Gandhinagar Institute of Science (03)

Academic Regulation & Curriculum

for

Master of Science (09)

in

Biotechnology Programme (150)

Gandhinagar University

Khatraj-Kalol Road, Moti Bhoyan

Ta. Kalol, Dist. Gandhinagar – 382721

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 committed to advancing higher education, scientific research, innovation, and ethical practices in the field of Biotechnology. The Master of Science (M.Sc.) in Biotechnology programme has been designed emphasizing multidisciplinary learning, research excellence, skill development, and outcome-based education. The programme aims to provide advanced theoretical knowledge and intensive practical training in various domains of Biotechnology. The programme integrates advanced laboratory courses, research methodology, dissertation work, internships, industrial training, seminars, scientific communication, and project-based learning to foster innovation, critical thinking, problem-solving skills, and independent research aptitude. The curriculum also incorporates interdisciplinary and Indian Knowledge System (IKS) components to promote holistic development, professional ethics, environmental sustainability, entrepreneurship, leadership qualities, and lifelong learning. The programme encourages students to actively engage in research projects, workshops, conferences, industrial visits, field studies, extension activities, MOOCs, and collaborative learning initiatives with academic and industrial partners. The curriculum has been developed after extensive consultation with academicians, researchers, industry experts, alumni, employers, and other stakeholders to ensure its relevance to current scientific advancements, national priorities, global trends, and workforce requirements. Through this programme, the Department strives to create a vibrant academic and research ecosystem that nurtures excellence, innovation, entrepreneurship, social responsibility, and ethical leadership, preparing graduates to contribute effectively to scientific progress and societal development at national and international levels.

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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)

PO1: Advanced Biotechnological Knowledge

Acquire in-depth knowledge of Bioinstrumentation, Enzymology, genetics, Agricultural Biotechnology, IPR and Bioethics, Nanobiotechnology, and Bioinformatics.

PO2: Laboratory Competency

Demonstrate proficiency in advanced Molecular, Biochemical, and analytical techniques for the extraction of nucleic acid and analysis of various metabolites.

PO3: Research and Innovation

Design, conduct, analyze, and interpret scientific experiments using appropriate methodologies, statistical tools, and modern research instruments.

PO4: Critical Thinking and Problem Solving

Apply scientific reasoning and analytical approaches to address complex biological challenges in healthcare, agriculture, environment, and industry.

PO5: Data Analysis and Bioinformatics

Utilize computational tools, bioinformatics resources, and data analysis techniques for interpreting biological data and supporting scientific research.

PO6: Industry and Entrepreneurship

Understand industrial applications of Biotechnology, quality control practices, bioprocess technology, and entrepreneurial opportunities in biotechnology and Biotechnology-based enterprises.

PO7: Communication and Teamwork

Communicate scientific concepts, research findings, and technical information effectively through oral presentations, reports, publications, and collaborative activities.

3. Program Educational Objectives (PEOs)

PEO 1:

Demonstrate advanced knowledge and technical expertise in Biotechnology and its allied disciplines, enabling them to contribute effectively in academia, research, healthcare, agriculture, environmental management, and industrial sectors.

PEO 2:

Apply scientific principles, analytical skills, and modern laboratory techniques to investigate problems and develop innovative solutions for societal and industrial challenges.

PEO 3:

Engage in independent research, lifelong learning, and professional development through higher studies, interdisciplinary collaborations, and continuous skill enhancement.

PEO 4:

Uphold ethical values, biosafety practices, environmental responsibility, and professional integrity while working in research laboratories, industries, and public health organizations.

PEO 5:

Develop leadership, communication, teamwork, and entrepreneurial skills to successfully function in multidisciplinary and global professional environments.

4. Program Details

4.1 Program structure & Duration

Duration & Intake: 2 Years & 30 Seats

Semesters: 4

Mode: Full Time

Credit Structure: As per UGC/University norms

Medium of Instruction: English

4.2 Eligibility Criteria for Admission

Candidate must have achieved Graduate degree in Biotechnology/Biochemistry/Microbiology with minimum three years on regular basis, from any UGC recognized university. Candidate should have basic knowledge and technical skill for the concern subject.

4.3 Admission Procedure

Admission to the M.Sc. Biotechnology program may be granted on the basis of merit obtained in the qualifying examination and/or performance in the Entrance Test, as prescribed by the University from time to time. Candidates seeking admission must have passed the Graduation examination from a recognized board with Biotechnology/Biochemistry/Microbiology, fulfilling the minimum eligibility criteria specified by the University.

Credit summary for M.Sc. Biotechnology in MIBT department with effect from 2024

Sl. No.	Course Type	Credit
1.	Core Courses	54
2.	Discipline Specific Elective	12
3.	Indian Knowledge System (IKS)	04
5.	Internship/Rerearch Project/on the job training (OJT)	16
	Total	**86**

Definition of Credit (as per UGC):

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

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

Semester	Total Credits
Semester I	20
Semester II	22
Semester III	22
Semester IV	22
Grand Total	**86 credits**

5. Curriculum Structure

First Year 1st Semester:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
101500101	Core Course	Agricultural Biotechnology	4	4	-	-	4
10360103	Core Course	IPR and Bioethics	4	4	-	-	4
101500102	Core Course Specialization	Nanobiotechnology	4	4	-	-	4
10230104	Discipline Specific Elective	Fundamentals of Biochemistry	4	4	-	-	4
101500103	Core Course	Bt Laboratory - I	4	-	-	8	8
			20				24

First Year 2nd Semester:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
10230201	Core Course	Bioinstrumentation	4	4	-	-	4
10230202	Core Course	Enzymology	4	4	-	-	4
101500201	Core Course Specialization	Advanced Food Biotechnology	4	4	-	-	4
10230204	Discipline Specific Elective	Bioinformatics	4	4	-	-	4
101500202	Core Course	Bt Laboratory - II	4	-	-	8	8
IKS0201	IKS	Indian Ancient History and Cultural Heritage	2	1	-	1	3
			22				27

Second Year 3rdSemester:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
10230301	Core Course	Genetic Engineering	4	4	-	-	4
10230302	Core Course	Biostatistics	4	4	-	-	4
101500301	Core Course Specialization	Veterinary Biotechnology	4	4	-	-	4
10230304	Discipline Specific Elective	Environmental Biotechnology	4	4	-	-	4
101500302	Core Course	Bt Laboratory-III	4	-	-	8	8
20230306	IKS	Traditional Fermented food and beverages	2	1		1	3
			22				27

Second Year 4th Semester:

Subject Code	Course Type	Subject Name	Credit	Hours per week			
				L	T	P	Total
10230401	Core Course	Research Methodology	4	4	-	-	4
101500401	Core Course	Seminar/Assignment	2	-	-	2	2
101500402	Core Course	Research Project	16	-	-	16	32
			22				38

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 practical, 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: 30%
- End Semester Examination: 70%

6.5 Passing Standards

- Minimum 50% marks in each component where applicable.
- Minimum 50% 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 internship.

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 2 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:

- 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 Biotechnology 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 practical, 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:

- Biotechnology 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 M.Sc. Biotechnology program. Such collaborations may include internships, industrial training, laboratory visits, live projects, expert lectures, workshops, research activities, skill development programs, and placement support. The institution may also establish Memoranda of Understanding (MoUs) with industries, research institutes, hospitals, and professional organizations for academic enrichment, technology support, training programs, certification courses, and collaborative initiatives aimed at improving employability, entrepreneurship, innovation, and professional competency among students.

8.2 Research and Consultancy

The department shall encourage faculty members and students to actively engage in research, consultancy, innovation, and applied studies related to Biotechnology, Bioinformatics, public health, food Biotechnology, industrial Biotechnology, environmental Biotechnology, agricultural Biotechnology, molecular biology, and emerging biological technologies. Students may undertake research projects, laboratory-based studies, nucleic acid 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 M.Sc. Biotechnology program. The department shall facilitate access to relevant textbooks, reference books, scientific journals, research publications, e-resources, Molecular Biology manuals, laboratory protocols, and digital learning platforms related to Biotechnology, Biochemistry, molecular biology, immunology, enzymology, 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 M.Sc. Biotechnology program. The department shall facilitate academic counselling, mentoring, career guidance, research support, and skill development activities to assist students in their academic progression and professional growth. Students may also be provided opportunities for interaction with scientists, healthcare professionals, industry experts, and researchers through workshops, seminars, industrial visits, laboratory training, conferences, and extracurricular activities aimed at enhancing employability, scientific aptitude, leadership qualities, communication skills, and overall personality development. Necessary support mechanisms for addressing academic and personal concerns shall also be made available as per institutional policies.

8.5 Placement and Career Development

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

9. Program Credibility

9.1 Executive Summary

The M.Sc. Biotechnology program is designed to develop scientifically skilled and industry-ready graduates with strong theoretical knowledge and practical expertise in Biotechnology, biochemistry, molecular biology, immunology, industrial Biotechnology, environmental Biotechnology, food Biotechnology, and medical Biotechnology. 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 Biotechnology 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 Biotechnology 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 Biotechnology 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 Biotechnology 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 Biofertilizer and Biopesticide Exercise

During a supervised laboratory session, students will carry out the production of biofertilizers and biopesticides using selected beneficial microorganisms. They will prepare suitable growth media, inoculate microbial cultures, monitor fermentation and incubation conditions, and formulate the final biofertilizer or biopesticide product. Students will evaluate microbial growth, assess product quality parameters, and document the production process. Submission shall include laboratory observations, production flow charts, microbial growth records, formulation details, quality assessment data, and a brief report on the applications and significance of the produced biofertilizer or biopesticide.

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 Biotechnology 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 Biotechnology 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 Biotechnology 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 Biotechnology 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 Biotechnology, biotechnology, environmental Biotechnology, food Biotechnology, industrial Biotechnology, 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 M.Sc. Biotechnology programme has gained significant importance due to the rapid growth of microbiological sciences and their expanding applications in healthcare, pharmaceuticals, biotechnology, agriculture, food industries, environmental management, and research. The increasing prevalence of infectious diseases, antimicrobial resistance, emerging pathogens, and global health challenges has created a strong demand for highly skilled Biotechnology professionals with advanced scientific knowledge and laboratory expertise. The programme provides comprehensive theoretical understanding and specialized practical training in areas such as Medical Biotechnology, Immunology, Virology, Microbial Genetics, Molecular Biology, Industrial Biotechnology, Environmental Biotechnology, Food Biotechnology, Microbial Biotechnology, and Bioinformatics. Through advanced laboratory training, research projects, dissertations, and scientific investigations, students develop analytical abilities, technical competencies, and research skills required for modern scientific and industrial environments.

