S.S. Jain Subodh P.G. College, Jaipur
(Autonomous)

Affiliated to University of Rajasthan

Faculty of Science

(Three/Four Year Bachelor of Science)
(Bio Group)

Subject: Microbiology

SYLLABUS

(Semester Scheme)
Choice Based Credit System (CBCS)
(As Per the National Education Policy - 2020)

I & II Semester Examinations 2025-2026

III & IV Semester Examinations 2026-2027

V &VI Semester Examinations 2027-2028

[Onwards]

Medium of Instruction: Hindi/English

S. S. Jain Subodh P.G. College (Autonomous), Jaipur
Department of Microbiology

Vision:

- *To become a centre of excellence for training and research in microbiology.*
- *To disseminate knowledge across the theoretical and practical aspects of microbiology that is imperative for the development of scientific research in the country.*
- *To impart quality education to the students in Microbiology to meet the needs of industry, profession and society; and to achieve excellence in teaching, learning and research.*

Mission:

- *To encourage critical thinking, scientific attitude and ethics, and promote abilities.*
- *To involve in outreach and extension activities for understanding of relevance and importance of Microbiology in community.*
- *To impart knowledge and training across the different fields of microbiology to be able to equip students for academics/industry.*
- *Cultivating talents and promoting all round personality development through multi-dimensional education to foster a spirit of self-confidence and self-reliance in our students.*
- *To prepare them to become responsible contributing citizens of society, who can take up leadership positions around the country.*
- *To train quality professionals to carry out creative, innovative and inventive research.*

Content:

1. Eligibility:

10+2 with 48% from Rajasthan Board / CBSE from Rajasthan state and 60% for CBSE or any other equivalent recognized Board from other state in Science Stream with Physics, Chemistry and Biology.

2. Scheme of examination:

Sr. No.	Paper	ESE	CIA	Total
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

1. 1 credit = 25marks for examination/ evaluation
2. For Regular Students there will be Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components- Continuous assessment (30% weightage) and (End of end-semester examination) EoSE (70% weightage).
3. For Regular Students,75% Attendance is mandatory for appearing in the EoSE.
4. To appear in the EoSE examination of a course/ subject a regular student must appear in the mid-semester examination.

Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration. Each Practical /Lab work 4 hours duration. The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately. Note: Maximum marks for a theory paper is 100 marks which include 70 marks for ESE and 30marks for internal assessment.

Mark distribution in question paper:

The question paper (EoSE - End of Semester Examination) will consist of two parts A & B

Part - A: 14 Marks.

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

Skill Enhancement Courses (SEC)

Credits: 2 Maximum Marks: 50
Classes per week: 2 EoSE: 35
CIA:15

Each question will be of **1 Mark** each.

Examination will be conducted on **OMR sheet.**

Name of proposed SEC from the upcoming session 2025-26.

Semester I: 101 Computer Fundamentals/104 Business Communication Skills

Semester II: 208 Introduction to Cyber Security/ 105 Effective Communication Skills

Semester III: 120 Disaster Management/ 109 Finance for everyone

Semester IV: 201 Environmental Management/ 220 Use of Chemicals in Daily Life

Semester VI: Logical and Critical Thinking

or

108 Quantitative Aptitude and Data Interpretation

Value added Course (VAC)

Credits: 2 Maximum Marks: 50
Classes per week: 2 EoSE: 35
CIA: 15

Examination will be of **one hour.**

Question paper will have multiple choice questions **(35 in number).**

Each question will be of **1 Mark** each.

Examination will be conducted on **OMR sheet**.

Name of proposed VAC from the upcoming session 2025-26.

First Year (Semester I and Semester II)		
S.No.	**Course Code**	**Course Name**
1.	VAC-51F-101/ VAC-52F101	Anandam-I
2.	VAC-51T-102/ VAC-52T102	Digital Enhancement
3.	VAC-51T-103/ VAC-52T103	Understanding Indian society & Culture
4.	VAC-51T-104/ VAC-52T104	Nutrition for Health and Fitness
5.	VAC-51T-105/ VAC-52T105	Geriatric Wellness and Care
6.	VAC-51T-106	National Cadet Corps (NCC)-I (Semester I)

7.	VAC-51T-107/ VAC-52T107	Indian value system
8.	VAC-51T-108	National Service Scheme (NSS)-I (Semester-I)
9.	VAC-51T-109/ VAC-52T109	Financial Literacy
10.	VAC-52T-110	National Cadet Corps (NCC)-I (Semester II)
11.	VAC-52T-111	National Service Scheme (NSS)-II (Semester-II)
12.	VAC-51T-112/ VAC-52T112	Environmental studies
Second Year (Semester III and Semester IV)		
S.No.	**Course Code**	**Course Name**
1.	VAC-63F-201/VAC-64F-201	Anandam-II
2.	VAC-63F-203/VAC-64F-203	Traditional & modern medicine systems for Everyday health solutions
3.	VAC-63F-204	National Service Scheme (NSS)-III (Semester-III)
4.	VAC-64F-205	National Service Scheme (NSS)-IV (Semester-IV)
5.	VAC-63F-206	National Cadet Corps (NCC)-III (Semester III)
6.	VAC-64F-207	National Cadet Corps (NCC)-IV (Semester IV)
7.	VAC-63T-208/VAC-64T-208	Content writing
8.	VAC-63T-209/VAC-64T-209	Cyber Law and Ethics
9.	VAC-63T-210/VAC-64T-210	Electoral Literacy

Multidisciplinary Course (MDC)

Credits: 4 Maximum Marks: 100
Classes per week: 4 EoSE: 70
CIA:30

Examination will be of **three hours.**
The question paper (EoSE-End of Semester Examination) will consist of two parts A & B.

Part A: 14 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.
MDC will run in Semester III, IV and V.

Name of proposed MDC from the upcoming session 2025-26

1. **English**

Basics of English Grammar and Composition	English	III
Basics of English Grammar and Composition	English	IV
Basics of English Grammar and Composition	English	V

2. **History**

Historical Evolution of Indian Society	History	III
Historical Trends in Indian culture	History	IV
Historical Methods and Historiography	History	V

3. **Business Administration**

Business communication skills	BBA	III
E-commerce	BBA	IV
Trade Unions and Industrial Relations	BBA	V

4. **Botany**

Introduction of Botany	Botany	III
Plants and Human health	Botany	IV
Biodiversity Conservation and Ecotourism	Botany	V

5. **Psychology**

Basics of Psychology-I	Psychology	III
Basics of Psychology-II	Psychology	IV
Personality Development	Psychology	V

3. Semester Structure:

The details of the courses with title assigned are as given below.

Syllabus: Microbiology

Semester	Name of Paper	Credits	Total Credits	Max. Marks (EoSE)
Semester-I				
Theory	Introduction to Microbiology and Microbial Diversity	04	6	100
Practical	Microbiology Practical Lab (I)	02		50
Semester-II				
Theory	Bioinstrumentation and Microbial Techniques	04	6	100
Practical	Microbiology Practical Lab (II)	02		50
Semester-III				
Theory	Microbial Biochemistry and Microbial Genetics	04	6	100
Practical	Microbiology Practical Lab (III)	02		50
Semester-IV				
Theory	Immunology and Medical Microbiology	04	6	100
Practical	Microbiology Practical Lab (IV)	02		50
Semester-V	**Any one from elective A/B**			
Theory Elective A	Food and Dairy Microbiology	04	6	100
Theory Elective B	Environment, Soil and Agriculture Microbiology	04		100
Practical	Microbiology Practical Lab (V-A / V-B)	02		50
Semester-VI	**Any one from elective A/B**			
Theory Elective A	Industrial Microbiology	04	6	100
Theory Elective B	Bioinformatics, Bioethics, Biosafety and IPR	04		100
Practical	Microbiology Practical Lab (VI-A / VI-B)	02		50

* Students have to choose any one elective paper out of two in fifth and sixth semester.

* Departments will offer minimum two and maximum four theory elective course for the semester based on options submitted by students and availability of faculty to teach the course.

DSC = Discipline Specific Core;
DSE = Discipline Specific Elective;

DSCP = Discipline Specific Core Practical;
SEM =Seminar; **PRJ** = Project Work;
EoSE = End-of-Semester Examination; CIA = Continuous Internal Assessment.

Marks Break-Up:

End-of-Semester Exam (EoSE) (70 Marks) + Continuous Internal Assessment (CIA) (30 Marks);
Practical Examination Marks = 50 Marks (20 Internal Exam + 30 External Exam); Grand Total = 150 Marks per Semester.
Theory Classes: Three hours per week for each of the papers; EoSE duration of three hours for each of the papers.
Practical Classes: Four hours practical classes per week and EoSE practical examination of three hours duration.

4. PROGRAMME OUTCOMES / PROGRAMME SPECIFIC OUTCOMES / COURSE OUTCOMES

Name of College	S.S. Jain Subodh P.G. College (Autonomous), Jaipur
Name of Faculty	Science
Name of Programme	Under Graduate (U.G.) – B.Sc. (Bio Group)
Name of Discipline	Microbiology

PROGRAMME SPECIFIC OUTCOMES

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

PSO 1: Academic skills:

A. The ability for understanding the fundamental ideas underlying the relevant domains of microbiology, which will enable them to assess problems related to microbiology and develop solutions.

B. Capable of understanding microbial activities that may be applied to the development of biochemical and immunological tools to enhance human life quality.

C. Understanding of the cytology, biochemistry, growth, and applications of ecologically and industrially significant microorganisms with a focus on enhancing environmental sustainability and human health.

