plasmids:** General properties, functional types of plasmid, maintenance of plasmids. **3. Gene transfer mechanisms:** A. Transformation: Competent cell, natural transformation and DNA uptake system in Gm +ve and Gm -ve bacteria, artificial transformation of bacteria using plasmid. B. Transduction: i. Lytic and Lysogenic life cycles of bacteriophage ii. Generalized and Specialized transduction C. Conjugation: Formation of mating pairs, F+ X F- Mating, Hfr Conjugation, F' Conjugation.	12	25%

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:

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. Principles of Microbiology, R. M. Atlas, 2nd Edition (Indian Edition) (2015), McGraw Hill Education (India) Private Limited –New Delhi.

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 2. Becker WM, Kleinsmith LJ.

Open e-Resource:

- https://onlinecourses.swayam2.ac.in/cec22_bt05/preview
- https://ocw.mit.edu/courses/7-13-experimental-microbial-genetics-fall-2008/
- https://unacademy.com/content/csir-ugc/study-material/life-sciences/microbial-genetics/
- https://www.microbiologyresearch.org/
- https://www.handbook.unsw.edu.au/undergraduate/courses/2023/BABS3021
- https://ocw.mit.edu/courses/7-014-introductory-biology-spring-2005/resources/15-bacterial-genetics/

List of Suggested Experiments:

1. Isolation of lac— mutants of Escherichia coli using UV radiations as mutagen.
2. Isolation of pigment less mutant of Serratia marcescens using UV radiations as mutagen.
3. Isolation of streptomycin resistant mutants of *Escherichia coli* by gradient plate method.
4. Isolation of drug/biochemical mutants of *E.coli* by replica plating technique.
5. Isolation of DNA (Demonstration only).

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 Institute of Science
B.Sc. Microbiology
Sem-4

Subject Code: 10170406	**Subject Title: Virology**
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 the history, classification and properties of viruses.
- To understand the different subviral entities.
- To acquire knowledge about methods used for isolation, cultivation, and assay of viruses.
- To learn about bacteriophage, plant viruses and animal viruses

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	**History**: History, origin and evolution of viruses, pioneers of Virology. Nomenclature and classification of viruses: Criteria used for naming and classification, Current ICTV classification of viruses of bacteria, plants and animals and humans. **Morphology and properties of viruses**: Chemical composition, nucleic acids, proteins, enzymes, lipids, carbohydrates, polyamines, cations, virus stability; **Transmission of viruses**: Non-vector and vector mode of transmission of viruses.	12	25%

2	**Isolation, cultivation and maintenance of viruses**: Isolation and cultivation of plant and animal viruses (experimental plants and tissue culture, experimental animals, embryonated eggs, organ cultures, primary and secondary cell cultures, suspension and monolayer cell cultures, cell strains, cell lines). **Assay of viruses:** Infectivity assay methods (plaque, pock, end point, local / systemic assay of plant viruses), physical (EM), serological (HA, HI, immunofluorescence, ELISA) and molecular (viral protein and nucleic acid based) approaches.	8	25%
3	**Bacteriophages:** Lytic cycle (T4 Phage); One step growth curve experiment, burst size; Phage adsorption and penetration, intracellular development, early and late events, replication of phage chromosome, phage morphogenesis (assembly) and release. **Single stranded DNA and RNA phages**: ΦX174 and MS2. Lysogenic cycle (lambda phage): Mechanism of establishment, induction, and replication.	15	25%
4	**Plant Viruses**: Introduction and replication of plant viruses (TMV) **Animal viruses**: Introduction and replication (adsorption, penetration, uncoating, replication,synthesis and assembly, and release) of animal viruses in general (HIV) **Subviral entities:** viroids, virusoids, prions, introduction to persistent, latent and slow viruses, oncogenic viruses	10	25%

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

CO1: Gain knowledge about the morphology and transmission of viruses.
CO2: Gain insight about the isolation and cultivation of viruses. Learn different assay use to study viruses
CO3: Acquiring an understanding of mechanism lytic and lysogenic cycle phage.
CO4: Understand about the life cycle of plant and animal viruses. Also learn about subviral entities.