The healthcare and pharmaceutical sectors have emerged as major employers of Biotechnology postgraduates due to the growing need for disease diagnosis, pathogen identification, vaccine development, antimicrobial resistance monitoring, infection control, and molecular diagnostic techniques. The global focus on public health preparedness and disease surveillance has further increased the demand for trained microbiologists in hospitals, diagnostic laboratories, pharmaceutical industries, vaccine manufacturing companies, and public health organizations. In addition, advancements in molecular diagnostics, genomics, proteomics, and precision medicine have expanded the role of microbiologists in biomedical research and healthcare innovation.

The industrial relevance of Biotechnology has also grown substantially with the expansion of biotechnology, pharmaceutical production, food processing, dairy technology, fermentation industries, and biopharmaceutical manufacturing. Microorganisms are extensively utilized for the production of antibiotics, enzymes, vaccines, probiotics, organic acids, biofuels, fermented foods, and other value-added products. Consequently, industries require professionals who possess expertise in fermentation technology, quality assurance, quality control, microbial process optimization, contamination monitoring, and product development. Food and dairy industries depend on microbiologists to ensure food safety, quality management, microbial testing, and compliance with regulatory standards, creating numerous employment opportunities for postgraduate students.

Environmental sustainability has become another important area contributing to the demand for

Biotechnology professionals. Environmental Biotechnology plays a crucial role in wastewater treatment, waste management, bioremediation, pollution control, renewable energy production, and sustainable agricultural practices. The use of microorganisms in biofertilizer production, biopesticide development, soil health management, and environmental monitoring has created significant opportunities in agricultural and environmental sectors. Government agencies, environmental consulting firms, and industrial organizations increasingly seek Biotechnology experts to address environmental challenges through sustainable microbial technologies.

Research and innovation have become central to the development of microbiological sciences, leading to increased opportunities in research institutions, universities, biotechnology companies, and government-funded scientific organizations. Emerging fields such as microbial genomics, metagenomics, synthetic biology, vaccine technology, microbial bioinformatics, industrial biotechnology, and antimicrobial resistance research require highly trained postgraduate professionals. The M.Sc. Biotechnology programme equips students with advanced research methodologies, scientific communication skills, data analysis techniques, and laboratory competencies necessary for pursuing doctoral studies, research fellowships, and scientific careers at national and international levels.

The programme also offers diverse career opportunities in research and development laboratories, pharmaceutical companies, biotechnology industries, hospitals, clinical laboratories, food and dairy industries, environmental agencies, agricultural biotechnology firms, forensic laboratories, water testing facilities, public health organizations, and academic institutions. Graduates can pursue careers as Microbiologists, Research Associates, Quality Control Officers, Quality Assurance Executives, Clinical Microbiologists, Laboratory Managers, Production Executives, Regulatory Affairs Professionals, Scientific Officers, and Academicians. Furthermore, the programme provides a strong foundation for higher studies such as Ph.D. programmes in Biotechnology, Biotechnology, Molecular Biology, Biomedical Sciences, Environmental Sciences, and related interdisciplinary fields.

Considering the continuous expansion of healthcare, biotechnology, pharmaceutical, environmental, and research sectors, the demand for qualified Biotechnology professionals is expected to increase steadily in the coming years. Industries and research organizations require graduates who possess advanced laboratory skills, critical thinking abilities, scientific temperament, problem-solving capabilities, and research aptitude. Therefore, the departmental action plan emphasizes curriculum enrichment, advanced laboratory training, industrial internships, collaborative research, workshops, seminars, field visits, skill development programmes, and

industry-academia interactions to enhance student employability and professional competence. The market survey clearly indicates that the M.Sc. Biotechnology programme is strategically feasible and highly relevant, offering excellent career prospects while contributing significantly to scientific advancement, industrial development, healthcare improvement, environmental sustainability, 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
Master of Science – Biotechnology
Semester-I

Subject Code: 101500101	Subject Title: Agricultural Biotechnology
Pre-requisite: • B.Sc. in Biotechnology, Botany, Agriculture, or equivalent. • Fundamental knowledge of genetics, plant physiology, molecular biology, and microbiology.	

Course Objective:

- To impart the knowledge regarding the biotechnological tools used in agriculture for crop improvement.
- Explain genetic engineering, molecular breeding, and genomic approaches applied in agriculture.
- Analyze applications of biotechnology in pest resistance, stress tolerance, and productivity enhancement.
- Evaluate biosafety, bioethics, and regulatory aspects of GM crops.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Agricultural Biotechnology:** Scope and significance in sustainable agriculture, History and development of agricultural biotechnology, Plant tissue culture and micropropagation, Somaclonal variation, embryo rescue, somatic hybridization, Haploid and doubled haploid production.	15	25%
2	**Genetic Engineering in Plants:** Gene cloning and vector systems (Ti plasmid, viral vectors), Agrobacterium-mediated and direct gene transfer methods, Marker genes and selection systems, Genetic transformation and regeneration protocols, Examples of genetically modified crops (Bt cotton, Golden rice, herbicide-resistant crops).	15	25%
3	**Molecular Tools and Breeding:** Molecular markers: RFLP, AFLP, SSR, SNP, Marker-assisted selection (MAS) and genomic selection, QTL mapping	15	25%

	and gene pyramiding, Transcriptional regulation and gene silencing (RNAi, CRISPR/Cas9), Bioinformatics in crop genomics.		
4	**Applications, Ethics, and Regulations:** Transgenic crops for biotic and abiotic stress tolerance, Biofertilizers and biopesticides, Biosafety concerns, risk assessment and regulatory guidelines (Cartagena Protocol, DBT guidelines), Intellectual Property Rights (IPR) and patents in agricultural biotech, Socio-economic impacts and ethical considerations of GM crops.	15	25%

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

CO1: Apply biotechnological tools for crop improvement and yield enhancement.

CO2: Evaluate transgenic technologies for resistance to pests, diseases, and environmental stress.

CO3: Utilize molecular breeding tools in crop development.

CO4: Understand and follow biosafety and regulatory frameworks in agricultural biotechnology.

List of Text Books:

- **Chawla, H.S.** – *Introduction to Plant Biotechnology*, Oxford & IBH Publishing
- **Purohit, S.S.** – *Agricultural Biotechnology*, Agrobios
- **Singh, B.D.** – *Biotechnology: Expanding Horizons*, Kalyani Publishers
- **Slater, A., Scott, N.W., Fowler, M.** – *Plant Biotechnology: The Genetic Manipulation of Plants*, Oxford University Press

List of Reference Books:

- Bhojwani, S.S. & Razdan, M.K. – Plant Tissue Culture: Theory and Practice
- Primrose, S.B., Twyman, R.M. – Principles of Gene Manipulation and Genomics
- Christou, P. – Molecular Farming: Plant-made Pharmaceuticals and Technical Products
- FAO & WHO Reports – Guidelines on GM crops and Biosafety

Open e-Resource:

- **NPTEL Courses**:
  - Agricultural Biotechnology – Prof. P.B. Kavi Kishor
  - Plant Biotechnology – Prof. M.K. Reddy
- **FAO Biotech Portal**: http://www.fao.org/biotech/
- **CGIAR Genebank Platform**: https://www.genebanks.org/
- **AgriXiv Preprints**: https://agrixiv.org/
- **ePGPathshala (UGC)**: https://epgp.inflibnet.ac.in/

List of Suggested Experiments:

- Plant tissue culture techniques – callus induction and micropropagation
- Agrobacterium-mediated transformation of model plants (e.g., tobacco leaf discs)
- DNA isolation from plant tissues
- ELISA for Bt protein expression in transgenic plants
- Bioassay for insect resistance in GM plants

- Bioinformatics tools for gene annotation and sequence alignment

GANDHINAGAR UNIVERSITY

Gandhinagar Institute of Science
Master of Science – Biotechnology/ Environmental Science/ Pharmaceutical Science
Semester-I

Subject Code: 10360103	Subject Title: IPR & Bioethics
Pre-requisite: Student must have achieved Graduate degree in Science and Environmental Science should be one of the major subjects with minimum 45%.	

Course Objective:

- To introduce basic concepts of ethics and safety that is essential for Life Science Labs.
- To understand the procedures involved in protection of Intellectual property.
- To give an insight into different treaties signed. To gain knowledge about patent filing.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**General overview of Intellectual Property Rights and Patents:** WIPO, WTO, Trade Related Intellectual Property Rights. Basic requirements of Patentability, Patentable subject matter, Types of patents (process and product), Procedure for obtaining Patent, Provisional and Complete specification.	15	25%
2	**Copyright and trademarks:** Meaning and objectives of copyright, Rights conferred by registration of copyright, Infringement of copyright Basic Principles of Trademark, Rights conferred by Registration of Trademark, Infringement of Trademark.	15	25%
3	**Geographical indicators:** Geographical Indications-Objectives of Geographical Indications, Rights conferred, Infringement of Geographical Indications, International Position Indian Position, Bioprospecting and Biopiracy.	15	25%
4	**Bioethics:** Ethical implications of biotechnological products and techniques: Ethical research, plagiarism, DBT regulations for biosafety and GMOs.	15	25%

Course Outcome: After completion of this course, students,

CO1: Gain Knowledge of working principles in a laboratory taking all safety measures, handling of live cultures, disposal of infectious waste, care of the equipment requiring safety audit.

CO2: Get an insight into Biosafety guidelines.

CO3: Analyze and Manage the Risks involved with GMOs.

CO4: Understand the International Agreements and Regulations with respect to Biosafety.

CO5: Gain Knowledge about Intellectual Property Rights.
CO6: Understand guidelines to protect biological inventions.
CO7: Understand about different treaties, rights and duties of Patent owner.
CO8: Understand the process of filing a patent.

List of Text/Reference Books:

- Intellectual Property Rights and the Life Sciences Industries by Graham Dutfield, Ashgate Publishing.
- Intellectual Property Rights by Brigitte Anderson, Edward Elgar Publishing.
- Intellectual Property Rights by William Rodelph Cornish, WIPO Intellectual Property Handbook.
- David Clewelyn.