D. Capable of describing and understanding the concepts relating to the function of microorganisms in geochemical processes such as metal leaching and bioremediation techniques.

PSO 2: Personal and Professional employability Skills:

A. The ability to use practical knowledge of microbiology, molecular biology, immunology, medical microbiology, and the search for relevant biomolecules in particular professional contexts.
B. Making use of bioinformatics and molecular taxonomy methods to examine various microbial groups.
C. Assess the purity, safety, and morally righteous application of industrially significant microbial products for the betterment of humanity.
D. Combine a solid understanding of microbial science with public speaking abilities that include clear articulation and nonverbal communication.

PSO 3: Successful Career and Entrepreneurial Skills:

A. Become an entrepreneur by employing microorganisms to generate biofertilizers and mushrooms.
B. Acquiring practical, hands-on training to work in laboratories conducting diagnostic, industrial, pharmaceutical, food, and research and development and program for practical training in agro-economic activity.
C. Assurance of quality and testing of pharmaceutically significant products in compliance with internationally recognized standards.
D. Evaluate the popularity of recent consumer products including nutraceuticals, probiotics, and prebiotics.
E. Concepts of microbial interactions in basic and sophisticated procedures for waste water treatment.

PSO 4: Hygiene practices and Environmental Consciousness

A. Develops healthy hygiene practices into habits.
B. Encourages students to engage in eco-consciousness and trash management.

PSO 5: Research and Scientific attitude:

A. Promotes a research mindset and scientific approach to the development of environmentally friendly bioproducts employing statistical techniques appropriate to the biological sciences.
B. Apply advanced approaches to standardize detection and quantification procedures while incorporating biological and physical scientific principles.

PSO 6: Social Interaction and Awareness:

A. Promotes community connections by conducting recurring surveys on the villagers' nutritional and health status.
B. Raises awareness of contagious and deadly diseases.

PROGRAM OUTCOMES

PO 1: Sound Domain and Disciplinary Knowledge:

A. Extensive understanding of the discipline required for a postgraduate program.

B. Execute strong theoretical and practical knowledge produced for the specific program in the field of work.

C. Developing a solid foundation in evolution and diversity in the practical discipline of microbiology.

PO 2: Research-related (Laboratory) skills and Scientific temper:

A. To acquire strong laboratory skills using advanced equipment, sophisticated instruments, and novel approaches to handle growing problems from a scientific standpoint.

B. Collect scientific literature, develop a spirit of enquiry, and be able to design, test, evaluate, and establish hypothesis and research questions.

C. Designing a research paper/project with an emphasis on academics and research ethics, scientific conduct, and raising awareness about intellectual property rights and plagiarism issues.

PO 3: Academic, Scientific and Trans-disciplinary Endeavour:

A. Students will learn a cognitive-innovative approach, technical maneuvering, innovative, and management skills in order to launch a new venture.

B. Create new conceptual, theoretical, and methodological knowledge of challenges that combines and transcends discipline-specific approaches.

PO 4: Personal, professional and Social aptitude:

A. Perform independently and collectively as a team member to fulfil stated goals and carry out work across diverse domains.

B. Execute interpersonal interactions, self-motivation, and versatility, while adhering to professional ethics.

C. Effectively communicate with others using suitable media; demonstrate ideas and concepts both vocally and in writing; develop interactive and presentation abilities to fulfil global competencies. In group settings, elicit others' perspectives, convey difficult material in a clear and succinct manner, and assist in reaching a resolution.

PO 5: Eco-friendly Environment and Sustainable Approach:

A. Futuristic strategy to create environmentally friendly management practices to improve socioeconomic conditions.

B. Know how scientific advancements affect societal and environmental issues, and be able to articulate the benefits of the necessity for sustainable growth.

PO 6: Effective Citizenship and Ethical Awareness:

A. To improve students' sensitivity to ethical issues in research and publishing.
B. Ability to behave with educated understanding of moral and ethical issues, commit to professional ethics and accountability, and promote national development that is equity-focused and socially conscious.

PO 7: Self-directed or as Team Work towards Life-long learning:

A. Learn to develop a collaborative approach to exploring new facts and perspectives of the subject, as well as lifelong learning, in the broader context of socio-technical changes
B. Develop the ability to engage in independent learning and the spirit of teamwork.

PO 8: Goal of life:

A. To develop in students a sense of purpose that will enable them to contribute significantly to the discipline's development for the betterment of society

COURSE OUTCOMES

- The students will gain a holistic concept on history, development, scope and aspects of Microbiology. They will also learn about the contributions of Microbiologists.
- Students learn about the diversity of microbial world, kingdom and domain concept; features of dark field, phase contrast & electron microscopes.
- Students develop a very good understanding of several microbiological techniques and instruments which are commonly used in a microbiology laboratory. Students will be made aware of biosafety protocols and laboratory management.
- Students will able to understand the basic and general concepts of causation of disease by the pathogenic microorganisms and the various parameters of assessment of their severity including the broad categorization of the methods of diagnosis.
- Conceptualized the protective role of the immune system of the host and developed an understanding of the basic components as well as the mechanisms underlying the immune system and its response to pathogenic microorganisms.
- Students will achieve knowledge on Enzyme immobilization and on microbial production of industrial products, Solid-state and liquid-state fermentation, Down- stream processing & other aspects of industrial microbiology
- Students are able to identify the important role microorganisms play in maintaining healthy environment by degradation of solid/liquid wastes; how these activities of microorganisms are used in sewage treatment plants, production of activated sludge and functioning of septic tanks.
- Developed a broader perspective of the discipline of Microbiology to enable him to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems
- Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.

Course Detail

Introduction: The syllabus for Microbiology at undergraduate level using the Choice Based Credit system has been designed in acquiescence with model syllabus given by UGC. Looking to the rapid inventions and technological developments in the field of Microbiology as well as keeping in view the recommendations of UGC, this syllabus has been formulated by the combined and coordinated efforts of all the faculty members of the Life Science Departments of College and University of Rajasthan. The main objective of designing this syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Microbiology. The ultimate goal of the syllabus is that the students at the end are able to secure a job.

Timely review of the Curriculum to incorporate new knowledge and information is a prime criterion of IQAC–NAAC and primary need for the college educational systems. The UNITs of the syllabus are well defined and the scope of each is given in detail. Microbiology being an experimental science, sufficient emphasis is given in the syllabus for training in laboratory skills and instrumentation. Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques of mapping and understanding of the subject. The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

Microbiology course primarily focuses on the microorganisms and their applications in the field of Research with Genetic engineering, Molecular biology, Biochemistry, Biotechnology, Bioinformatics and Medical Microbiology and hence holds the central position in the curriculum of these subjects. While the syllabus is in compliance with UGC model curriculum, it is necessary that Microbiology students should learn "Bioinformatics, Microbes in Sustainable Agriculture and Development & Instrumentation and Biotechniques" as one of the core courses rather than as elective while.

Also, it is been recommended that the **Project Work** and **Industrial Tour/ Institute visit is compulsory for all the students as per their respective semester curriculum**.

B. Sc. (Pass Course /Subsidiary) Microbiology

Semester Structure: The details of the courses with code, title assigned is as given below.

Duration: 6 Semesters (3 Years)

Semester–I

Paper - I: Introduction to Microbiology and Microbial Diversity

Practical: Based on Theory Papers

Semester II

Paper - I: Bioinstrumentation and Microbial Techniques

Practical: Based on Theory Papers

Semester III

Paper - I: Microbial Biochemistry and Microbial Genetics

Practical: Based on Theory Papers

Semester IV

Paper - I: Immunology and Medical Microbiology

Practical: Based on Theory Papers

Semester V (Any one from A/B)

Paper A: Food and Dairy Microbiology

Paper B: Environment, Soil and Agriculture Microbiology

Practical: Based on Theory Papers

Semester VI (Any One from A/B)

Paper A: Industrial Microbiology

Paper B: Bioinformatics, Bioethics, Biosafety and IPR

Practical: Based on Theory Papers

Marking Scheme for CBCS Curriculum

B.Sc. Semester-I

Max. Marks: Theory- 100 Teaching Hours per week for theory paper: 6

Practical- 50 Teaching Hours per week for practical paper: 4

Type of Exam	Course code	Course Nomenclature	Credit	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	MIC-T-101	Introduction to Microbiology and Microbial Diversity	4	EoSE	3Hrs	EoSE	70 Marks	EoSE	28 Marks
				CIA	1Hrs	CIA	30 Marks	CIA	12 Marks
Practical	MIC-P-101	Microbiology Practical	2	EoSE	3Hrs	EoSE	30 Marks	EoSE	12 Marks
				CIA	1Hrs	CIA	20 Marks	CIA	8 Marks

B.Sc. Semester-II

Max. Marks: Theory- 100 Teaching Hours per week for theory paper: 6

Practical- 50 Teaching Hours per week for practical paper: 4

Type of Exam	Course code	Course Nomenclature	Credit	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	MIC-T-201	Bioinstrumentation and Microbial Techniques	4	EoSE	3Hrs	EoSE	70 Marks	EoSE	28 Marks
				CIA	1Hrs	CIA	30 Marks	CIA	12 Marks
Practical	MIC-P-201	Microbiology Practical	2	EoSE	3Hrs	EoSE	30 Marks	EoSE	12 Marks
				CIA	1Hrs	CIA	20 Marks	CIA	8 Marks