List of Text Books:

Virology (2019), P. Saravanan.
Introduction to Modern Virology. (2001). 5th ed. Dimmock et al., Blackwell Sci. 17 Publ.

List of Reference Books:

1. Evidence-Based Diagnosis: An Introduction to Clinical Epidemiology 2nd Edition, by Thomas B. Newman, Michael A. Kohn (2020).2 edition, Publisher: Cambridge University Press.

2. Virusphere: From Common Colds to Ebola Epidemics--Why We Need the Viruses That Plague Us (2020). 1st edition, Frank Ryan (Author), Publisher: Prometheus.
3. Guide to Clinical and Diagnostic Virology (2019), (ASM Books) 1st Edition, by Reeti Khare, Publisher: ASM Press.
4. Recent Advances in Animal Virology (2019) 1st Edition, Kindle Edition, by Yashpal Singh Malik, Raj Kumar Singh, Mahendra Pal Yadav, 471 pages, Publisher: Springer
5. Virology (2017) Ren Warom, Titan Books.
7. Virus: An Illustrated Guide to 101 Incredible Microbes (2016), 1st Edition (ASM Books) Fourth Edition, by Marilyn J. Roossinck, Carl Zimmer,Publisher: Princeton University Press.
8. A Planet of Viruses: (2015) 2nd ed, by Carl Zimmer (2015) University of Chicago Press.

Open e-Resource:

- https://onlinecourses.swayam2.ac.in/cec21_bt18/preview
- https://youtu.be/gjr1l3KlIdU
- https://virologyresearchservices.com/2022/11/13/alphaviruses/
- https://virologyresearchservices.com/2022/09/04/the-virus-of-the-month-hiv/

List of Suggested Experiments:

- Study of symptoms caused by plant viruses
- Bioassay of virus cultures on indicator plants and host differentials
- Mechanical Transmission of plant viruses through sap and study of disease development
- Isolation of bacteriophages from sewage water
- Cultivation of viruses in embryonated eggs: different routes of inoculation.
- Sap, aphid and graft transmission of plant viruses.
- Determination of stability of plant virus in cell sap- TIP, DEP, LIV.
- Determination of chlorophylls in healthy and virus infected leaves

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 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
Bachelor of Science - Microbiology
Semester-V

Subject Code: 10170502	Subject Title: Immunology-II
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 Diploma Course (First Year, Second Year B.Sc.) with Basic Microbiology and Chemistry subjects.	

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 - Microbiology
Semester-V

Subject Code: 10170503	Subject Title: MLaboratory - V
Pre-requisite: Students should have a basic understanding of: • Fundamental knowledge of cell biology and genetics. • Basic understanding of DNA, RNA, and proteins. • Introductory biochemistry and medical microbiology.	

Course Objective: This course aims to:

- To provide in-depth understanding of gene regulation in prokaryotes and eukaryotes.
- To study molecular mechanisms of gene expression control in development and disease.
- To familiarize students with modern molecular biology tools and 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)				
				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	Study of Gene Expression Using Lac Operon (ONPG Assay).	8 hours per week	Equal weightage to each experiment.
2	Isolation and Visualization of Genomic DNA from Bacteria/Plants.		
3	Agarose Gel Electrophoresis of DNA.		
4	DNA Quantification by UV Spectrophotometry.		
5	Restriction Enzyme Digestion of DNA.		
6	RNA Isolation from Plant Tissues.		

7	Slide and tube agglutination tests (e.g., Widal test for *Salmonella* antibodies).		
8	Precipitation reaction: Ouchterlony double diffusion or radial immunodiffusion.		
9	ELISA (Enzyme-linked immunosorbent assay) for detection of antigen or antibody (e.g., HBsAg, HIV).		
10	Western blotting (demonstration or interpretation of pre-run blot for antigen detection).		
11	ABO and Rh blood group determination using slide agglutination.		
12	Quantitative estimation of immunoglobulins by radial immunodiffusion (RID).		

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

CO1: Apply modern molecular biology tools in experimental design and data analysis.

CO2: Evaluate the significance of non-coding RNAs in gene expression.

CO3: Understand and explain the structure, function, and coordination of non-specific and specific host defence mechanisms.

CO4: 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.