Open E-resources:

- Best Intellectual Property Courses Online with Certificates [2024] | Coursera
- Biosafety, Intellectual Property Right and Bioethics (eopcw.com)
- Bioethics Biosafety and IPR | Sathyabama Institute of Science and Technology (Deemed to be University)

GANDHINAGAR UNIVERSITY

Gandhinagar Institute of Science
Master of Science – Biotechnology/ Pharmaceutical Science
Semester-I

Subject Code: 101500102	Subject Title: Nanobiotechnology
Pre-requisite: • Basic understanding of **Molecular Biology**, **Biochemistry**, and **Cell Biology** • Introductory knowledge of **Nanoscience** and **Biotechnology tools** • Familiarity with **biomaterials**, **enzymes**, and **biomolecular interactions**	

Course Objective:

1. To introduce the principles and scope of nanotechnology in biological sciences.
2. To understand the synthesis, characterization, and applications of nanomaterials in biotechnology.
3. To explore biological systems for nanomaterial fabrication and their biomedical applications.
4. To examine the ethical and safety aspects of nanobiotechnology in healthcare and the environment.
5. To integrate nanotechnology concepts with biotechnology for drug delivery, diagnostics, and biosensing.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Fundamentals of Nanotechnology and Nanobiotechnology:** Introduction to nanoscience and nanotechnology, Definitions, dimensions, and types of nanomaterials (0D, 1D, 2D, 3D), Overview of nanobiotechnology: interdisciplinary nature and significance, Properties of nanomaterials (optical, magnetic, electrical, mechanical), Top-down and bottom-up approaches in nanomaterial synthesis, Role of biological molecules (proteins, DNA, lipids) in nanoscale systems.	15	25%
2	**Synthesis and Characterization of Nanomaterials:** Biological synthesis of nanoparticles: microbial, plant-mediated, enzyme-based methods, Chemical and physical methods: sol-gel, co-precipitation, hydrothermal, laser ablation, Types of nanoparticles: metal, metal oxide, carbon-based (fullerenes, graphene, CNTs), quantum dots, liposomes,	15	25%

	Characterization techniques: UV-Vis spectroscopy, Dynamic Light Scattering (DLS), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), X-ray Diffraction (XRD), FTIR, Zeta potential.		
3	**Applications of Nanobiotechnology:** **Drug delivery systems**: liposomes, dendrimers, nano-emulsions, polymeric nanoparticles, **Diagnostics and imaging**: nano-sensors, quantum dots, magnetic nanoparticles, biosensors, **Tissue engineering**: scaffolds, hydrogels, and nanofibers in regenerative medicine, **Agricultural nanobiotechnology**: nano-fertilizers, nano-pesticides, smart delivery, **Food nanotechnology**: packaging, nano-encapsulation, food safety detection, **Nanotoxicology**: toxicity testing, cellular uptake, and biodistribution.	15	25%
4	**Ethics, Safety, and Regulatory Aspects:** Environmental impact of nanomaterials, Nanotoxicity: mechanisms and risk assessment, Ethical, legal, and social implications (ELSI) of nanobiotechnology, Biosafety and bioethics in nanotech R&D, Regulatory frameworks: global and Indian perspective (FDA, DBT, DST, ISO standards), Future prospects and career opportunities in nanobiotechnology.	15	25%

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

CO1: Understand core concepts of nanobiotechnology and the properties of nanomaterials.

CO2: Demonstrate knowledge of synthesis and characterization of biological nanomaterials.

CO3: Apply nanotechnology principles in medical, agricultural, and industrial biotechnology.

CO4: Analyze ethical, environmental, and regulatory concerns related to nano-biotech products.

CO5: Innovate and design nanotech-based solutions for biotechnological problems.

List of Text Books:

- C.M. Niemeyer & C.A. Mirkin – *Nanobiotechnology: Concepts, Applications and Perspectives*, Wiley-VCH
- M. Rai & N. Duran – *Nanotechnology in Life Sciences*, Springer
- Tuan Vo-Dinh – *Nanotechnology in Biology and Medicine: Methods, Devices, and Applications*, CRC Press

List of Reference Books:

- Bionanotechnology: Lessons from Nature – David S. Goodsell, Wiley-Liss
- Gunter Oberdorster et al. – Nanotoxicology: An Emerging Discipline, Springer
- K.K. Jain – The Handbook of Nanomedicine, Springer
- Nanobiotechnology Protocols – Sandra J. Rosenthal & David W. Wright (Methods in Molecular Biology), Humana Press

Open e-Resource:

- NPTEL Course – Nanobiotechnology – https://nptel.ac.in
- Coursera – Nanotechnology and Nanosensors – https://www.coursera.org
- MIT OpenCourseWare – NanoBiotech – https://ocw.mit.edu
- SpringerOpen Journals – Nanobiotechnology – https://nano-biotechnology.biomedcentral.com
- Nano.gov (US National Nanotechnology Initiative) – https://www.nano.gov

Gandhinagar Institute of Science
Master of Science – Microbiology/ Biotechnology/ Environmental Science/ Pharmaceutical Science
Semester-I

Subject Code: 10230104	**Subject Title: Fundamentals of Biochemistry**
Pre-requisite: Student must have achieved Graduate degree in Microbiology/Biotechnology with minimum three years on regular basis, from any UGC recognized university. Student should have basic knowledge and technical skill for the concern subject.	

Course Objective:

- Biochemistry is, in simplest terms, the study of the chemistry of living things. The general objective of this course, therefore, is to train students to understand biological processes and events by learning the logic of chemistry.
- It is far more than simply memorizing structures and metabolism; the fascination of the field is to see how and why biological molecules are built the way they are and how this makes life possible–on many levels and with an amazing degree coordination and control.
- To give students the knowledge about the important biomolecules like Protein, Carbohydrates, Lipids, Nucleic acids.
- To make students familiar with the vitamins and their structures & functions.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Chemical Bonding:** Introduction to chemical bonds, covalent bonds, ionic bonds, hydrogen bond, coordinate bond, metallic bond, Van der Waals forces. **Protein chemistry:** Amino acids: Properties, structures, functions and classification of common amino acids. Uncommon amino acids. Peptides and proteins: Peptides bond formation, types of peptides, and lengths of peptides chain, conjugated proteins and their classification. Protein structure: Levels of organization of protein structures – primary, secondary, tertiary and quaternary structures. The three-dimensional structure of proteins, determination of sequence of amino acids in peptides or protein.	15	25%

	Proteins purification and characterization: Fractionation, Dialysis, Chromatographic techniques, Electrophoresis, Sequencing methods for polypeptide.		
2	**Lipid chemistry:** Storage lipids: fatty acids – nomenclature structure and properties of some naturally occurring fatty acids, Triacylglycerols and their functions as storage lipids. **Structural lipids in cell membranes:** Glycerophospholipids, galactolipids, sulfolipids, sphingolipids, and sterols. Lipids as signals, cofactors and pigments. Phosphatidyl inositol and sphingosine derivatives as intracellular signals Eicosanoids, Prostaglandins, Thromboxanes, Leukotrienes, Vitamins: A, D, E and K. An outline of method of the extraction, separation and identification of cellular lipids.	15	25%
3	**Carbohydrate chemistry:** Nomenclature of carbohydrates, **Types of carbohydrates: (a)** Monosaccharides & disaccharides **(b)** Polysaccharides **(c)** Glycoconjugates Carbohydrate as informational molecules – the sugar code, An outline of methods of carbohydrate analysis. **Vitamins: (Water soluble and fat-soluble vitamins):** **Structure and functions of: (a)** Water soluble Vitamins – Vitamins B1, B2, B6, B12, Folic acid, Pantothenic acid, Niacin and Biotin. **(b)** Fat soluble Vitamins – Vitamins A, D, E and K.	15	25%
4	**Nucleic acid chemistry:** Nucleotides (the building blocks of nucleic acids): components, structures and nomenclature. **Nucleic acid structures: (a)DNA:** Watson – Crick Model, Three-dimensional forms of DNA (Comparison of A, B and Z form of DNA) Unusual DNA structures – palindromes, mirror repeats, inverted repeats, hairpin (or cruciform), Hoagsteen pairing, triplex DNA's, G tetraplex DNA, H - DNA. **(b) RNA:** monocistronic and polycistronic RNA, base – paired helical structure in RNA. **(c)** Denaturation and renaturation of double stranded DNA and RNA, DNA hybridization, DNA sequencing by Sanger method. Chemical synthesis of DNA (Automated)-Principle and major steps involved. Ribozymes- types and therapeutic applications.	15	25%

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

CO1: Know the chemical structures and chemistry of biological polymers (proteins, carbohydrates, lipids and nucleic acids) and their monomers (amino acids, sugars, fatty acids and other lipid monomers, and nucleotides).

CO2: Well versed on the fundamental principles of Biochemistry.

CO3: Understand the roles of these biological molecules in living cells.

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:

- "Principles of Microbiology", by Atlas R.M., 1st edition, 1995,Mosby–YearBook Inc. St.Louis, Missouri.
- Biochemistry by Jeremy Berg, John Tymoczko and LubertStryer, Fifth Edition, Freeman Company.
- Fundamentals of Biochemistry by Debajyothi Das 11/e, 2002.
- Fundamentals of biochemistry- Life at the molecular level By: Voet, Voet and Pratt, Second edition, 2006.
- Harper's Biochemistry by Robert.KK.Murray 26/e, 2003.
- Human Biochemistry by James.M.Orten&Oho.W.Neuhaus, 10/e, 1983.
- Lehninger Principles of Biochemistry by David Nelson and Michael Cox, Fifth Edition Freeman Company. (2005).

Open e-Resource:

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

Gandhinagar Institute of Science
Master of Science – Biotechnology
Semester-I

Subject Code: 101500103	Subject Title: BTLaboratory - I
Pre-requisite: Candidate should have basic hypothetical knowledge regarding the all subjects covered in theory for Biotechnology program. Should have opted basic graduation degree in biological science from recognized university as a regular candidate.	