B.Sc. Semester-III

Max. Marks: Theory- 100 Teaching Hours per week for theory paper: 6

Practical- 50 Teaching Hours per week for practical paper: 4

Type of Exam	Course code	Course Nomenclature	Credit	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	MIC-T-301	Microbial Biochemistry and Microbial Genetics	4	EoSE	3Hrs	EoSE	70 Marks	EoSE	28 Marks
				CIA	1Hrs	CIA	30 Marks	CIA	12 Marks
Practical	MIC-P-301	Microbiology Practical	2	EoSE	3Hrs	EoSE	30 Marks	EoSE	12 Marks
				CIA	1Hrs	CIA	20 Marks	CIA	8 Marks

B.Sc. Semester-IV

Max. Marks: Theory- 100 Teaching Hours per week for theory paper: 6

Practical- 50 Teaching Hours per week for practical paper: 4

Type of Exam	Course code	Course Nomenclature	Credit	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	MIC-T-401	Immunology and Medical Microbiology	4	EoSE	3Hrs	EoSE	70 Marks	EoSE	28 Marks
				CIA	1Hrs	CIA	30 Marks	CIA	12 Marks
Practical	MIC-P-401	Microbiology Practical	2	EoSE	3Hrs	EoSE	30 Marks	EoSE	12 Marks
				CIA	1Hrs	CIA	20 Marks	CIA	8 Marks

B.Sc. Semester-V

Max. Marks: Theory- 100 Teaching Hours per week for theory paper: 6

Practical- 50 Teaching Hours per week for practical paper: 4

Type of Exam	Course code	Course Nomenclature	Credit	Duration of Examination		Maximum Marks		Minimum Marks	
Elective Theory	MIC-T-501A	Food and Dairy Microbiology	4	EoSE	3Hrs	EoSE	70 Marks	EoSE	28 Marks
				CIA	1Hrs	CIA	30 Marks	CIA	12 Marks
Elective Theory	MIC-T-501B	Environment, Soil and Agriculture Microbiology		EoSE	3Hrs	EoSE	70 Marks	EoSE	28 Marks
				CIA	1Hrs	CIA	30 Marks	CIA	12 Marks
Practical	MIC-P-501	Microbiology Practical-	2	EoSE	3Hrs	EoSE	30 Marks	EoSE	12 Marks
				CIA	1Hrs	CIA	20 Marks	CIA	8 Marks

B.Sc. Semester-VI

Max. Marks: Theory- 100 Teaching Hours per week for theory paper: 6

Practical- 50 Teaching Hours per week for practical paper: 4

Type of Exam	Course code	Course Nomenclature	Credit	Duration of Examination		Maximum Marks		Minimum Marks	
Elective Theory	MIC-T-601A	Industrial Microbiology	4	EoSE	3Hrs	EoSE	70 Marks	EoSE	28 Marks
				CIA	1Hrs	CIA	30 Marks	CIA	12 Marks
Elective Theory	MIC-T-601B	Bioinformatics, Bioethics, Biosafety and IPR		EoSE	3Hrs	EoSE	70 Marks	EoSE	28 Marks
				CIA	1Hrs	CIA	30 Marks	CIA	12 Marks
Practical	MIC-P-601	Microbiology Practical-	2	EoSE	3Hrs	EoSE	30 Marks	EoSE	12 Marks
				CIA	1Hrs	CIA	20 Marks	CIA	8 Marks

B.Sc. Semester- I Microbiology

Theory Paper - Introduction to Microbiology and Microbial Diversity

1 credit -25 marks
4 credit -100 marks
Question paper: 70 Marks
Internal Assessment: 30 marks

Objectives:

1. To understand the history, scope, and applications of microbiology.
2. To study systems of classification of microorganisms.
3. To understand the structure and functions of bacteria and archaebacteria.
4. To study viruses, viroids, prions, and protozoa.
5. To understand the characteristics and reproduction of algae and fungi.
6. To recognize the economic importance of microorganisms.

Learning outcomes / Course Outcome:

Understanding

- Explain the historical development of microbiology and contributions of key scientists.
- Describe Whittaker's five-kingdom and Woese's three-domain systems of classification.
- Interpret structural features of bacteria, archaebacteria, viruses, protozoa, algae, and fungi.
- Discuss the scope and applications of microbiology in health, environment, and industry.

Memorizing

- Recall types of bacterial shapes, arrangements, and structural components.
- Identify characteristics of archaebacteria, viroids, prions, protozoa, algae, and fungi.
- Classify microorganisms based on taxonomy and unique features.
- List examples of economically important bacteria, algae, and fungi.

Applying

- Differentiate Gram-positive and Gram-negative bacteria based on cell wall composition.
- Compare enveloped and non-enveloped viruses with their structural properties.
- Relate microbial diversity to their roles in ecosystems and human welfare.
- Utilize knowledge of microorganisms to appreciate their industrial, medical, and environmental significance.

Marks distribution in Question Paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts A & B

Part – A: 14 marks

Part A will be compulsory having 10 very short answer type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part- B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

UNIT-I

History of Microbiology: Theory of Spontaneous generation, Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch (Germ Theory of disease), Alexander Fleming. Establishment in the field of medical microbiology: Role of Edward Jenner. Scope and applications of microbiology in various fields.

Systems of classification: Basic idea about Whittaker's five kingdom classification and Carl Woese's three domain classification systems. **(15 hours)**

UNIT –II

Bacteria: Bacterial shapes and arrangement, cell wall of bacteria, chemical composition of cell wall of Gram positive and Gram negative bacteria. nucleoid, ribosomes, flagella, pili and Bacterial endospores (structure, formation and germination) and economic importance of bacteria.

Archaebacteria: General characteristics, cell wall, Types of Archaebacteria (Methanogens, Thermophiles and Halophiles). **(15 hours)**

UNIT –III

Virus: Discovery and general properties of virus, Structure of viruses. Enveloped and non-enveloped viruses. General properties of viroids, virusoids and prions.

Protozoa: General Characteristics: size and shape, habitat, nutrition and reproduction and various examples of protozoa. **(15 hours)**

UNIT –IV

Algae (Phycology): General characteristics of Algae including habitat and cell ultrastructure. *Chlamydomonas*, *Nostoc*, *Spirogyra*, *Anabena* and *Oscillatoria*

Fungi (Mycology): General characteristics of fungi including habit, habitat, nutritional requirements. Thallus organization and aggregation, asexual and sexual reproduction in fungi, Economic importance of Fungi. *Aspergillus* and *Alternaria* **(15 hours)**

References:

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- Sharma, P.D. (2019). Microbiology. Rastogi Publication.
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Suggested E-resources:

- General Microbiology – Swayam Course. This course covers majority of topics like bacteria, fungi, algae, protozoa and other related to the general microbiology. General Microbiology – SWAYAM Course
- Microbiology – NPTEL. This online course covers most of the topics relevant to the principles of classification and general concepts of microbiology. NPTEL :: MICROBIOLOGY - Introduction to the course
- Introductory Microbiology – UGC moocs via Swayam. This online course is very resourceful for undergraduate students new to the field of microbiology. UGC MOOCs: A Vertical of SWAYAM
- Bacteriology and Virology, Swayam course. This course covers all topics related to bacteria and virus with undergraduate level explanation. Bacteriology and Virology - Course
- Virology – Swayam. This course covers all aspects related to viruses with undergraduate level explanation. Virology - Course

Signature of BoS Members	Signature of BoS Convener

B.Sc. Semester- I Microbiology

Microbiology Practical

Maximum practical Marks	=	50 marks
Internal marks	=	30 Marks
External marks	=	20 Marks
		60 Hours

Learning outcomes/Course Outcome:

- Awareness through Demonstration of the techniques of sterilization, sterilization of glassware, learning instruments handling and scientific communication, good understanding of the Microscope and other instruments in laboratory.
- Students gather practical skills of handing microorganisms in the laboratory for study.
- Knowledge of preparation of slides for observation under compound microscope and identification of microorganisms, simple staining, Gram's staining of bacteria and basic microbiological techniques.
- Students will learn slide preparation of plant/animal cells, study of Cyanobacteria and protozoa, observe cell division and special chromosomes, and perform basic molecular biology techniques like genomic DNA isolation.

Suggested Practical Exercises:

1. Safety measures and Good Laboratory Practices in microbiology laboratory.
2. Introduction, operation, precautions and use of common laboratory glass wares and microbiology laboratory instruments: Hot air oven, Autoclave, Laminar air flow hood, Light Microscope.
3. Explanation of principles and various methods of sterilization and cleaning of glass ware.
4. Identification of common morphological forms of bacteria
5. Bacterial smear preparation.
6. Simple staining.
7. Study of different bacteria through permanent slides.
8. Microscopic examination and study of free-living protozoa.
9. Identification and study of Cyanobacteria (blue-green algae) - *Nostoc* and *Oscillatoria*.
10. Identification of Fungi from given sample/permanent slides.
11. Observation of motility in bacteria using: Hanging drop Method.
12. Study of common morphological forms of viruses through charts.
13. Study of common morphological forms of bacteriophage through charts.

*** Any other practical exercise as per theory syllabus.**

Signature of BoS Members	Signature of BoS Convener

B.Sc. Semester- II Microbiology

Theory Paper - Bioinstrumentation and Microbial Techniques

1 credit -25 marks
4 credit -100 marks
Question paper: 70 Marks
Internal Assessment: 30 marks

Objectives:

1. To understand sterilization techniques and culture methods used in microbiology.
2. To study microbial staining, isolation methods, pure culture maintenance, and microscopy.
3. To learn centrifugation techniques, principles of spectroscopy, and use of basic laboratory instruments.
4. To understand principles and applications of chromatography, electrophoresis, and molecular techniques like PCR.