List of Text Books:

- Genes XII – Benjamin Lewin, Jones and Bartlett.
- Molecular Biology of the Gene – Watson et al., Pearson.
- Molecular Cell Biology – Lodish et al., W.H. Freeman.

List of Reference Books:

- Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (Year). Roitt's essential immunology (Edition). Publisher.
- Epigenetics – C. David Allis et al., Cold Spring Harbor Laboratory Press.
- Lydyard, P., Whelan, A., & Fanger, M. (2003). Immunology (3rd ed.). Garland Science.
- Molecular Biology – Robert Weaver, McGraw-Hill.
- Molecular Biology: Principles of Genome Function – Nancy Craig et al., Oxford.
- Principle and practice of Immunoassay (IInd ed.) Christopher P. Price and David J.
- RNA Worlds – Gesteland, Cech, Atkins, Cold Spring Harbor Laboratory Press.

Open e-Resource:

- NCBI Bookshelf – https://www.ncbi.nlm.nih.gov/books/
- Cold Spring Harbor Protocols – https://cshprotocols.cshlp.org/
- iBiology Lectures – https://www.ibiology.org/
- Nature Reviews Molecular Cell Biology – https://www.nature.com/nrm/
- EMBL-EBI Training – https://www.ebi.ac.uk/training/online/
- https://onlinecourses.swayam2.ac.in/cec24_bt09/preview
- https://www.immunopaedia.org.za/immunology/
- https://pll.harvard.edu/course/hmx-immunology

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

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: 10170501	Subject Title: Advanced Microbial Genetics
Pre-requisite: Students should have a basic understanding of: • Fundamental knowledge of cell biology and genetics. • Basic understanding of DNA, RNA, and proteins. • Introductory biochemistry and microbiology. • Prior exposure to basic molecular biology techniques is recommended.	

Course Objective: This course aims to:

- To provide in-depth understanding of gene regulation in prokaryotes and eukaryotes.
- To explore chromatin structure, epigenetics, and non-coding RNAs.
- To study molecular mechanisms of gene expression control in development and disease.
- To familiarize students with modern molecular biology tools and techniques.

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	**Regulation of Gene Expression in Prokaryotes and Eukaryotes (15 hours)**
	• Operon models beyond lac and trp (e.g., arabinose, tryptophan attenuation)
	• Transcriptional regulation in eukaryotes
	  ○ Enhancers, silencers, insulators
	  ○ Transcription factors and mediator complexes
	• Chromatin remodelling complexes
	• Post-transcriptional regulation and mRNA stability
		15	25%

2	**Epigenetics and Non-Coding RNAs** • DNA methylation and histone modification.	15	25%

	• Epigenetic inheritance and gene silencing. • Role of small RNAs: siRNA, miRNA, piRNA. • Long non-coding RNAs (lncRNAs) in development and disease. • CRISPR-Cas and epigenome editing.		
3	**Molecular Basis of Development and Differentiation** • Gene regulation in embryonic development (e.g., HOX genes, morphogen gradients). • Transcriptional networks in stem cells and cell fate decisions. • Molecular basis of cancer and oncogene regulation. • RNA localization and translational control in development.	15	25%
4	**Molecular Tools and Techniques in Biology** • Electrophoretic mobility shift assay (EMSA), ChIP, ChIP-Seq. • Real-time PCR and digital PCR. • RNA-Seq, transcriptomics, and data analysis. • RNA interference (RNAi) and gene knockdown. • Molecular cloning and synthetic biology applications.	15	25%

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

CO1: Analyze regulatory mechanisms of gene expression in different organisms.
CO2: Interpret the role of epigenetic modifications in health and disease.
CO3: Evaluate the significance of non-coding RNAs in gene expression.
CO4: Understand molecular mechanisms involved in development and cell differentiation.
CO5: Apply modern molecular biology tools in experimental design and data analysis.

List of Text Books:

- Genes XII – Benjamin Lewin, Jones and Bartlett.
- Molecular Biology of the Gene – Watson et al., Pearson.
- Molecular Cell Biology – Lodish et al., W.H. Freeman.