Course Objective:

- To introduce the fundamental concepts and tools of biotechnology as applied to agriculture
- To provide the students with the current updates in the areas of Analytical Techniques, Instrumentation, Basic knowledge of media preparation.
- To introduce the basic concepts and types of Intellectual Property Rights relevant to biotechnology.
- To understand the process and legal framework of patenting biological inventions.
- To provide foundational knowledge of nanomaterials and nanoscale phenomena.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture	Tutorial	Practical	Credit	Theory		Practical		Total
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
-	-	8	04	-	-	140	60	200

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
	Agricultural Biotechnology		
1	Biofertilizer Production: Isolation and Culturing of *Rhizobium / Azospirillum.*		
2	Isolation of Genomic DNA from Plant Tissues.		
3	Restriction Digestion of Plant DNA.		
4	Quantification of Plant Hormones (IAA) from Rhizosphere Bacteria.		
5	Assessment of Biopesticide Activity (e.g., *Bacillus thuringiensis*)		

	IPR & Bioethics and Nanotechnology	Approx. 8 hours per week	100 %
6	Case Study Analysis on Patent Infringement.		
7	Search and Analysis of a Biotechnology Patent using Patent Databases (e.g., Google Patents, WIPO, USPTO).		
8	Study of Antibacterial Activity of Silver Nanoparticles.		
9	Nanoparticle Toxicity Assay using Yeast or Bacterial Cells.		
10	Characterization of Nanoparticles using UV-Visible Spectroscopy.		
	Fundamentals of Biochemistry		
11	Preparation of standard solutions.		
12	Demonstration of basic laboratory instruments		
13	Quantification of biomolecules: Carbohydrates: Cole's method, Folin's Wu method, Nelson Somogyi method, Anthrone method		
14	Quantification of biomolecules: Proteins: Folin Lowry's method, Bradford's method.		
15	Quantification of biomolecules: Lipids: Bligh and Dyer's method, Van Handel's method.		
16	Quantification of biomolecules: Nucleic Acids: DNA by DPA; and RNA by Orcinol method.		
17	Qualitative analysis of biomolecules by chromatography: sugars, amino acids & organic acids by: (i) Paper Chromatography (ii) Thin layer Chromatography		

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

CO1: Describe the role and impact of biotechnology in enhancing crop yield, quality, and resistance.
CO2: Identify and differentiate various forms of IPR applicable to life sciences.
CO3: Demonstrate synthesis and characterization of nanoparticles.
CO4: Perform analytical techniques for qualitative as well as quantitative analysis of biomolecules.

List of Text Books:

- C.M. Niemeyer & C.A. Mirkin – Nanobiotechnology: Concepts, Applications and Perspectives.
- Chawla, H.S. – *Introduction to Plant Biotechnology*, Oxford & IBH Publishing.
- Laboratory manual in Biochemistry, by Jayraman, J., 1998, New age International Publishers, New Delhi.
- Neeraj Pandey and Khushdeep Dharni – *Intellectual Property Rights.*

List of Reference Books:

- Murray Moo-Young (Ed.) – *Comprehensive Biotechnology*, Elsevier.
- Krishna V. – *Bioethics and Biosafety*
- Bionanotechnology – David S. Goodsell
- Experimental Microbiology Vol-1&2, by Rakesh Patel and Kiran Patel, 5th edition, Book Publisher: Delhi Aditya Book Centre 2009 Edition.

Open e-Resource:

- https://nptel.ac.in/courses/102103017
- https://nptel.ac.in/courses/126105015
- https://icar.org.in
- Indian Patent Office: https://ipindia.gov.in
- Nanotechnology Now: http://www.nanotech-now.com
- http://www.vlab.co.in

Gandhinagar Institute of Science
Master of Science – Microbiology/ Biotechnology/ Environmental Science/ Pharmaceutical Science
Semester-II

Subject Code: 10230201	**Subject Title: Bioinstrumentation**
Pre-requisite: Student must have achieved Graduate degree in Microbiology/Biotechnology with minimum three years on regular basis, from any UGC recognized university. Student should have basic knowledge and technical skill for the concern subject.	

Course Objective:

- To gain a deeper insight into the techniques they use for analysis and research including Nanotechnology.
- To make student understand about basic techniques for isolation, separation, purification, detection, and analysis of biological molecules.
- To get trained in Molecular Biology Techniques.
- Basic understanding of instrumentation routinely used in biotechnology.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Microscopy Techniques:** Principle and applications of light, phase contrast, fluorescent microscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), scanning tunneling microscopy (STM), atomic force microscopy (AFM), confocal microscopy. **Measurement of colligative properties:** Viscosity, osmosis, surface tension, diffusion, dialysis. **Bio-nanotechnology:** Introduction to concept and principles of nanotechnology, Properties of nanomaterials, carbon nanotubes, Techniques and methodology used to study	15	25%

	nanoparticles, Application of nanoparticles in molecular biology, industry agriculture and environment.		
2	**Separation techniques:** **Centrifugation:** Types and Applications **Electrophoresis:** Types of electrophoresis, instrumentation and applications: Capillary, Agarose gel, SDS-PAGE, 2D-Elecrophotresis **Chromatography:** Types of chromatography, instrumentation and applications: paper, TLC, HPTLC, Column, HPLC, GC.	15	25%
3	**Molecular Biology Techniques:** Isolation, purification and analysis of DNA (Genomic and plasmid), RNA, Proteins and Lipids, Instrumentation and applications of PCR and Its modifications (reverse transcriptase PCR, real time PCR, anchored PCR, emulsion PCR, SAGE etc.), Blotting techniques, DNA Sequencing techniques, Sanger 's Method and Next generation sequencing methods, Protein sequencing, Microarray, SAGE, RFLP, RAPD, AFLP.	15	25%
4	**Spectroscopy Techniques:** UV/Vis, fluorescence, circular dichroism (CD), NMR, ESR, X-ray diffraction, light scattering, mass spectrometry, atomic absorption spectroscopy, surface plasma emission spectroscopy, IR and Raman spectroscopy. **Electrochemical and radio isotope techniques Radioisotope techniques:** types and applications Guideline to use radio isotopes Electrochemical Techniques: types and application	15	25%

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

CO1: Will have detailed understanding of the concepts and principles of sample preparation.

CO2: Will have thorough knowledge of different microscopic techniques, spectroscopic techniques, Chromatography techniques, and the techniques for the measurements of colligative properties.

CO3: Will have fundamental and critical understanding of the current approaches to the analysis of biomolecules.

CO4: Will have insights of routine instruments used in biotechnology.

CO5: Will be able to troubleshoot the errors in the analytical experiments.

CO6: Will be able to analyze and interpret the data obtained using instrumentation.

CO7: Will learn various applications of instruments in biotechnology.

List of Text Books:

- Analytical biochemistry by Wilson and walker.
- Gene cloning: An introduction by TA Brown.
- Prescott 's Microbiology by Willey, Sherwood, Woolverton Tata McGraw Hill.
- Principles and techniques of Biochemistry and Molecular Biology by Wilson and Walker.

List of Reference Books:

- Biochemical Calculations by Segel. I. R. - 1995 - John Wiley and Sons.
- Biochemical Methods by Pingoud A. et al.
- Biotechnology Exploartions: Applying the fundamentals By Judith A Scheppler, Pattricia E Cassin and Rosa M Gambler.
- Instrumental methods of chemical analysis by Anand and Chatwal, Himalaya Publishing Co.
- Physical Biochemistry, applications to biochemistry and molecular biology, second edition (Freifelder, David).
- Principles of Gene manipulations and genomics by Primrose.
- Spectrometric Identification of Organic compounds by R M Silverstein and F X Webster, Sixth edition (2002).
- Spectroscopy: D.R. Browning.
- Standard Methods of Biochemical analysis by S.R. Thimmaiah.
- Validation Standard Operating Procedures, 2nd edn., by Haider, SI (2006) CRC Press Taylor and Francis Group, NY (ISBN: 0-8493-9529).

Open e-Resource:

- https://onlinecourses.nptel.ac.in/noc22_bt33/preview
- OpenStax: Microbiology - OpenStax.
- https://www.edx.org/learn/cellular-biology
- https://www.coursera.org/courses?query=cell%20biology
- https://www.ibiology.org/online-biology-courses/cell-biology-flipped-course/

Gandhinagar Institute of Science
Master of Science – Microbiology/ Biotechnology/ Pharmaceutical Science
Semester-II

Subject Code: 10230202	Subject Title: Enzymology
Pre-requisite: Student must have achieved Graduate degree in Microbiology/Biotechnology with minimum three years on regular basis, from any UGC recognized university. Student should have basic knowledge and technical skill for the concern subject.	

Course Objective:

- To make the students conversant about enzymes, enzyme catalysis, rate of reactions, order of reactions, kinetics of enzyme catalyzed reactions and enzyme inhibitions and their regulatory processes.
- To give the students' knowledge about the extraction, purification, immobilization and biotechnological applications of enzymes.
- To make the students gain the knowledge of isoenzymes, multi enzymes and multi enzyme complexes.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Enzymes (History, naming and classification of Enzymes)** **Specificity of Enzyme action** (Active site of enzymes; The Fischer's 'Lock and Key' hypothesis; **The Koshland** 'Induced fit' hypothesis; and hypothesis involving strain or transition-state (stabilization). **Kinetics of Single-substrate-enzyme catalysed reactions:** Derivation and significance of the 'Henri and Michaelis-Menten' equation The 'Briggs-Haldane' modification of the 'Michaelis-Menten' equation Derivation of the 'Line Weaver-Berk' equation and plots The 'Eadie-Hofstee' and 'Hanes' plots The 'Eisenthal and Cornish-Bowden' plots	15	25%

	Derivation of the 'Haldane' relationship for reversible reactions **Rapid-Reaction kinetics:** pre-steady state kinetics, Relaxation kinetics Procedure to determine Rate equation for a reaction sequence involving two and three enzyme species **Kinetics of Multi-substrate-enzyme catalyzed reactions:** Introductory knowledge of Ping-Pong bi-bi mechanism; Random-order mechanism; and Compulsory-order mechanism. **Steady-state kinetics:** Derivation of the 'General Rate Equation' of Alberty, Plots for mechanisms which follow the 'General Rate Equation, The 'General Rate Equation' of Dalziel, Rate constants and the constants of Alberty and Dalziel. **Investigation of Reaction Mechanisms using Steady-state methods:** The use of Primary plots, the use of inhibitors which compete with substrate for binding sites. **Investigation of Reaction mechanisms using non-steady-state methods:** Isotope exchange at equilibrium, Rapid-reaction studies.		
2	**Sigmoidal Kinetics and Allosteric Enzymes:** **The 'Monod-Wyman-Changeux (MWC) Model':** Derivation of MWC equation, MWC model and cooperative effects, MWC model and Allosteric regulation, MWC model and Hill equation **The 'Koshland-Nemethy-Filmer (KNF) Model':** The KNF model for a dimeric protein, The KNF model for any oligomeric enzyme, The KNF model and Allosteric regulation **Differentiation between models for cooperative binding in proteins:** **Sigmoidal kinetics in the absence of cooperative binding:** Ligand-binding evidence versus Kinetic evidence, The 'Ferdinand' mechanism, The 'Rabin and Mnemonical' mechanisms **Significance of Sigmoidal Behavior:** **Allosteric enzymes and Metabolic regulation:** Characteristics of Steady-state metabolic pathways, Regulation of Steady-state metabolic pathways by control of enzyme activity, Allosteric enzymes of metabolic regulation (availability of coenzymes; cellular compartmentation; active and inactive forms of enzymes).	15	25%
3	**Enzyme Inhibition: Competitive Inhibition:** Characteristics of competitive inhibition, Michaelis-Menten and Lineweaver-Burk plot showing the effect of a competitive inhibitor, Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalyzed reaction in the presence of a competitive inhibitor. **Uncompetitive inhibition:** Characteristics of Uncompetitive inhibition, Lineweaver-Burk plot showing the effect of a uncompetitive inhibitor, Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalyzed reaction in the presence of a uncompetitive inhibitor. **Non-competitive inhibition:** Characteristics of non-competitive inhibition, Lineweaver-Burk plot showing the effect of a non-competitive inhibitor,	15	25%

	Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalyzed reaction in the presence of a non-competitive inhibitor. **Mixed inhibition:** Characteristics of mixed inhibition, Lineweaver-Burk plot showing the effect of a mixed inhibitor, Steady-state Kinetics of a single-substrate single-binding-site single-intermediate enzyme-catalyzed reaction in the presence of a mixed inhibitor. **Partial inhibition:** **Substrate inhibition and Michaelis-Menten and Lineweaver-Burk plots showing the effects of substrate inhibition, Allosteric inhibition, Irreversible inhibition.**		
4	**Chemical nature of enzyme catalysis:** **Metal activated enzymes and metalloenzymes:** Definitions of metal-activated enzymes and metalloenzymes, Activation by alkali metal cations (Na^+ and K^+), Activation by alkaline earth cations (Ca^{2+} and Mg^{2+}), Activation by transition metal cations (Cu, Zn, Mo, Fe and Co cations). **Involvement of Coenzymes in enzyme-catalyzed reactions:** Nicotinamide nucleotides (NAD^+ and $NADP^+$), Flavin nucleotides (FMN and FAD), Adenosine phosphates (ATP, ADP and AMP), Coenzyme A (CoA-SH), Thiamine pyrophosphate (TPP), Pyridoxal phosphate, Biotin, Tetrahydrofolate, Coenzyme B12. **Enzyme utilization in Industry:** Application in Food and Drink industries, Application in Artificial kidney machines, Application in other industries (pharmaceutical industry; washing powder manufacturing industries).	15	25%

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

CO1: Student would able to describe structure, functions and the mechanism of action of enzymes, kinetics of enzyme catalyzed single and multi-substrate reactions.

CO2: Students would have the knowledge and exposure of Sigmoidal Kinetics and Allosteric Enzymes.

CO3: Students would have deep knowledge of various kind of inhibition reactions.

CO4: Students would gain the knowledge of enzyme catalysis, isoenzymes, multi enzymes and multi enzyme complexes.

List of Text Books:

- Trevor Palmer (2004) Enzymes Biochemistry, Biotechnology, Clinical Chemistry. Affiliated East-West Press Pvt Ltd, New Delhi.

List of Reference Books:

- "Lehninger Principles of Biochemistry", David L. Nelson & Michael M. Cox. 4th edition, W.H. Freeman & Co.
- Lehninger Principles of Biochemistry by David Nelson and Michael Cox, Fifth Edition Freeman Company. (2005).
- Prescott 's Microbiology by Willey, Sherwood, Woolverton Tata McGraw Hill.
- "Principles of Microbiology", by Atlas R.M., 1st edition, 1995,Mosby–YearBook Inc. St.Louis, Missouri.

Open e-Resource:

- https://onlinecourses.nptel.ac.in/noc22_bt33/preview
- OpenStax: Microbiology - OpenStax.
- https://www.edx.org/learn/cellular-biology
- https://www.coursera.org/courses?query=cell%20biology
- https://www.ibiology.org/online-biology-courses/cell-biology-flipped-course/

Gandhinagar Institute of Science
Master of Science –Biotechnology
Semester-II

Subject Code: 101500201	Subject Title: Advanced Food Biotechnology
Pre-requisite: Students are expected to have prior knowledge and foundational understanding in the following areas: Fundamentals of Genetics and Molecular Biology, Basics of Plant Biology and Plant Biotechnology, Biochemistry and Nutritional Science, Principles of Microbiology and Food Microbiology, Introduction to Agricultural Biotechnology, Basic Concepts of Metabolomics and Omics Technologies.	

Course Objective:

- To impart foundational and advanced knowledge.
- To familiarize students with real-world case studies.
- To introduce the principles and emerging applications of metabolomics.
- To equip students with a comprehensive understanding of biosafety and regulatory frameworks.
- To train students in molecular approaches and quality control technologies.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Biotechnological Approaches for Nutritionally Enhanced Food Crop Production:** Introduction, The Case For Biofortified Food: Rice, Maize And Cassava, Wheat, Oilcrops Biofortified With Omega-3 Fatty Acids, Nutritionally Enhanced Feed Crops, Plants With Other Health Benefits, Biopharmaceuticals Produced In Plants, Genome Editing For Nutritionally Enhanced Plants, Epigenetics And Nutritionally Enhanced Plants, Risk Assessment And Regulation Of Nutritionally Enhanced Crops.	15	25%
2	**Current and Emerging Applications of Metabolomics in the field of Agricultural Biotechnology:** Introduction, Metabolomics of Cereals for food production, Metabolomics and its Application in the production of Wine.	10	25%
3	**Safety Assessment of Genetically Modified Foods:** Safety Assessment Of GM-Crop-Derived Foods, Recurrent Items Addressed During The Food And	15	25%

	Feed Safety Assessment, Outlook And Future Challenges.		
4	**Towards a Universal Molecular Approach for the Quality Control of New Foodstuffs:** Food Quality And Safety Assessment In The Era Of Genomics, DNA Barcoding, Microbial Composition Of Food Stuff, Pathogenic Microorganisms And Food Spoilage, Towards A Molecular Identification Of Food – Related Microorganisms, Towards A Standardized Molecular Identification Of Food Raw Material, Next – Generation Technologies to Characterize Complex Food Matrices And Their Microbiome.	20	25%

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

CO1: Understand the biotechnological strategies employed for enhancing the nutritional value of food and feed crops, including biofortification and metabolic engineering.

CO2: Explore case studies of nutritionally enhanced crops such as rice, maize, cassava, wheat, and oilseeds enriched with essential nutrients and health-promoting compounds like omega-3 fatty acids.

CO3: Examine the role of metabolomics in agricultural biotechnology with a focus on food crop improvement, quality analysis, and applications in beverages like wine.

CO4: Critically analyze the safety assessment protocols and regulatory frameworks governing genetically modified and biofortified food products.

List of Text Books:

- **"Genetically Modified Crops and Food"** – Natalie Kuldell et al. *Elsevier, 1st Edition, 2015.*
- **"Genomics and Biotechnology for Livelihood Improvement in Developing Countries".** – R. K. Tyagi and P. K. Agrawal. *Scientific Publishers, 2011.*
- **"Introduction to Food Biotechnology"**– Perry Johnson-Green *CRC Press, 2nd Edition, 2012.*
- **"Plant Biotechnology and Genetics: Principles, Techniques, and Applications"** – C. Neal Stewart Jr. *Wiley-Blackwell, 2nd Edition, 2016.*
- **"Plant Metabolomics: Methods and Applications"** – Kazuki Saito, Robert A. Dixon, and Lothar Willmitzer *Springer, 2006.*

List of Reference Books:

- **"Biotechnology in Agriculture and Forestry" – Series** – Edited by Y.P.S. Bajaj *Springer Series – Volumes on transgenic crops, nutrition enhancement, and food safety.*
- **"Food Safety: The Science of Keeping Food Safe"** – Ian C. Shaw *Wiley-Blackwell, 2nd Edition, 2013.*
- **"Foodomics: Advanced Mass Spectrometry in Modern Food Science and Nutrition"** – Alejandro Cifuentes *Wiley-Blackwell, 2013.*
- **"Metabolomics in Food and Nutrition"** – Bart C. Weimer and Carolyn D. Slupsky *Springer, 2013.*
- **"Molecular Techniques in Food Biology: Safety, Biotechnology, Authenticity & Traceability"** – Aly Farag El Sheikha et al. *Wiley-Blackwell, 2018.*

Open e-Resource:

- FAO – Biofortification Resources and GM Food Safety. http://www.fao.org/food
- International Food Policy Research Institute (IFPRI) Publications. https://www.ifpri.org/publications
- Metabolomics Society Learning Resources. https://metabolomicssociety.org/resources/
- Open CourseWare – MIT Biology & Biotechnology. https://ocw.mit.edu
- European Food Safety Authority (EFSA) – Safety assessment of GM foods. https://www.efsa.europa.eu
- PubMed Central (PMC) – Open access journal articles on GM foods, metabolomics, and crop biofortification. https://www.ncbi.nlm.nih.gov/pmc
- CGIAR Biofortification Resources – HarvestPlus Program. https://www.harvestplus.org

Gandhinagar Institute of Science
Master of Science – Microbiology/ Biotechnology/ Environmental Science/ Pharmaceutical Science
Semester-II

Subject Code: 10230204	**Subject Title: Bioinformatics**
Pre-requisite: Student must have achieved Graduate degree in Microbiology/Biotechnology with minimum three years on regular basis, from any UGC recognized university. Student should have basic knowledge and technical skill for the concern subject.	