Learning outcomes / Course Outcome:

Understanding

- Explain principles of sterilization, disinfection, pasteurization, and microbial control methods.
- Understand the preparation and applications of different types of culture media.
- Describe the principles behind microbial staining, isolation techniques, and microscopy.
- Interpret working principles of centrifugation, spectroscopy, chromatography, and electrophoresis.

Memorizing

- Recall various staining techniques (Gram, capsule, flagella, acid-fast, endospore).
- Identify methods of microbial isolation and pure culture maintenance.
- List different types of microscopes, centrifuges, and their uses.
- Remember the types and applications of chromatography, electrophoresis, and PCR.

Applying

- Apply sterilization and culture techniques to maintain microbial cultures safely.
- Differentiate microorganisms using staining and microscopy techniques.
- Use centrifugation, spectroscopy, and chromatography in separation and analysis of biomolecules.
- Employ PCR and electrophoresis methods in microbial identification and molecular biology experiments.

Marks distribution in Question Paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts A & B.

Part – A: 14 marks

Part A will be compulsory having 10 very short answer type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part- B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

UNIT-I

Sterilization techniques: Concept of Sterilization- Definition, Physical and chemical methods of sterilization, pasteurization, radiation, ultra sonication, filtration, disinfection, sanitization, antisepsis and fumigation.

Culture techniques: Culture media preparation solid, liquid and semi-solid media, Special Media. Enriched, selective, transport, differential, maintenance and enrichment media. **(15 hours)**

UNIT-II

Basic Principles of microbial cell staining: Gram's staining, negative, capsule, flagella, acid-fast and endospore staining.

Methods of isolation of bacteria: Serial dilution, pour plate, spread plate and streak plate. Maintenance of pure cultures. Batch and continuous culture - chemostat and turbidostat, synchronous growth.

Microscopy: Principles and applications of Bright Field and Dark Field Microscopy and Phase contrast microscopy. Electron Microscope-Principles and applications of Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM)**. (15 hours)**

UNIT-III

Centrifugation: Preparative and Analytical centrifuge, High speed, low speed and ultracentrifuge, differential and density gradient centrifuge.

Laminar Air Flow, Autoclave, pH mater, Incubator

Spectroscopy: Beer-Lambert law and its limitations. Basic design of photoelectric colorimeter and spectrophotometer. Applications of UV-visible spectroscopic techniques. **(15 hours)**

UNIT-IV

Chromatography: Principle, instrumentation and applications of Adsorption chromatography, Paper chromatography and Thin Layer Chromatography.

Electrophoresis: Basic principle and types of electrophoresis. Technique and uses of Agarose gel electrophoresis, PAGE, PCR and applications of PCR. **(15 hours)**

References:

- Chaudhary, N. (2016). Instrumentation, Measurement and Analysis 4th Edition. McGraw Hill Education India Pvt. Ltd.
- Chelamalla, R. (2019). Basic Principles and Practices in Analytical Techniques. Dreamtech Press.
- Hames, G.G. (2005). Spectroscopy for the Biological Sciences. John Wiley & Sons Inc.
- Khandpur, R.S. (2015). Handbook of Analytical Instruments. McGraw Hill Education.
- Lodish, H. (2016). Molecular cell biology, Global Edition. W.H. Freeman and Co.
- Nakra, B.C. and Chaudhary, K.K. (2017). Instrumentation measurements and analysis Tata Mc Graw Hill.
- Narayanan, P. (2000). Essential's of Biophysics, New Age Int. Pub. New Delhi.
- Notting, B. (2009). Methods in Modern Biophysics, Springer Verlag Berlin Heidelberg New York.
- Wilson, K. and Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology, 8th Edition. Cambridge University Press.

Suggested E-resources:

- Analytical Techniques in Instrumentation – NPTEL. This online course covers most of the topics with focus on Physical and chemical measurement methods. Analytical chemistry - Course
- Analytical Techniques – AIIMS (Swayam). This online course is very resourceful for undergraduate students with coverage to General microbiological lab techniques. Analytical Techniques - Course
- Microbial Technology – Swayam. A resourceful UG level course with details on microbial techniques**.** Microbial Technology - Course
- General Microbiology – Swayam. The main focus of this online course is Core microbial methods and techniques. General Microbiology - Course
- Advanced Microbiology – Swayam. A very useful Practical Modules that includes microbiological lab experiment relevant to UG level students. Advanced Microbiology - Course.

Signature of BoS Members	Signature of BoS Convener

B.Sc. Semester- II Microbiology

Microbiology Practical

Maximum practical Marks	=	50 marks
Internal marks	=	30 Marks
External marks	=	20 Marks
		60 Hours

Learning outcome:

- Student will learn handling instruments like Incubator and BOD Incubator, Centrifuge, Colorimeter and Spectrophotometer.
- Students will gain practical skills in handling bacteria and viruses, staining methods, serial dilution, media preparation, and isolating, identifying, and preserving bacterial strains using streak, spread, and pour plate techniques
- Students perform chromatographic techniques to carry out estimations of biochemical compounds and understand the principle and working of pH meter, paper and thin layer chromatography and Gel electrophoresis.

Suggested Practical Exercises:

1. Introduction, operation, precautions and use of common microbiology laboratory instruments: Incubator and BOD Incubator, Centrifuge, Colorimeter and Spectrophotometer.
2. Gram's staining
3. Negative Staining
4. Serial dilution technique.
5. Media preparation and their types-liquid and solid media (PDA and NA) and preparation of slants.
6. Culture inoculation techniques - spread plate
7. Culture inoculation techniques - streak plate
8. Culture inoculation techniques - pour plate method.
9. Study of bacterial growth curve.
10. Determination of size of a given microorganism using micrometry.
11. Observation of motility in bacteria using: Swarming growth method.
12. Determination of pH of a given sample.
13. Separation of serum and cells from blood sample using centrifuge.
14. Perform Paper chromatography.

*** Any other practical exercise as per theory syllabus.**

Signature of BoS Members	Signature of BoS Convener

B.Sc. Semester- III Microbiology

Theory Paper - Microbial Biochemistry and Microbial Genetics

Course Code:

1 credit -25 marks
4 credit -100 marks
Question paper: 70 Marks
Internal Assessment: 30 marks

Objectives:

1. To understand chemical and molecular interactions, structure and classification of carbohydrates, proteins, and lipids.
2. To study enzymes, their kinetics, regulation, and the biochemical role of vitamins.
3. To learn characteristics, replication, and applications of plasmids, and mechanisms of gene transfer in bacteria.
4. To understand phage genetics and the role of transposable elements in prokaryotes and eukaryotes.

Learning outcomes / Course Outcome:

Understanding

- Explain sterilization, culture, staining, and microscopy principles.
- Understand centrifugation, spectroscopy, chromatography, and electrophoresis.

Memorizing

- Recall staining methods, isolation techniques, and culture media types.
- List microscopes, centrifuges, chromatography, and PCR techniques.

Applying

- Apply sterilization and culture methods for microbial work.
- Differentiate microbes using staining and microscopy.
- Use centrifugation, spectroscopy, chromatography, and PCR in analysis.

Marks distribution in question Paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts A & B

Part – A: 14 marks

Part A will be compulsory having 10 very short answer type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part- B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

UNIT-I

Fundamentals of Carbohydrates: Classification, Basic chemical structure of monosaccharides, Disaccharides and polysaccharides.

Protein: General properties, Structure and Classification based on structure and functions.

Nucleic Acid: DNA & RNA- Structure, classification and functions.

Lipids: General properties, Structure and Classification of major lipids. **(15 hours)**

UNIT-II

Enzymes: Definition, Classification and Nomenclature of enzymes. Enzyme kinetics, Factors influencing enzyme activity (Enzyme inhibition). Isozymes and Allosteric enzymes. Ribozymes and DNAzymes.

Vitamins: Classification, Biochemical properties of water soluble and fat soluble vitamins. Vitamins B-Complex and Vitamin C with reference to biochemical function, sources and application and functions of vitamins. **(15 hours)**

UNIT-III

General characteristics of Plasmids: Types of plasmids - F plasmid, R Plasmids, Ti plasmid, Yeast- 2µ plasmid. Plasmid-replication and Applications of Plasmids

Gene transfer mechanisms in Bacteria: Recombination in bacteria- Site specific recombination.

Bacterial Transformation and Transduction-Discovery, Mechanism of transformation and transduction. **Conjugation-** Discovery, mechanism of conjugation. **Phage Genetics:** Features of T4 genetics. **(15 hours)**

UNIT-IV

Transposable elements-I: Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition.