List of Reference Books:

- Epigenetics – C. David Allis et al., Cold Spring Harbor Laboratory Press.
- Molecular Biology – Robert Weaver, McGraw-Hill.
- Molecular Biology: Principles of Genome Function – Nancy Craig et al., Oxford.
- RNA Worlds – Gesteland, Cech, Atkins, Cold Spring Harbor Laboratory Press.

Open e-Resource:

- NCBI Bookshelf – https://www.ncbi.nlm.nih.gov/books/
- Cold Spring Harbor Protocols – https://cshprotocols.cshlp.org/
- iBiology Lectures – https://www.ibiology.org/
- Nature Reviews Molecular Cell Biology – https://www.nature.com/nrm/
- EMBL-EBI Training – https://www.ebi.ac.uk/training/online/

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
Bachelor of Science - Microbiology
Semester-VI

Subject Code: 10170604	Subject Title: Biostatistics and Computer Applications
Pre-requisite: Basic understanding of biology and mathematics at undergraduate level, familiarity with scientific data handling and elementary computer literacy.	

Course Objective: This course aims:

- Understand basic statistical terms, types of data, and their applications in biological research.
- Apply appropriate sampling techniques and minimize sampling errors.
- Present data using graphical and tabular methods.
- Understand and compute correlation, regression, and apply ANOVA techniques.
- Perform statistical hypothesis testing using chi-square, t, F, and Z tests.
- Understand fundamental components of computers, software, and their use in statistical analysis.

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 Biostatistics:** Basic definitions and applications. Sampling: Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram.	15	25%
2	**Measures of central tendency:** Measures of central tendency: Mean, Median, Mode. Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation. Correlation and regression: Positive and negative correlation and calculation of Karl Pearsons co-efficient of correlation. Linear regression and regression equation and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation.	15	25%

3	**Tests of significance Tests of significance:** Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error. Introduction to probability theory and distributions, (concept without deviation) binomial, poison and normal (only definitions and problems) Computer oriented statistical techniques. Frequency table of single discrete variable, bubble spot, computation of mean, variance and standard Deviations, t test, correlation coefficient.	15	25%
4	**Introduction to computers and computer applications:** Introduction to computers: Computer application, basics, organization, PC, mainframes and Super-computers, concept of hardware and software, concept of file, folders and directories, commonly used commands, flow charts and programming techniques. Introduction to Q basic and C. Introduction in MS Office software concerning Word processing, spreadsheets and presentation software.	15	25%

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

CO1: Use appropriate sampling and data collection techniques for biological experiments.
CO2: Calculate and interpret mean, median, mode, standard deviation, variance, and coefficient of variation.
CO3: Apply appropriate statistical tests for significance (t-test, F-test, Z-test, chi-square).
CO4: Execute basic ANOVA (one-way and two-way classification) and interpret the results.
CO5: Utilize computer-based tools and software for data analysis and presentation.

List of Text Books:

- P.S.S. Sundar Rao & J. Richard – An Introduction to Biostatistics: A Manual for Students in Health Sciences.
- R. Gnanadesikan – Methods for Statistical Data Analysis of Multivariate Observations.
- S. Chandrasekaran – Introduction to Computers.
- Wayne W. Daniel – Biostatistics: A Foundation for Analysis in the Health Sciences.

List of Reference Books:

- Biostatistics - 7th Edition by Daniel
- How Computers work - 2000. By Ron White. Tech. Media
- How the Internet Work 2000 by Preston Gralla Tech. Media.
- Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
- Programming in C by E. Ballaguruswamy.
- Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
- Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.

Open e-Resource:

- NCBI Bookshelf: https://www.ncbi.nlm.nih.gov/books
- Khan Academy – Statistics & Probability: https://www.khanacademy.org/math/statistics-probability
- MIT OpenCourseWare – Intro to Computer Science and Programming: https://ocw.mit.edu
- R Tutorials for Biostatistics: https://cran.r-project.org
- Microsoft Learn – Office Skills: https://learn.microsoft.com

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

Subject Code: 10170602	Subject Title: Industrial Bioprocess Technology
Pre-requisite: Student should have basic knowledge of Microbiology, Biotechnology and Biochemistry as well as fundamental knowledge of Genetics and Molecular Biology.	