Course Objective:

- To give the students the basic knowledge about computers, operating system, internet resources.
- To acquaint the students with the various important tools and techniques of information technology, Metabolimics and Phylogenetic analysis.
- To make the students understand the basics of biological databases, Methods of sequence alignment, Genomics & Proteomics, Protein structure prediction & drug designing.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to databases:** **Databases:** Primary, Secondary; Relational and Non-relational; Redundant and Non-Redundant. **E-R Model:** a. Entity and Entity sets b. E-R Diagrams c. Reducing E-R diagram to tables. **Introduction to SQL**: a. Select statement b. Data definition Statements c. Data manipulation statements.	15	25%
2	**Biological Databases:** **Bioinformatics Resources:** NCBI, EBI, ExPASY**.** **Biological search Engines:** SRS and ENTREZ**.**	15	25%

	Biological Databanks: PDB, MMDB. **Derived, Databases:** PROSITE, Pfam, PRINTS, CATH, SCOP, DSSP, FSSP, DALI. **Nucleic Acid databases and Protein databases:**		
3	**Biological Data Analysis:** 1) Overview, Concepts and tools. 2) Sequence comparison by Dot Matrix and Dynamic Programming. 3) Pair wise Sequence Analysis by Needle man and Wunch algorithm 4) Scoring Matrices: PAM, BLOSSUM 5) Database Search: BLAST and FASTA 6) Multiple Sequence Alignment: Basic concepts, Progressive and Hierarchical approaches CLUSTAL-W, Applications. 7) Immunoinformatic databases.	15	25%
4	**Protein structure prediction:** 1) Necessity of Protein structure Prediction 2) Secondary structure prediction 3) Fold Recognition 4) Homology Modeling 5) Ab-initio Methods. **Microbial Genomics and Proteomics:** **Genomics:** 1) Functional genomics and comparative genomics. 2) Insight from microbial Genomes- Identification of genes with unknown function, Genomic analysis of pathogenic microbes and extremophiles, Environmental genomics (metagenomics) **Proteomics:** Functional proteomics, structural proteomics, protein modeling **Metabolimics':** 1) Metabolic Pathway databases a. KEGG b. EcoCyc and MetaCyc 2) Enzyme compounds and Reaction Databases a. LIGAND-Biochemical and Reaction Databases b. ENZYME- Enzymes c. BRENDA d. Metabolic Pathway Prediction. **Structure based Drug Design:** Introduction	15	25%

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

CO1: Students will acquire the knowledge of computers, operating system, internet resources.

CO2: Students will get introduced with tools and techniques of information technology, Metabolimics and Phylogenetic analysis.

CO3: Students will acquire the knowledge of biological databases, Methods of sequence alignment, Genomics and Proteomics.

CO4: Students will get introduced with protein structure prediction and drug designing.

List of Text Books:

- "Bioinformatics", by C.S.V. Murthy, 2003, Himalaya Publishing House, Mumbai.
- "Fundamentals of computers", by Rajaraman, V. Printice Hall of India, New Delhi.

List of Reference Books:

- "Discovering genomics, proteomics and Bioinformatics", by Campbell, A.M, and Heyer, L.J., 2003, Benjamin cunnings, San Francisco, CA.
- "Fundamental concepts of Bioinformatics", by Krane, D.E. and Raymer, M. L. 2003, Benjamin cunning, San Francisco, Calif.
- "Introduction to computers", by Leon A. and Leon M. Vikas Publishing House Pvt., New Delhi.
- "Introduction to SQL and PLSQL", by Ivan Dayross".
- "Prescott, Harley and Klein's microbiology", by Willey, Sherwood and Woolverton, 2008, Mc Graw- Hil companies, Inc, New york.

Open e-Resource:

- Swayam Portal
- OpenStax: Bioinformatics - OpenStax.
- https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SMB2103.pdf
- https://www.pdfdrive.com/
- http://www.ebi.ac.uk/embl/
- http://www.ncbi.nlm.nih.gov/Genbank/
- http://www.ddbj.nig.ac.jp/
- http://www.uniprot.org/
- http://www.rcsb.org/pdb/
- lab-manual-cs-2019.pdf (psgrkcw.ac.in)
- https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BI0505%20LAB%20MANUAL.pdf

Gandhinagar Institute of Science
Master of Science – Biotechnology
Semester-II

Subject Code: 101500202	Subject Title: BTLaboratory – II
Pre-requisite: Candidate should have basic hypothetical knowledge regarding the all subjects covered in theory for Biotechnology program. Should have opted basic graduation degree in biological sciences from recognized university as a regular candidate.	

Course Objective:

- To provide the students with the current updates in the areas of Analytical Techniques, Instrumentation, Enzyme production, purification, analysis of enzymes.
- To generate competent skilled for various microbial technological productions.
- To impart the practical skills for Bioinformatics.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture	Tutorial	Practical	Credit	Theory		Practical		Total
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
-	-	8	04	-	-	140	60	200

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
	Bioinstrumentation		
1	Verification of Beer-Lambert Law.		
2	Determination of absorption maxima of given sample using spectrophotometer.		
3	Colorimetry and spectrophotometry: Estimation of sugar and total carbohydrates, estimation of protein by lowry. Bradford and UV spectrophotometry.		
4	Electrophoresis: Agarose gel electrophoresis.		
5	Electrophoresis: SDS PAGE of proteins.		

	Enzymology	Approx. 8 hours per week	100 %
6	To study oxidase activity of given microbial culture.		
7	Production of fungal alpha amylase using solid-state fermentation/ production of protease by bacterial species and confirmation by determining the achromic point.		
8	Purification of fungal alpha-amylase or bacterial protease by fractionation, chromatographic techniques and electrophoretic separation.		
9	Determination of Acid-Phosphatase activity in soil.		
10	Determination of Alkaline-Phosphatase activity in soil.		
	Advanced Food Biotechnology & Bioinformatics		
11	Isolation and Characterization of Probiotic Bacteria from Fermented Foods.		
12	Fermentation of Fruit Juice using Yeast for Functional Beverage Development.		
13	Production of Bioethanol from Agro-Waste using Yeast Fermentation.		
14	Assessment of Food Spoilage Organisms from Perishable Products.		
15	Production of Single Cell Protein (SCP) from Yeast or Algae.		
16	Data base exploration		
17	BLAST		
18	Phylogenetic tree construction		

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

CO1: Operate and access different microscopic techniques, spectroscopic techniques, Chromatography techniques, and the techniques for the measurements of colligative properties.

CO2: Learn commercial production of Alcoholic products, organic acids, antibiotics, exopolysaccharides, wine etc.

CO3: Acquire the knowledge of computers, operating system, internet resources.

CO4: Access biological databases, Methods of sequence alignment, Genomics and Proteomics applicability.

List of Text Books:

- "Laboratory exercises in Microbiology", by Harlcy Prescott, 2002, 6th edition, The MaCraw Hill.
- "Laboratory manual in Biochemistry", by Jayraman, J., 1998, New age International Publishers, New Delhi.
- "Hand book of microbiological media", by Atlas, R. M., 1993, CRC Press, Inc. Florida.1.

List of Reference Books:

- "Bioinformatics", by C.S.V. Murthy 1st edition publishers Himalaya Publishing House, Mumbai.
- "Laboratory Manual in Industrial Biotechnology", by P. Chellapandi 2007, Pointer Publishers, Jaipur.
- "Manual of laboratory techniques", by Rghumulla, N., Nair, K. M., and Kalyansundaram, S., 2nd edition, 2003, National Institute of Nutrition Press, Hyderabad. "Methods in Microbiology", Vol.3A and Vol.3B edited by Norris and Ribbons, Academic Press,
- "Practical Biotechnology", by P. Ramadass and A. Wilson Aruni, 2007, Jaypee Brothers Medical Cox M. M., Nelson D. L., (2008)
- Lehninger Principles of Biochemistry, Fifth edition, W. H. Frreman and CompanyNew York. London.

Open e-Resource:

- http://www.vlab.co.in
- https://vlab.amrita.edu/?sub=3&brch=73
- https://www.futurelearn.com/courses
- https://www.labster.com/explore/microbiology-virtual-labs

Gandhinagar University
Master of Science
Semester-II

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

Course Objective:

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

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

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

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

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

List of Text Books:

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

Gandhinagar Institute of Science
M.Sc. Microbiology
Sem-3

Subject Code: 10230301	**Subject Title: Genetic Engineering (Theory)**

Pre-requisite:

- Candidate should have opted graduation degree in any biological field as per UGC norms in any recognized Board/University.
- 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) To gain a thorough understanding of the basic principles of molecular biology.
(2) To understand the tools of DNA technology.
(3) To design approaches to addressing questions in molecular biology and to interpret experimental data in molecular biology.
(4) To become proficient with a number of advanced and basic tools in molecular biology.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Principle, Tools and Concept of Gene Cloning:** Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT-(Reverse transcription) PCR.	**15**	25%

2	**Cloning Vectors and Host Strains:** Plasmid based vectors, Phage based vectors, Cosmids, Phagemids, BACs and yeast-based vectors. Salient features of Host strains.	**15**	25%
3	**Methods of Gene Manipulation and Selection of Clones:** Screening and selection of clones, Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).	**15**	25%
4	**Applications of Genetic Engineering:** Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors. Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).	**15**	25%

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

1) Describe various theoretical models of the creative process.
2) Identify and interact with creative pockets in the community to continue to re-energize their skills.
3) Develop understanding about the molecular mechanisms behind different modes of gene regulation in bacteria and eukaryotes.
4) Gain basic concepts of synthetic biology and its applications.
5) Interpret and critique data from primary research articles.

List of Text Books:

- Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
- Desmond, S. T. Nicholl, (2008). An Introduction to Genetic Engineering. 3rd Edition. Cambridge University Press.

List of Reference Books:

- Clark DP and Pazdernik NJ. (2010). Biotechnology-Applying the Genetic Revolution. 1st Edition. Elsevier Academic Press, USA.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Primrose SB and Twyman RM. (2013). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
- Sambrook J, Fritsch EF and Maniatis T. (2012). Molecular Cloning-A Laboratory Manual. 4th edition. Cold Spring Harbor Laboratory Press.

Open e-Resource:

- Genetic Engineering: Theory and Application - Course (nptel.ac.in)
- Free Online Certificate Courses to Become a Genetic Engineer - Alison
- Free Online Course: Genetic Engineering: Theory And Application from Swayam | Class Central

Gandhinagar Institute of Science
Master of Science – Microbiology/ Biotechnology/ Environmental Science/ Pharmaceutical Science
Semester-III

Subject Code: 10230302	Subject Title: Biostatistics (Theory)

Pre-requisite:

- Candidate should have opted graduation degree in any biological field as per UGC norms in any recognized Board/University.
- 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:

- To impart the knowledge regarding basic statistics.
- To make students enable to perform the basic statistical analysis in the field of Biology.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Concepts of population and sample:** need for sampling, census and sample surveys, designing of a questionnaire, sampling and non-sampling errors, sample size determination, finite population sampling techniques-SRSWR, SRSWOR, Measures of Central Tendency-Arithmetic Mean, Median, Mode, Standard Deviation. **Representation of Data.**	15	25%
2	**Correlation And Regression:** Introduction, Correlation analysis, Types of Correlation, Methods of studying correlation, Degree of Correlation, Significance test for Correlation Coefficient, Regression analysis, Significance test for Regression Coefficient, Uses of Regression Analysis.	15	25%

3	**Chi- Square test, One way classification, Analysis of variance (ANOVA):** One-way and Two-way, Single factor ANOVA, Two-factor ANOVA with unequal and equal replication (with/without interactions). **Three basic principles of design of experiments:** Randomization, replication and local control. Designs of Experiments: Completely Randomized Designs (CRD), Randomized Block Designs (RBD), Latin Square Designs (LSD).	15	25%
4	Advanced Designs for Analysis, Repeated measures designs, ANCOVA (for CRD and RBD), Factorial Designs.	15	25%

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

CO1: Interpret commonly used statistics

CO2: Develop judgment about the application of statistical techniques in a given situation.