Transposable elements-II: Eukaryotic transposable elements- Yeast (Ty retrotransposon), Drosophila (P elements) and uses of transposition. **(15 hours)**

References:

- Berg, J. M. (2019). Biochemistry, 9th Edition. W. H. Freeman Publishers.
- Caldwell, D. R. (1995). Microbial Physiology and Metabolism. Brown Publishers.
- Cooper, E. (2018). Microbial Physiology: A Practical Approach. Callisto Reference Publisher.
- Elliot, D. C. and Elliott, W. H. (2005). Biochemistry and Molecular Biology, 4th Edition, Oxford University press.
- Jain *et. al*., (2021). Basic Techniques in Biochemistry, Microbiology and Molecular Biology: Principles and Techniques. Humana Press.
- Jain, J. L. and Jain, S. (2021). Fundamentals of Biochemistry. S. Chand Publication.
- Lieberman, M. A. (2019). BRS Biochemistry, Molecular Biology and Genetics. Wolters Kluwer India Pvt. Ltd.
- Moat, A. G. *et al.,* (2009). Microbial Physiology, 4th Edition. John Wiley and Sons, Inc.
- Nelson, D. L. and Cox, M. (2021). Lehninger Principles of Biochemistry: International Edition. W.H. Freeman & Co. Ltd.
- Poole, R. K. (2011). Advances in Microbial Physiology. Volume 59. Academic Press.
- Powar, C. B. and Daginawala, H. F. (2010). General Microbiology Vol II Himalaya Publishing House.
- Rajan, S. S. (2008). Microbial Physiology. Anmol Publication Pvt. Ltd.
- Satyanarayana, U. (2021). Biochemistry, 6th Edition. Elsevier India
- Srivastava, H. S. (2007). Elements of Biochemistry, Rastogi Publication.
- Voet, *et. al*. (2018). Voet's Principles of Biochemistry, Global Edition. Wiley Publication.
- Watson, D. (2017). Microbial Physiology. Callisto Reference Publisher.
- Wilson, K. and Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology, 8th edition. Cambridge University Press.

Suggested E-resources:

- Biochemistry – NPTEL (IIT Bombay / IIT Kharagpur). This course cover: Enzyme kinetics and regulation, Carbohydrate, lipid, protein, and nucleic acid metabolism in microorganisms, Bioenergetics and metabolic integration. Biochemistry - Course
- Microbial Technology – SWAYAM. This is a Biochemistry related course with focus on Microbial growth kinetics and nutrient utilization, Aerobic & anaerobic respiration pathways, Nitrogen fixation biochemistry. Microbial Technology - Course.
- Microbial Biotechnology – NPTEL (IIT Guwahati). A **r**elevant Biochemistry course covering topics**:** Microbial physiology and metabolism. Microbial Biotechnology - Course.
- Microbial Genetics – SWAYAM. This is a good online resource for UG students to understand microbial genetics related topics along with lab experiment demonstration. Microbial Genetics - Course
- Genetics and Molecular Biology – NPTEL. This course has a focus on broader genetics with microbial examples, DNA replication, transcription, translation in prokaryotes, Gene regulation (operons, repressors, activators), Mutagenesis and DNA repair, Recombinant DNA technology are well explained. Cell and Molecular Biology - Course

Signature of BoS Members	Signature of BoS Convener

B.Sc. Semester- III Microbiology

Microbiology Practical

Maximum practical Marks	=	50 marks
Internal marks	=	30 Marks
External marks	=	20 Marks
		60 Hours

Learning outcome:

- Students will perform Qualitative & Quantitative estimation of carbohydrates, amino acids, proteins, DNA and RNA. Students will gain knowledge of enzyme kinetics.
- Students will be able to perform isolation of DNA, RNA, and plasmid and is able to perform restriction digestion and carry out its analysis by agarose gel electrophoresis.
- Students will learn techniques for biochemical analysis of carbohydrates, proteins, lipids, ions, and micronutrients, and apply them to real-life quality assurance.

Suggested Practical Exercises:

1. Concept of pH and buffers, preparation of buffers.
2. Qualitative Analysis of Carbohydrates.
3. Qualitative Analysis of lipids.
4. Qualitative Analysis of proteins.
5. Quantitative estimation of proteins by Biuret / Lowry method.
6. Estimation of reducing sugar - Anthrone method /titration method-Benedict's method.
7. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
8. Plasmid Isolation from bacterial culture.
9. Study of phage morphology using photograph.
10. Study of Replica Plate Technique.
11. Isolation of bacterial DNA/plasmid DNA.
12. Demonstration of AMES test.
13. Estimation of DNA by diphenylamine.
14. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.

*** Any other practical exercise as per theory syllabus.**

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B.Sc. Semester- IV Microbiology

Theory Paper - Immunology and Medical Microbiology

Course Code:

1 credit -25 marks
4 credit -100 marks
Question paper: 70 Marks
Internal Assessment: 30 marks

Objectives:

1. To explore types of immunity, immune cells, organs, antigens, antibodies, and immunoglobulins.
2. To examine antigen–antibody interactions, antigen presentation, immune deficiencies, and hypersensitivity.
3. To analyze human microbial flora, bacterial pathogenicity, virulence factors, and epidemiology.
4. To recognize fungal, bacterial, and viral diseases along with their diagnosis, treatment, and prevention.
5. To analyze the importance of immunization programs in disease control

Learning outcomes / Course Outcome:

Understanding

- Explain immunity types, immune cells, antigens, antibodies, and antigen-antibody interactions.
- Understand MHC, immune receptors, hypersensitivity, and immune-related diseases.
- Recognize microbial interactions with humans, pathogenic mechanisms, and epidemiology.
- Describe bacterial, viral, and fungal diseases with prevention and treatment strategies.

Memorizing

- Recall structure, types, and functions of immunoglobulins.
- List immune organs, cells, and hypersensitivity types.
- Remember normal microbial flora and virulence factors.
- Identify pathogens causing major bacterial and viral diseases.

Applying

- Apply immunological techniques for diagnosis.
- Differentiate infections based on symptoms and lab results.
- Interpret disease transmission patterns and preventive measures.
- Relate immunization programs to control of infectious diseases.

Marks distribution in question Paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts A & B.

Part – A: 14 marks

Part A will be compulsory having 10 very short answer type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part- B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

UNIT –I

Immunity and Immune system: Immunity; definition, Types of Immunity-Innate and adaptive immunity, Active and passive immunity. **Cells and organs of the immune system:** B and T-lymphocytes.

Antigen and Antibody: Antigenicity, Immunogenicity, antigen, immunogen, Antibody: structure and types. Immunoglobulins: structure, classification and functions. **Antigen-antibody interaction:** Precipitation, Agglutination, Neutralization, ELISA, Radial immunodiffusion. **(15 hours)**

UNIT –II

Antigen processing and Presentation: Structure, Types and Functions of Major histocompatibility complex (MHC). **Immune cells:** B and T-Cell Receptor. **Diseases related to immune system:** Deficiencies/defects of T cells, B cells, and phagocytic cells.

Hypersensitivity: Types of hypersensitivity reactions and their features. **(15 hours)**

UNIT –III

Beneficial and Harmful Microbial Interactions with Human: Introduction about human microbial population, normal microbial population of healthy human body- skin, mouth, upper respiratory tract, intestinal tract, urino-genital tract.

Mechanism of bacterial pathogenicity: Entry of pathogens into the host, colonization and growth. **Virulence:** Virulence factors- exotoxins, enterotoxins, endotoxins. **Epidemiology**- Principles of epidemiology, reservoirs of pathogens, transmission of infectious agents. **Fungal diseases:** Mycoses, mycotoxicoses. **(15 hours)**

UNIT-IV

Bacterial diseases: General idea of infections: symptoms, treatment and preventive measure of diseases caused by Gram positive bacteria: *Mycobacterium* (Tuberculosis and leprosy), Gram negative bacteria: *Salmonella* (Typhoid), **Viral diseases: RNA viruses**- influenza virus. **DNA viruses**- Hepatitis viruses. Immunization programs in India. **(15 hours)**

Suggested Readings:

- Abbas. (2021). Cellular and Molecular Immunology, 10th Edition. Elsevier Publisher.
- Chapel, H. *et. al*., (2014). Essential of Clinical Immunology, Wiley-Blackwell Publisher.
- Ivan, M.R. and Peter J.D. (2001), Roitt's, Essential Immunology, 10th edition, Blackwell Science.
- Khan, F. H. (2009). The Elements of Immunology. Pearson Education India.
- Latha, P.M. (2012). A Textbook of Immunology, S. Chand Publication.
- Punt, J. (2018). Kuby's Immunology. 8th Edition. W. H. Freeman Publisher.
- Sharma, P. and Kumar, P. (2021). Basics of Immunology, IP Innovative Pvt. Ltd
- Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th ed., University Press Publication.
- Apurba, S.S. and Sandhya, B. (2020). Essentials of Medical Microbiology, Revised Edition. Jaypee Brothers Medical Publishers.
- Brooks, G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
- Levinson, W.E. (2020). Review of Medical Microbiology and Immunology. 16th Ed. McGraw Hill Medical.
- Morag, C. and Timbury, M.C. (1994). Medical virology- 10th Ed. Churchill Living stone,London.
- Murray, P.R. *et al*., (2020). Medical Microbiology. Elsevier Publisher.

- Nester E.W. *et. al*., (1995). Microbiology A Human Perspective, McGraw-Hill Higher Edu. Pub.