Course Objective: This course aims to:

- To introduce the concepts and applications of biotechnology in industrial processes.
- To understand microbial and enzymatic production of industrial products.
- To explore the principles of bioprocess engineering and downstream processing.
- To examine the role of biotechnology in food, pharmaceuticals, and environmental industries.

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 Industrial Biotechnology** Scope and significance of industrial biotechnology, Types of biotechnological industries: food, pharma, biofuels, environment, Overview of industrial microbial strains: bacteria, fungi, yeast, Strain improvement and preservation techniques.	15	25%
2	**Fermentation Technology** Types of fermentation: batch, fed-batch, continuous, Fermenter design and components, Media formulation and sterilization, Inoculum development and scale-up.	15	25%
3	**Downstream Processing** Cell separation techniques: centrifugation, filtration, Cell disruption methods Product recovery and purification: precipitation, chromatography, drying, Quality control and assurance.	15	25%

4	**Applications of Industrial Biotechnology** Biotechnological production of food additives and beverages, Bioremediation and biofertilizers, Bioplastics and biofuels (biodiesel, bioethanol, biogas), Biopharmaceuticals: vaccines, monoclonal antibodies, recombinant proteins.	15	25%

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

CO1: Understand the principles and applications of industrial biotechnology.

CO2: Apply knowledge of microbial fermentation in large-scale production processes.

CO3: Analyse and design fermentation processes for commercial biomolecules.

CO4: Demonstrate understanding of downstream processing and quality control.

CO5: Recognize safety, regulatory, and ethical aspects of industrial biotech applications.

List of Text Books:

- Casida, L.E. (2018). *Industrial Microbiology.* New Age International.
- Crueger, W., & Crueger, A. (2017). *Biotechnology: A Textbook of Industrial Microbiology.* Panima Publishing.
- Glazer, A.N. & Nikaido, H. (2018). *Microbial Biotechnology: Fundamentals of Applied Microbiology.* Cambridge University Press.

List of Reference Books:

- Moo-Young, M. (2015). *Comprehensive Biotechnology.* Pergamon Press.
- Satyanarayana, U. (2019). *Biotechnology.* Elsevier India.
- Stanbury, P.F., Whitaker, A., & Hall, S.J. (2017). *Principles of Fermentation Technology.* Elsevier.

Open e-Resource:

- 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
- https://www.ncbi.nlm.nih.gov – National Centre for Biotechnology Information
- https://bioinfo.ernet.in – Indian Bioinformatics Portal

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

Subject Code: 10170603	Subject Title: MLaboratory - VI
Pre-requisite: Students should have theoretical understanding and clear concepts regarding Mycology and Industrial Technology as per the program.	

Course Objective: This course aims to:
To provide in-depth understanding and hands on training for Mycology and Industrial Bioprocess Technology.

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	Isolation of fungi from soil and air (using Potato Dextrose Agar).	8 hours per week	Equal weightage to each experiment.
2	Lactophenol cotton blue staining of fungal hyphae and spores.		
3	Identification of common fungi**:** *Rhizopus*, *Mucor*, *Penicillium*, *Aspergillus*, *Fusarium*, etc.		
4	Slide culture technique for studying fungal morphology.		
5	Antifungal sensitivity testing (disc diffusion method).		
6	Microscopic observation of mycorrhizal roots (stained root samples).		
7	Demonstration of yeast budding using *Saccharomyces cerevisiae.*		
8	Isolation and screening of industrially important microbes.		
9	Estimation of biomass (cell dry weight, OD).		
10	Enzyme production and assay (e.g., amylase or protease).		

11	Enzyme production and assay (e.g., amylase or protease).		
12	Fermentation for ethanol or citric acid production.		

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

CO1: Apply tools and techniques for isolation, cultivation and microscopic examination of Fungi.

CO2: Imply production of various industrially important commercial products using plants or microbial cultures.

List of Text Books: As per mentioned in theoretical courses.

List of Reference Books: As per mentioned in theoretical courses.

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 - Microbiology
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

AEC/VAC/SEC basket

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	Wed development framework	SEC024
25	Cyber Crime	SEC025
26	Cyber Security	SEC026
27	Agribusiness 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