CO3: Implement basic statistical techniques, including descriptive and inferential (estimation and hypothesis testing) by hand.

List of Text Books:

- Kempthorne O. (2007): Design and Analysis of Experiments, 2nd Edition, Vol I-II, Wiley. 2.
- Montgomery D. C. (2008): Design and Analysis of Experiment, 7th Edition, John Wiley & sons.
- Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.

List of Reference Books:

- Des Raj and P. Chandhok (1998): Sample Survey Theory. Narosa publishing House.
- Sukhatme P.V., Sukhatme B.V., Sukhatme S. and Ashok C. (1997): Sampling Theory of Surveys and Applications-Piyush Publications.
- William G. Cochran (1977): Sampling Techniques, 3rd edition- John Wiley & Sons.

Open e-Resource:

- Best Biostatistics Courses & Certifications [2023] | Coursera
- Learn Biostatistics With Online Courses and Programs | edX
- Free Online Biostatistics Courses | Alison
- Introduction to Biostatistics - Course (nptel.ac.in)

GANDHINAGAR UNIVERSITY

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

Subject Code: 101500301	Subject Title: Veterinary Biotechnology (Theory)

Pre-requisite:

- Students should have a **basic understanding of animal biology, veterinary science, and physiology**.
- Knowledge of **molecular biology, genetics, and microbiology** is required to understand biotechnological techniques.
- Basic familiarity with **laboratory techniques and bioinformatics tools** will be helpful for studying applications in veterinary biotechnology.

- **Course Objective:**

CO1: This course covers the essentials of animal cell culture, including media, cell lines, and lab setup.
CO2: It explains core techniques like cell propagation, cryopreservation, and in vitro fertilization.
CO3: Students are introduced to genetic engineering and the creation of transgenic animals.
CO4: It explores applications in medicine, such as monoclonal antibodies, stem cells, and gene therapy.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Animal Cells and Media:** History, basic requirements for cell culture laboratory, Types of cell culture media and reagents, Serum, growth supplements, Balanced salt solution, serum and protein free defined media, types of animal cell lines with examples.	15	25%

2	**Animal Cell Culture and Embryology:** Animal cell culture methods, primary culture, secondary culture, suspension cultures, Serum free media, Enzymes used in cell culture, Factors that affecting the growth of cells, Cell culture contaminants, Cryopreservation of primary culture and cell line, Cell cloning, Types of cell culture bioreactor, Cell counting and cytotoxic assay, Collection and preservation of embryos; culturing of embryos; gametogenesis and fertilization in animals; In vitro fertilization and stem cell research.	15	25%
3	**Advanced Tools and Transgenic Techniques :** Gene Editing Tool: Zinc Finger, TALEN, Clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system. SNP, STR, RFLP, RAPD, genetic basis for disease resistance, gene knock out technologies. Transgenic animals: Applications of transgenic animal technology. Techniques of gene transfer: Microinjection, lipofection, electroporation, chemical-based transformation, and viral vectors.	15	25%
4	**Application:** Applications of animal cell culture, Hybridoma technology and monoclonal antibody production, Applications of monoclonal antibodies in diagnostic and cancer research, Isolation and culturing of adult and embryonic stem cells, Therapeutic applications of adult stem cells. Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia), Recombinant DNA in medicines: recombinant insulin and human growth hormone, Gene therapy.	15	25%

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

CO1: Explains principles of cell culture, media, and lab requirements.
CO2: Demonstrates cell culture techniques, cryopreservation, and IVF.
CO3: Applies gene-editing tools like CRISPR for transgenics.
CO4: Evaluates biotech applications in medicine and therapy.

List of Text Books:

- Culture of Animal Cells: A Manual of Basic Technique, R. Ian Freshney, A John Wiley & Sons, Inc., Publication, 2000
- Basic Cell Culture: A Practical Approach, J. M. Davis (Editor), IRL Press at Oxford University Press (OUP) , 1994.
- Advances and Applications in Biotechnology Volume 2 – Prospects of Transgenic Animals in Biotechnology, Arti Gupta, Ali Asghar Rastegari (Editors), CRC Press , 2026.
- Animal Biotechnology 1: Reproductive Biotechnologies, Heiner Niemann, Christine Wrenzycki (Editors), Springer, Berlin, Ethan Ray, Kruger Brentt Publisher Uk. Ltd., 2026.

List of Reference Books:

- Advances in Animal Biotechnology, Birbal Singh, Gorakh Mal, Sanjeev K. Gautam, Manishi Mukesh, Springer, 2019.
- Laboratory Manual Animal Biotechnology, Dr. Asita Elengoe (Editor), Lincoln University College, 2024.

Open e-Resource:

- https://onlinecourses.swayam2.ac.in/cec26_ma06/preview
- https://onlinecourses.nptel.ac.in/noc23_bt68/preview
- https://www.coursera.org/learn/stem-cells

Gandhinagar Institute of Science
Master of Science -Microbiology/Biotechnology/Environmental Science
Semester-III

Subject Code: 10230304	Subject Title: Environmental Biotechnology (Theory)

Pre-requisite:

- Candidate should have opted graduation degree in any biological field as per UGC norms in any recognized Board/University.
- 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:

- Become aware of the important role microbes play in bio-geochemical cycling of essential elements occurring within an ecosystem and its significance.
- Gain in depth knowledge of different types of solid waste, liquid waste and their management.
- Get familiar with problems of pollution and applications of clear up technologies for the pollutants.
- Know about the diverse microbial populations in various natural habitats like soil, air, water.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Principles of Waste Treatment:** 1. Issues and scopes of environmental biotechnology. 2.Waste water treatment: Waste water characterization and its significance: COD, BOD, Inorganic constituents, solids, biological components. 3.Principles and aims of biological wastewater treatment processes: Primary, secondary and tertiary treatment of waste water. 4. Biochemistry and Microbiology of inorganic phosphorus and nitrogen removal. 5.Suspended growth technologies: Activated sludge,	15	25%

	oxidation ditches, waste stabilization ponds. 6.Fixed film technologies: Trickling filters, rotating biological contactors, fluidized bed and submerged aerated filters.		
2	**Techniques of Waste Treatment:** 1.Toxicity testing in waste water treatment plants using microorganisms. 2. Anaerobic digestion: microbiological and biochemical fundamentals, factors influencing anaerobic digestion. 3.Anaerobic waste water treatment systems: RBC, UASB, anaerobic filters. Merits and demerits of anaerobic treatment of waste.	15	25%
3	**Biodegradation and Deterioration:** 1.Biodegradation of organic pollutants: Mechanisms and factors affecting biodegradation. 2.Pollution problems and biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes, lignin and pesticides. 3.Bioremediation: Intrinsic bioremediation, Bio stimulation and Bioaugmentation. In situ and ex situ bioremediation technologies. Bioremediation of oil spills. Bioremediation of heavy metal pollution, Phytoremediation. 4. Use of GMO in bioremediation. Biological treatment of waste gas (polluted air): biofilters, bio scrubbers, membrane bioreactors, bio trickling filters.	15	25%
4	**Biogeotechnology:** 1.Bioleaching of metals: Characteristics of commercially important microbes, mechanisms of bioleaching, factors affecting bioleaching and current biomining processes. 2. Bio beneficiation of gold ores. Microbially enhanced oil recovery. 3. Bio desulfurization of coal: Removal of organic and inorganic Sulphur from coal.	15	25%

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

CO1: Student will understand the characterization of wastes.
CO2: Student will understand the treatment of wastes.
CO3: Will be able to explain Biodegradation principles and related environmental issues.
CO4: Student will know geology and geological techniques for Bioremediation.

List of Text Books:

- Biotechnology-Rehm and Reid.
- Comprehensive Biotechnology Vol-4, Murray Moo Young.

List of Reference Books:

- Waste water microbiology by G. Bitton
- Biodegradation and bioremediation by M. Alexander
- Waste water treatment for pollution control, 2nd edition. Arceivala
- Environmental Biotechnology by H. Jordening and Josef Winter.

Open e-Resource:

- https://www.classcentral.com/tag/microbiology
- https://www.mooc-list.com/tags/biotechnology
- https://asm.org/articles/2020/december/virtual-resources-to-teach-microbiology-techniques
- https://www.futuredirections.org.au/publication/living-soils-role-microorganisms-soil-health

Gandhinagar Institute of Science
M.Sc. Biotechnology
Sem-3

Subject Code:101500302	**Subject Title:** BTLaboratory-III
Pre-requisite: Candidate should have completed graduation degree in any biological field as per UGC norms in any recognized Board/University. Candidates must have studied core subjects like Biology, Chemistry and Mathematics.	

Course Objective:

- To provide the students with laboratory (experimental) training so that they are competent enough to work in industries.
- To train the students in the field of Animal biotechnology.
- Hands-on training in the field of Genetic Engineering.
- To impart practical skills for waste characterization, treatment and other bioremediation techniques for creating a better environment.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-	12	06	-	-	140	60	200

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	To induce mutation by UV radiation and to exhibit DNA repair by photoreactivation.	12	100%
2	To isolate and produce UV induced auxotrophic mutants by replica plating method.		
3	Isolation of antibiotic-resistant mutants by chemical mutagenesis.		
4	To prepare competent cells and transform plasmid.		
5	Isolation of genetic material of Yeast.		
6	Preparation and Filter sterilization of Animal tissue culture medium		
7	Quantification of cells by hemocytometer		
8	Quantification of viable and non-viable cells by trypan blue dye exclusion method		
9	Preparation of sera		
10	Primary Cell Culture		

11	Preparation of established Cell lines		
12	Bio-oxidation and determination of oxidation rate: Fe, Cu, S.		
13	Bioleaching of Cu from sulphidic ore.		
14	Desulphurization of coal.		
15	Physical Characterization of water odour, colour, turbidity, temperature, salinity, Volatile Solids (VS), Dissolved Solids (DS), Suspended Solids (SS) and Total Solids (TS)		
16	Chemical characterization of water: acidity, alkalinity, chloride, phosphate, sulphate, copper, magnesium and total hardness.		
17	Decolorization of dye.		
18	Biodeterioration of lignocellulosic waste and pharmaceutical products: • Determination of microbial load • Characterization of bio deteriorating microorganisms		
19	Statistical analysis of data: Calculation of Standard Mean and deviation.		
20	Antioxidant activity of pigment		

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

CO-1: Perform molecular biology experiments.