Suggested E-resources:

- Immunology – NPTEL (IIT Kharagpur). A very good online resource to understand the basics of immunology**.** Immunology - Course
- Immunology – Swayam (Manipur University). This course dive deep into the immunology but keep the pace slow and explanation at undergraduate level. Immunology - Course.
- Medical Microbiology – UGC moocs via Swayam. This online course covers most of the topics with focus on all the topics relevant to medical microbiology. UGC MOOCs: A Vertical of SWAYAM
- General Microbiology – SWAYAM. A good online course covering Microbial pathogenesis and diseases, Host resistance and immunity and Foodborne pathogens and spoilage organisms. General Microbiology - Course.
- Microbial Biotechnology – NPTEL (IIT Guwahati). An online resource with focus on Microbes in medical biotechnology, Production of antibiotics, vaccines, and therapeutic enzymes, Genetic engineering of pathogens for research and vaccine development. Microbial Biotechnology - Course

Signature of BoS Members	Signature of BoS Convener

B.Sc. Semester- IV Microbiology

Microbiology Practical

Maximum practical Marks	=	50 marks
Internal marks	=	30 Marks
External marks	=	20 Marks
		60 Hours

Learning outcome:

- Students will perform Qualitative & Quantitative estimation of carbohydrates, amino acids, proteins, DNA and RNA. Students will gain knowledge of enzyme kinetics.
- Perform physiology experiments and use chromatographic techniques to carry out estimations of phytochemicals.
- Student will learn to choose appropriate techniques for biochemical investigations associated with qualitative and quantitative analysis of carbohydrates, proteins, lipids, and confidently applying this learning to real-life quality assurance situations.

Suggested Practical Exercises:

1. Identification of Blood Group and Rh factor.
2. Blood film preparation and identification of cells.
3. Counting of RBC and WBC by Hemocytometer.
4. Single Immunodiffusion.
5. Agglutination tests (Widal test).
6. Separation of serum from the blood sample (demonstration).
7. Estimation of blood hemoglobin.
8. Identify bacteria using laboratory strains on the basis of cultural, morphological and biochemical characteristics.
9. Isolation of bacterial flora of skin by swab method.
10. Endospore staining
11. Study symptoms of the diseases with the help of photographs: Anthrax, Polio, Herpes, chicken pox, HPV warts, Dermatomycoses (ring worms).

*** Any other practical exercise as per theory syllabus.**

Signature of BoS Members	Signature of BoS Convener

B.Sc. Semester- V Microbiology

Theory Elective Paper V A

Food and Dairy Microbiology

Course Code:

1 credit -25 marks
4 credit -100 marks
Question paper: 70 Marks
Internal Assessment: 30 marks

Objectives:

1. To explore the principles of food spoilage, microbial activities, and their impact on different foods.
2. To identify the role of microorganisms in food substrates and their applications in preservation and fermentation.
3. To analyze sources of milk contamination, microbial changes in milk, spoilage organisms, and probiotics.
4. To study industrial dairy fermentations, microorganisms involved, and the processes for producing fermented dairy products.
5. To analyze the nutritional and industrial significance of fermented foods and dairy products.

Learning outcomes / Course Outcome:

Understanding

- Explain principles and types of food spoilage, role of microorganisms in spoilage.
- Describe methods of food preservation and microbial role in food fermentations.
- Understand microbial contamination and biochemical changes in milk.
- Explain industrial dairy fermentations, yoghurt and cheese production processes**.**

Memorizing

- Recall types of spoilage organisms in different foods and dairy products.
- List methods of physical, chemical, and natural food preservation.
- Identify fermented foods, beverages, and their microbial agents.
- Remember classification of microorganisms associated with dairy industry.

Applying

- Apply knowledge of preservation techniques to extend shelf life of foods.
- Relate microbial activity to production of fermented foods and beverages.
- Interpret spoilage in milk and dairy products with respect to microbial contamination.
- Use probiotics and fermentation processes in improving nutritional and industrial value of dairy products.

Marks distribution in question Paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts A & B

Part – A: 14 marks

Part A will be compulsory having 10 very short answer type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part- B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

UNIT – I

Food spoilage: General principle underlying spoilage, Types of food spoilage, Chemical changes caused by microorganisms. Spoilage of different kinds of foods caused by microorganisms. **Food as a substrate for micro-organisms:** General characteristics and importance of microorganisms in food microbiology; Molds, yeasts and bacteria. **(15 hours)**

UNIT – II

Food preservation methods: Asepsis - removal of microorganisms, Food preservation by Radiations, Food preservation by low and high Temperature, Chemical preservation and naturally occurring antimicrobials. **Industrial Food fermentations:** Introduction, food fermentation. Fermented foods (Soya sauce, Bread, Sauerkraut), Fermented beverages (Wine and Beer). **(15 hours)**

UNIT – III

Microbiology of Milk: Sources of Milk contamination and their control**.** Microbiology of raw and pasteurized milk, Biochemical changes in fermented milk. (Fermentation of lactose in to lactic acid, hydrolysis of proteins and lipids). Study of spoilage organisms in dairy industry. Introduction to Probiotics. **(15 hours)**

UNIT – IV

Industrial Dairy fermentations: Classification of various groups of microorganisms associated with dairy industry. Production of fermented dairy products (Yoghurt and Cheese) used microorganisms, enzymes and other additives.

Cheese production: steps involved in manufacture of cheese, preservation, classification and nutritional aspects. **(15 hours)**

Suggested Readings:

- Adams, M.R. and Moss, M.O. (2018). Food Microbiology. New Age International Private Limited.
- Aneja, K.R. (2018). Modern Food Microbiology. Med tech Publisher.
- Ango, H. (2021). Applied Dairy Microbiology. Random Publishing UK Ltd.
- David, J. and Khalua, R.K. (2020). Basic Food and Dairy Microbiology. Ocean Publishing House.
- Foster, W.M. (2020). Food Microbiology. C.B.C. Publisher.
- Frazier, C.W. (2016). Food Microbiology. McGraw-Hill Publisher.
- Garg, *et. al*., (2020). Laboratory Manual of Food Microbiology. Dreamtech Press.
- Joshi, R.D. *et. al*. (2018). Dairy Microbiology and Technology. Oxford Book Company.
- Marth, E.H. and Steel, J. (2001). Applied Dairy Microbiology: Food Science & Technology. CRC Press.
- Nader, G. (2020). Applied Dairy Microbiology. White Press Academic.
- Osei, G. (2017). Handbook of Dairy Microbiology. Agri-Horti Press.
- Ray, A.B.B. (2017). Fundamental Food Microbiology. 5th Ed. Bibek Ray, Arun Bhunia Publishers.
- Robinson, R.K. (2002). Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products. Wiley- Interscience Publisher.

Suggested E-Resources:

- Food Microbiology – Swayam. This course is designed for undergraduate students and covers vast topics like microorganisms in food, food as a microbial substrate, food spoilage (meat, fish, poultry, eggs, dairy), foodborne diseases & mycotoxins, fermented foods & dairy products (acidophilus milk, yogurt, cheese). Food Microbiology - Course
- Food Microbiology for Safe and Sustainable Food Systems – NPTEL (IIT Kharagpur). This is good online resource covering variety of topics in Food and Dairy microbiology for undergraduate students. Food Microbiology for Safe and Sustainable Food Systems - Course
- Food Microbiology and Food Safety, Swayam. The content of this online course is foundational and accessible covering scope of food microbiology and safety, microbial enumeration and control techniques, food spoilage, fermentation, and disease investigation, Food Safety management. Food Microbiology and Food Safety - Course.
- Food Fermentation: The Science of Cooking with Microbes (via edX / Harvard). Content of this online course include role of microbes in fermentation (bread, yogurt, tempeh, kombucha, chocolate, etc.), science of flavor, microbial communities, experimental design, and analytical techniques. HarvardX: Food Fermentation: The Science of Cooking with Microbes | edX

Signature of BoS Members	Signature of BoS Convener

B.Sc. Semester- V Microbiology

MICROBIOLOGY PRACTICAL V-A

Maximum practical Marks	= 50 marks
Internal marks	= 20 Marks
External marks	= 30 Marks
	60 Hours

Learning outcome:

- Students will gain knowledge about soil, water and air microflora and perform hands on training on physicochemical properties of different water sources.
- Students will have an idea about steps of application of patent process.
- Students will be able to perform various test for quality of milk and other food products and get hand on experience and laboratory skills in area of bioprocess.

Suggested Practical Exercises:

1. Isolation of microorganism from spoiled fruits.
2. Methylene blue reductase time (MBRT) test for checking microbial quality of milk.
3. Milk adulteration test.
4. Isolation of milk fermenting organisms from milk.
5. Production of fermented food using microbial culture.
6. Preparation of yogurt /dahi
7. Isolation of casein from milk sample.
8. Preparation of fermented food Sauer Kraut.
9. Field survey and educational visit.
10. Preparation of grapes wine

*** Any other practical exercise as per theory syllabus.**

Signature of BoS Members	Signature of BoS Convener

B.Sc. Semester- V Microbiology

Theory Elective Paper V B

Environmental, Soil and Agriculture Microbiology

Course Code:

1 credit -25 marks
4 credit -100 marks
Question paper: 70 Marks
Internal Assessment: 30 marks

Objectives:

1. To explore microbial populations of air, water, soil, and their role in biogeochemical cycles.
2. To examine waste treatment processes, biodegradation, and bioremediation.
3. To analyze soil microbes, organic matter decomposition, and rhizosphere interactions.
4. To recognize biofertilizers and microbial agents in crop protection.

Learning outcomes / Course Outcome:

Understanding

- Understand microbial diversity in air, water, and soil.
- Explain waste treatment and biodegradation processes.
- Describe organic matter decomposition and soil microbes.
- Recognize biofertilizers and microbial agents for crops.

Memorizing

- Recall microbial populations of air, water, and soil.
- List solid and liquid waste treatment methods.
- Identify soil microbes and rhizosphere organisms.
- Remember types of biofertilizers and biocontrol microbes.

Applying

- Apply waste management methods for sustainability.
- Relate microbes to nutrient cycles and soil health.
- Use biofertilizers for better crop productivity.
- Apply microbial processes in agriculture and bioremediation.