CO-2: Learn biodeterioration process *in vitro* with use of microorganisms.

CO-3: Perform animal cell culture techniques.

CO-4: Analyze statistical data of all experiments.

List of References:

- "Experiments in Microbiology, Plant Pathology and Tissue Culture", by Aneja, K. R., 1993, Wishwa Prakashan.
- "Hand book 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.
- "Laboratory manual in Biochemistry", by Jayraman, J., 1998, New age International Publishers, New Delhi.
- "Manual of laboratory techniques", by Rghumulla, N., Nair, K. M., and Kalyansundaram, S., 2nd edition, 2003, National Institute of Nutrition Press, Hyderabad.
- Culture of Animal Cells: A Manual of Basic Technique, R. Ian Freshney, A John Wiley & Sons, Inc., Publication, 2000
- Basic Cell Culture: A Practical Approach, J. M. Davis (Editor), IRL Press at Oxford University Press (OUP) , 1994.
- Methods in Microbiology", Vol.4 edited by Booth, C., Academic Press, London.
- Methods in Microbiology", Vol.5 edited by Norris and Ribbons, Academic Press, London.
- "Practical Biotechnology", by P. Ramadass and A. Wilson Aruni, 2007, Jaypee Brothers Medical Publishers(p) Ltd. New Delhi.
- "Standard methods for the examination of water and waste water", 20th edition, edited by Greenberg, *et al.*, 1998, APHA, AWWA, Washington, DC.

Open e-Resource:

- NCBI – Molecular Biology Resources, https://www.ncbi.nlm.nih.gov , Provides protocols and explanations on DNA isolation, mutation, and gene expression.
- Cold Spring Harbor Laboratory – DNA Learning Center, https://dnalc.cshl.edu , Interactive resources on mutation, DNA repair, and molecular techniques.
- ATCC Cell Culture Guides, https://www.atcc.org/resources , Standard protocols for cell culture techniques and maintenance of cell lines.
- Microbiology Society Resources, https://microbiologysociety.org, Educational materials on microbial ecology and environmental biotechnology.
- World Health Organization Water Quality Guidelines, https://www.who.int/water_sanitation_health
- NPTEL Biostatistics Courses, https://nptel.ac.in
- Swayam Portal: General Microbiology - Course (swayam2.ac.in)
- OpenStax: Microbiology - OpenStax.

Gandhinagar Institute of Science
Master of Science - Microbiology
Semester-3

Subject Code: 20230306	**Subject Title: Traditional Fermented Foods and Beverages**
Pre-requisite: Candidate should have ● Basic understanding of Food Microbiology and Biochemistry ● Knowledge of microbial growth, metabolism, and enzyme activity ● Familiarity with food preservation and processing principles	

Course Objective:

(1) Introduce the microbial and biochemical basis of traditional food fermentations.
(2) Explore the cultural, nutritional, and economic importance of traditional fermented foods and beverages.
(3) Understand microorganisms involved, fermentation conditions, and product characteristics of selected traditional foods.
(4) Develop knowledge on quality, safety, and standardization aspects of fermented products.
(5) Provide hands-on experience in the preparation and analysis of fermented foods and beverages.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
01	-	02	02	-	25	-	25	50

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Fundamentals of Food Fermentation** ● Definition, history, and importance of food fermentation ● Classification of fermented foods (based on substrate, microorganisms, and region) ● Role of lactic acid bacteria, yeasts, and molds in fermentation ● Nutritional and functional benefits of fermented foods ● Microbiological and biochemical changes during fermentation ● Factors affecting fermentation (temperature, pH, salt concentration, etc.)	15	33%
2	**Traditional Fermented Foods of India and the World** ● Cereal-based fermentations: Idli, Dosa, Dhokla, Bhatura, and Appam ● Vegetable and fruit fermentations: Sauerkraut, Kimchi, Pickles ● Dairy fermentations: Yogurt, Dahi, Lassi, Kefir, and Cheese	15	33%

	• Meat and fish fermentations: Fermented sausages, Fish sauce, and Ngari • Microbial diversity and starter cultures used in traditional fermentations		
3	**Fermented Beverages and Quality Aspects** • Overview of alcoholic and non-alcoholic traditional beverages • Fermented beverages: Toddy, Sonti, Palm wine, Kombucha, Kvass, and Sake • Fermentation processes and microorganisms involved • Quality control, safety, and standardization in fermented foods and beverages • Probiotic and health-promoting fermented foods • Industrialization and commercialization of traditional fermented products • Preservation and packaging of fermented foods and beverages	15	34%

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

CO1: Explain the principles and microbiology of traditional food fermentations.

CO2: Identify microorganisms involved in various traditional fermented foods and beverages.

CO3: Analyze the biochemical and nutritional changes occurring during fermentation.

CO4: Demonstrate the preparation of selected traditional fermented foods and beverages in the laboratory.

CO5: Evaluate the safety, quality, and probiotic aspects of fermented products.

List of Text Books:

- Joshi, V.K. & Pandey, A. (1999). *Biotechnology: Food Fermentation – Microbiology, Biochemistry, and Technology.* Vol. I & II. Educational Publishers & Distributors, New Delhi.
- Ray, R.C. & Joshi, V.K. (2014). *Fermented Foods: Part I – Biochemistry and Biotechnology.* CRC Press.
- Steinkraus, K.H. (1996). *Handbook of Indigenous Fermented Foods.* CRC Press, Boca Raton.

List of Reference Books:

- Campbell-Platt, G. (1994). *Fermented Foods of the World – A Dictionary and Guide.* Butterworths.
- Holzapfel, W. (Ed.). (2014). *Advances in Fermented Foods and Beverages: Improving Quality, Technologies and Health Benefits.* Woodhead Publishing.
- Hutkins, R.W. (2019). *Microbiology and Technology of Fermented Foods.* Wiley-Blackwell.
- Tamang, J.P. (Ed.). (2015). *Ethnic Fermented Foods and Beverages of India: Science History and Culture.* Springer.

Suggested Practicals:

1. Preparation and study of lactic acid fermented foods (e.g., curd, idli batter).
2. Isolation and identification of microorganisms from fermented foods (microscopic and cultural characteristics).
3. Preparation of vegetable or fruit fermented products (e.g., sauerkraut, pickles).
4. Production of fermented beverages such as ginger beer or kombucha.
5. Measurement of pH, acidity, and microbial count during fermentation.
6. Sensory and biochemical evaluation of fermented foods.
7. Study of starter cultures used in traditional fermentations.
8. Safety assessment – detection of spoilage or contamination in fermented foods.

Open e-Resource:

- Fermentation Technician Training | Free Online Course | Alison
- Food Microbiology - Course
- Food Microbiology and Food Safety - Course
- Free Course: Food Microbiology from CEC | Class Central
- HarvardX: Food Fermentation: The Science of Cooking with Microbes | edX

Gandhinagar Institute of Science
Master of Science - Chemistry
Semester-IV

Subject Code: 10230401	**Subject Title: Research Methodology**
Pre-requisite: Student must have achieved Graduate degree in Chemistry with minimum three years on regular basis, from any UGC recognized university. Student should have basic knowledge and technical skill for the concern subject.	

Course Objective:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.

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	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Research Methodology:** Research Defined: Understanding the Meaning of Research, Research Goals: Exploring Objectives and Motivations, Diverse Research Types and Approaches, Significance of Research and Its Place in Scientific Methods, Navigating the Research Process, Identifying Criteria for High-Quality Research.	15	25%
2	**Defining the Research Problem & Research Design:** Deciphering the Research Problem, Selecting and Framing Research Questions, The Importance of Problem Definition, Techniques for Articulating Research Problems. Unpacking Research Design: Meaning and Necessity, Features of an Effective Research Design, Core Concepts and Types of Research Design, Basics of Experimental Design Principles, Design a Research Plan.	15	25%
3	**Testing of Hypothesis:** Understanding Hypothesis Testing: Concepts and Flow, Evaluating the Power of a Hypothesis Test, Parametric Tests: Hypothesis Testing for Means and Proportions, Comparing Variances and Correlation Coefficients, Recognizing Limitations in Hypothesis Testing.	15	25%
4	**Methods of Data Collection:**	15	25%

	Collecting Primary Data: Observation, Interviews, Questionnaires and More, Gathering Secondary Data and Selecting the Appropriate Method, Insights into Case Study Methodology, Guidelines for Developing Effective Questionnaires, Comparing Surveys and Experiments. **Processing and Analysis of Data:** Data Processing Fundamentals and Challenges, Analyzing Data Elements, Statistical Tools in Research, Measures of Central Tendency and Dispersion, Exploring Relationships and Regression Analysis.		

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

1. Demonstrate the ability to choose methods appropriate to research aims and objectives.
2. Understand the limitations of particular research methods.
3. Develop skills in qualitative and quantitative data analysis and presentation.
4. Develop advanced critical thinking skills.

References:

1. Kothari, C.R.,1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.
2. Das, S. K., 1986, An Introduction to Research, Kolkata, Mukherjee and Company Pvt. Ltd.
3. Misra R.P., 1989, Research Methodology: A Handbook, New Delhi, Concept Publishing Company Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for for Beginners, (2nd.ed.), Singapore, Pearson Education.
4. Bhattachraya, D.K., 2006, Research Methodology, (2nd.ed.), New Delhi, Excel Books.
5. Panneerselvam R., 2012, Research Methodology, New Delhi, PHI Learning Pvt. Ltd.
6. Khan, Irfan Ali, 2008, Fundamentals of Biostatistics, Ukaaz Publications
7. Rosner B.A., 2011, Fundamentals of Biostatistics, Cengage Learning
8. Katz J.M., 2009, Form Research to Manuscript: A guide to scientific writing, USA, Springer Science