Marks distribution in question Paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts A & B

Part – A: 14 marks

Part A will be compulsory having 10 very short answer type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part- B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

UNIT- I

Microbiology of Air, water & soil: Microbial population of air, water (drinking and potable) and soil.
Aeromicrobiology: aero-microbiological pathway, microbial survival in air, extramural and intramural aeromicrobiology.

Terrestrial environment: microorganisms in surface soil, shallow and deep subsurface environment. **Biogeochemical Cycles:** carbon cycle, nitrogen cycle, sulphur cycle, phosphorus cycle. **(15 hours)**

UNIT- II

Solid and Liquid Waste Disposal: Different types of liquid waste treatment: Primary, Secondary and tertiary treatment.

Solid Wastes: Sources and management (Sanitary landfills, incineration, composting, vermiculture, methane production).

Aerobic and anaerobic process: activated sludge, oxidation ditches, and trickling filters, Anaerobic Process- anaerobic digestion and anaerobic filters, up flow anaerobic sludge.

Biodegradation and Bioremediation: Biodegradation of environmental pollutants, Bioremediation of xenobiotics, Bioaccumulation and Biomagnification. **(15 hours)**

UNIT - III

Organic matter decomposition: Composition of litter (cellulose, hemicelluloses, lignin and proteins). Carbon assimilation and immobilization, microorganisms associated with organic matter decomposition, factors affecting decomposition.

Soil as habitat for microorganisms - Soil quality, Physico-chemical properties of soil (Organic matter, soil water and Air). Soil microbes, Rhizosphere and Rhizoplane microorganisms. Factors affecting microbial community in soil. **(15 hours)**

UNIT - IV

Microbial inoculants, production of bacterial bio-fertilizer: Green manuring; algae and other biofertilizers; mass cultivation of cyanobacteria

Bio fertilizer: Biofertilizers aiding phosphorus nutrients: production of mycorrhizal biofertilizers. **Crop protection:** Microbial herbicides; Bacterial insecticides*; Pseudomonas*, *Bacillus* sp. as bacterial insecticides; Virus insecticides; Entomopathogenic fungi- *Verticillium*, *Hirsutella*. **(15 hours)**.

Suggested Readings:

- Aneja, K.R. (2017). Fundamental Agricultural Microbiology. New Age International Pvt.Ltd.
- Bolger, A. (2010). Environmental Microbiology. Oxford Book Company.
- Buckley, R. G. (2019). Environmental Microbiology. CBS Publisher.
- Kumar, A. and Sharma, S. (2020). Microbes and Enzymes in Soil Health and Bioremediation: (Microorganism for Sustainability). Springer Link Publishers.
- Madsen, E.L. (2015). Environmental Microbiology: From Genomes to Biogeochemistry. Willey Blackwell Publications.
- Maier, R.M. *et. al*. (2000). Environment Microbiology. Acad. press an imprint of Elsevier.
- Mishra, R.R. (2014). Soil Microbiology. CBS Publishers.
- Mohapatra, P.K. (2006), Textbook of Environmental Biotechnology. I.K. International Publications, Mumbai.
- Nagamani, B. (2017). Soil and Agricultural Microbiology. Margham Publications.
- Pareek, R.P. and Pareek, N. (2019). Agricultural Microbiology. Scientific Publishers (India).
- Paul, E.A. (2014). Soil Microbiology, Ecology and Biochemistry. Academic Press. Publisher.
- Prabhakaran, G. (2018). Introduction to Soil and Agri Micro. Himalaya Publishing House Pvt. Ltd.
- Purohit, S.S. (2016). Principles of Agricultural Microbiology. Agrobios (India).
- Ramesh, K.V. (2019). Environmental Microbiology. M.J.P. Publishers.
- Sharma, P.D. (2016). Environmental Microbiology, Rastogi Publication.
- Subba Rao, N.S. (2020). Soil Microbiology. Oxford & IBH Publishing.
- Trivedi, P.C. (2010). Agricultural Microbiology. Pointer Publishers.

- Varnam, A. and Evans, M. G. (2018). Environmental Microbiology. CRC Press.
- Vendan, R. (2021). Soil Microbiology. New India Publishing Agency NIPA.
- Yogranjan, *et. al*., (2020). Essentials of Agricultural Microbiology. IP Innovative Publication Pvt. Ltd

Suggested E-resources:

- Applied Environmental Microbiology, NPTEL. This online course cover all the topics in the UG curriculum for Enviromental, soil and agriculture microbiology. Applied Environmental Microbiology - Course
- Environmental, Food & Dairy Microbiology, Swayam. This course covers topics related to Environmental microbiology with undergraduate level explanation. Environmental, Food & Dairy Microbiology - Course.
- Environmental, Food & Dairy Microbiology, Swayam. This online course is a good deal for undergraduates looking for broad soil-related microbiology. Environmental, Food & Dairy Microbiology - Course
- Advanced Microbiology, Swayam. This online course is a good for undergraduates looking for content in soil microbiology. https://onlinecourses.swayam2.ac.in/cec24_bt22/preview
- Biological Approaches to Sustainable Farming (Food4Sustainability MOOC). Soil microbiology, AMF fungi, biofertilizers, soil fauna, agroecology. MOOC: Biological Approaches to Sustainable Farming

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B.Sc. Semester- V Microbiology

MICROBIOLOGY PRACTICAL V-B

Maximum practical Marks	=	50 marks
Internal marks	=	20 Marks
External marks	=	30 Marks
		60 Hours

Learning outcome:

- Students will gain knowledge about soil, water and air microflora and perform hands on training on physicochemical properties of different water sources.
- Students will have an idea about steps of application of patent process.
- Students will be able to perform various test for quality of milk and other food products and get hand on experience and laboratory skills in area of bioprocess.

Suggested Practical Exercises:

1. Analysis of soil – pH and moisture content.
2. Study of the presence of microflora in the environment by exposing nutrient agarplates to air.
3. Isolation of microbes (bacteria & fungi) from soil/air (28ºC & 45ºC).
4. Assessment of microbiological quality of water.
5. Analysis of dissolved oxygen - DO in pond water.
6. Analysis of BOD of waste water sample.
7. Analysis of TDS in water samples.
8. Isolation and identification of bacteria and fungi from soil.
9. Enumeration and identification of rhizosphere microflora.
10. Isolation of *Rhizobium* from root nodules.
11. Observation description of any three bacterial and fungal plant diseases.
12. Isolation and identification of fungi from leaves, stems and other aerial parts of the plants.
13. Mushroom cultivation.
14. Identification of edible mushrooms.
15. Study of Microbes that can be used as biopesticides.

*** Any other practical exercise as per theory syllabus**

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B.Sc. Semester- VI Microbiology

Theory Elective Paper VI A

Fermentation Technology and Industrial Microbiology

Course Code:

1 credit -25 marks
4 credit -100 marks
Question paper: 70 Marks
Internal Assessment: 30 marks

Objectives:

1. To explore media formulation, selection of industrial strains, inoculum development, sterilization, and fermentation methods.
2. To examine fermentative production of microbial biomass, metabolites, antibiotics, and pharmaceutical products.
3. To analyze downstream processing techniques for recovery and purification of microbial products.
4. To recognize industrial applications of recombinant vaccines, biofuels, microbial leaching, and cell immobilization.
5. To appreciate the role of metabolic engineering and technology in improving food and industrial products.

Learning outcomes / Course Outcome:

Understanding

- Understand microbial diversity in air, water, and soil.
- Explain waste treatment and biodegradation processes.
- Describe organic matter decomposition and soil microbes.
- Recognize biofertilizers and microbial agents for crops.

Memorizing

- Recall microbial populations of air, water, and soil.
- List solid and liquid waste treatment methods.
- Identify soil microbes and rhizosphere organisms.
- Remember types of biofertilizers and biocontrol microbes.

Applying

- Apply waste management methods for sustainability.
- Relate microbes to nutrient cycles and soil health.
- Use biofertilizers for better crop productivity.
- Apply microbial processes in agriculture and bioremediation

Marks distribution in question Paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts A & B

Part – A: 14 marks

Part A will be compulsory having 10 very short answer type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part- B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

UNIT- I

Industrial Practices: Media formulation for fermentation: Water, carbon and nitrogen source, minerals, growth factors, precursors, aeration and antifoam agents, oxygen. Criteria for selection of industrial organisms, screening from natural habitat and strain improvement.
Inoculums development, Sterilization, Bioreactor, media, air exhaust and waste.
Cultures of microorganisms and fermentation: solid or semisolid cultures, Batch, continuous, fed batch. Fermenter design – parts & their functions. **(15 hours)**

UNIT - II

Fermentative production of Microbial biomass: Culture medium, process and recovery of fermentative products (Edible mushroom, Baker's yeast and SCP. Fermentative production of Primary metabolites: Citric acid, Alcohol, acetone and vitamin B12 and Antibiotics and Application of biotechnology in pharmaceutical. **(15 hours)**

UNIT – III

Downstream processing of microbial products: Cell harvesting, cell disruption (homogenization, ball milling, and ultrasonic, permeabilization), Clarification and enrichment of extract (centrifugation, liquid extraction, precipitation, ultrafiltration), Purification: by chromatographic methods (Ion exchange, affinity, gel filtration, adsorption chromatography) Dialysis and Distillation, Crystallization and drying. **(15 hours)**

UNIT- IV

Production of Pharmaceutical and industrial Products: Production of recombinant vaccines and proteins (Hepatitis vaccines, Insulin, Human growth hormone), Microbial leaching.
Biofuel production**,** Immobilization of microbial cells methods and applications. Metabolic engineering and industrial applications of microorganisms and role of technology to improve food quality. **(15 hours)**

Suggested Readings:

- Alexandar N. Glazer & Hiroshi Nikaido Microbial Biotechnology (Fundamental of Applied Microbiology)
- El-Mans, E.M.T., and Bryce, C.F.A. (2002) Fermentation Microbiology and Biotechnology. Taylor.
- Huffnagle, G.B. & Wernick, S. (2007). The Probiotics Revolution: The Definitive Guide to Safe,Natural Health. Bantam Books.
- Kun LY. (2006). Microbial Biotechnology. World Scientific.
- Patel, A. H. (2005). Industrial Microbiology –MacMillan Publishers
- Ponmurugan, P., Ramasubramanian, N., and Fredimoses. (2012). Experimental Procedures inBioprocess technology and Downstream processing. Anjana Book House, Chennai.
- Primrose, S.B. (2001). Molecular Biotechnology. Panima.
- Satyanarayana, U. 2008. Biotechnology, Books and Allied (p) Ltd. Kolkata.

Suggested E-resources:

- Industrial Microbiology and Immunology, SWAYAM. Covers relevant topics to Industrial Microbiology with UG level explanation. Swayamugcmoocs.inflibnet.ac.in
- Industrial Biotechnology, NPTEL (IIT Kharagpur). This online course focuses on applying microbes and enzymes in industrial manufacturing. nptel.ac.in/courses/102105058
- Fundamentals of Bioprocess Engineering (IIT Guwahati). This course deals with Fundamentals of bioprocess engineering. nptel.ac.in/courses/102103672
- Microbial Biotechnology (IIT Guwahati). Content covers roles of microbes in agriculture (biofertilizers, biopesticides), environmental uses, food, energy, pharmaceuticals, and patenting in microbial biotech. nptel.ac.in/courses/102103555
- Applied Environmental Microbiology (IIT Roorkee). This course offers foundational insights that complement environmental applications. nptel.ac.in/courses/105107173

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B.Sc. Semester- VI Microbiology

MICROBIOLOGY PRACTICAL VI-A

Maximum practical Marks	=	50 marks
Internal marks	=	20 Marks
External marks	=	30 Marks
		60 Hours

Learning outcome:

- Students will be able to isolate pure cultures of bacteria from various food, soil and agricultural sources, one must be familiar with general bacteriology and microbial procedures**.**
- Students will gain knowledge about various computer software's like Microsoft etc. They will be able to perform various computer applications in their related field.
- They will get hands on experience on production of various industrially important microbial products.

Suggested Practical Exercises:

1. Isolation of industrially important microorganisms.
2. Production of ginger wine.
3. Production of citric acid using *Aspergillus* in batch culture.
4. Soya sauce production.
5. Study of Production of alcohol.
6. Study of Biogas production
7. Demonstration of immobilization of enzyme.
8. Estimation of lactic acid in curd.
9. Isolation of amylase producing microorganisms from soil.
10. Isolation of protease producing microorganism.
11. Demonstration of fermenters.
12. Effect of pH, temperature and salt concentration on the Growth curve of microorganisms.

*** Any other practical exercise as per theory syllabus.**

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B.Sc. Semester- VI Microbiology

Theory Elective Paper VI B

Bioinformatics, Bioethics, Biosafety and IPR

Course Code:

1 credit -25 marks
4 credit -100 marks
Question paper: 70 Marks
Internal Assessment: 30 marks

Objectives:

1. To explore bioinformatics, biological databases, sequence alignment, and tools such as GenBank, BLAST, and PDB.
2. To examine ethical issues in animal research, stem cell cloning, genome projects, and biological weapons.
3. To analyze biosafety regulations, guidelines for GMOs/LMOs, and risk management approaches.
4. To recognize the importance, forms, and applications of Intellectual Property Rights in biotechnology and microbiology.
5. To analyze the global framework of IPR including patents, TRIPS, WTO regulations, and their relevance to India

Learning outcomes / Course Outcome:

Understanding

- Understand basics of bioinformatics, databases, and sequence alignment.
- Explain ethical issues in biotechnology and the Human Genome Project.
- Describe biosafety guidelines, GMOs, and national/international regulations.
- Recognize the role of IPR, patents, and global conventions.

Memorizing

- Recall primary databases, tools (GenBank, BLAST, FASTA, PDB).
- List types of ethics, animal rights, and bioethical concerns.
- Identify forms of IPR protection (copyrights, patents, trademarks).
- Remember WTO, TRIPS, and landmark Indian patent cases.

Applying

- Apply bioinformatics tools for sequence analysis and data retrieval.
- Relate bioethics and biosafety principles to research practices.
- Use IPR knowledge in biotechnology innovations.
- Apply understanding of patents and regulations to case studies

Marks distribution in question Paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts A & B

Part – A: 14 marks

Part A will be compulsory having 10 very short answer type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part- B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

UNIT-I

Introduction to Bioinformatics: Definition, introduction, applications of bioinformatics technology, Biological Databases and Sequence analysis introduction.

Primary Databases: Primary Sequence database.

Sequence Alignment: Introduction to sequence alignment and its applications.

Pair wise sequence alignment: Concept of global and local alignment.

Data banks: Gen Bank, PubMed, BLAST, FASTA, NCBI and Protein Data Bank (PDB). Applications of bioinformatics. **(15 hours)**

UNIT-II

Bioethics: Introduction. Animal ethics, Animal rights, Ethical issues related to research in embryonic stem cell cloning.

Ethical, Legal and Social Implications (ELSI) of Human Genome Project. Ethical issues, moral values on experimental animals. Social and ethical implications of biological weapons. **(15 hours)**

UNIT-III

Biosafety regulation and National and International guidelines: Operation at National level; GMO's and LMO's- Definition, Institutional Biosafety Committee, RCGM, GEAC for GMO applications in Food and Agriculture, Assessment and management of risks associated with GMO.

Intellectual Property Right (IPR): Definition of IPR, function and importance. Forms of protection. **(15 hours)**

UNIT-IV

Importance of IPR: in developing world with special reference to India. IPRs in Biotechnology/Microbiology. Intellectual Property Management: Patent application process (national and International) and patent designs, patent claims methods and application of patents. Landmark cases in Indian patent history. WTO, TRIPS, International conventions, patents and copy rights. **(15 hours)**

Suggested Readings

- Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
- Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
- Campbell A.M. and Heyer L.J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
- Goel, A. (2010). Fundamentals of Computers; Forthcoming title in Pearson Edu.1st ed.
- Goel, D. and Parashar, S. (2013). IPR, Biosafety and Bioethics. Pearson Education India
- Nambisan, P. (2017). An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology, Academic Press.
- Joshi R. (2007). Biosafety and Bioethics. Isha Book Publisher.
- Sateesh, M.K. (2010). Bioethics and Biosafety, I. K. International Pvt. Ltd.
- Sreekrishna, V. (2007) Bioethics and Biosafety in Biotechnology, New Age international publishers

Suggested E-resources

- BioInformatics: Algorithms and Applications (IIT Madras). This online course covers DNA/protein databases, sequence alignment (BLAST, PAM, phylogenetics), structural analyses, protein stability and folding, docking, QSAR, and machine learning. nptel.ac.in/courses/102106065
- Computational Systems Biology (IIT Madras). This online resource not only gives fundamental insights to the students but also hands-on computational tools. nptel.ac.in/courses/102106068
- NPTEL – Issues in Bioethics (IIT Madras). A course covering bioethics from historical evolution to modern-day dilemmas like genetic engineering, epidemics, and resource allocation. nptel.ac.in/courses/109106092
- Intellectual Property (IIT Madras). A broad, in-depth elective covering the IP landscape in India and its role in the intangible economy. nptel.ac.in/courses/109106137
- Awareness on "Biosafety Aspects of GE Plants" *(SWAYAM / MoEFCC).* This self-paced course explores biosafety in the context of genetically engineered plants—covering regulatory frameworks, confined field trials, food and environmental safety, and the Cartagena Protocol. Awareness on "Biosafety Aspects of GE Plants" - Course

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B.Sc. Semester- VI Microbiology

MICROBIOLOGY PRACTICAL VI-B

Maximum practical Marks	=	50 marks
Internal marks	=	20 Marks
External marks	=	30 Marks
		60 Hours

Learning outcome:

- Students will gain knowledge about soil, water and air microflora and perform hands on training on physicochemical properties of different water sources.
- Students will have an idea about steps of application of patent process.
- Students will be able to perform various test for quality of milk and other food products and get hand on experience and laboratory skills in area of bioprocess.

Suggested Practical Exercises:

1. Applications of computers in biology using MS-Office. A] MS-Word B] Excel C] PowerPoint.
2. Creating an e-mail account, sending and receiving mails. Search engines, websites, browsing and Downloading. Searching research articles in Medline and Pub med.
3. Demonstrate the BLAST and FASTA.
4. Proxy filing of Indian Product patent.
5. Study of components and design of a laboratory
6. Study of steps of patenting process
7. Process of primary applications for patents
8. Planning of establishing a hypothetical microbiology industry in India.
9. Review study on clinical trials of drugs in India with emphasis on ethical issues.
10. Field survey and educational visit.

*** Any other practical exercise as per theory syllabus.**

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