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

FACULTY OF SCIENCE

THREE YEAR UNDERGRADUATE PROGRAMME

IN

SCIENCE

SYLLABUS

Subject/Discipline: Microbiology

(Syllabus as per NEP-2020 and Choice Based Credit System)

Medium of Instruction: Hindi/English

w.e.f. Academic Session 2023-24 Onwards

Contents:

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

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 50 marks which include 35 marks for ESE and 15marks for internal assessment.

Examination Question Paper Pattern for all semester Exams.
Attempt all questions

I 10 Questions (very short answer questions) 7x 1 Mark = 7
II 4 Questions (1 question from each unit with internal choice) 4x7 Marks = 28

Total of End Sem. Exam - 35
Internal Assessment – 15
Maximum Marks - 50
Minimum Marks – 20

3. Semester Structure

The details of the course with code, title and the credits assign are as given below.

B. Sc. (Basic Course) Microbiology

Semester	Subject 1/ Discipline1 (DSC/DSE) (credits)	Subject 2 / Discipline 2 (DSC/DSE) (credits)	Subject 2 / Discipline 2 (DSC/DSE) (credits)	Generic Elective (GE) (credits)	Ability Enhancement Course (AECC) (credits)	Skill enhancement course (SEC) (credits)	Internship/ Apprentice-ship/Project / Community	Value addition course (VAC) (credits)	Total Credits
I	DSC-1 (2)	DSC - 3(2)	DSC – 5 (2)		English (2)			Choose one from a pool of courses (0)	20 credits
	DSC-2 (2)	DSC - 4(2)	DSC – 6 (2)						
	DSCP (2)	DSCP (2)	DSCP (2)						
II	DSC-7 (2)	DSC - 9(2)	DSC - 11(2)		Hindi (2)			Choose one from a pool of courses (0)	20 credits
	DSC-8 (2)	DSC – 10(2)	DSC – 12(2)						
	DSCP (2)	DSCP (2)	DSCP (2)						
	Students on exit shall be awarded Undergraduate Certificate in Science after securing the requisite 40 credits in Semesters I and II								***40+4***
III	DSC-13 (2)	DSC – 15 (2)	DSC - 17(2)	Choose one from pool of courses. GE -1 (2)**		Computer Science (2)		Choose one from a pool of courses (0)	22 credits
	DSC-14 (2)	DSC - 16 (2)	DSC – 18 (2)						
	DSCP (2)	DSCP (2)	DSCP (2)						
IV	DSC-19 (2)	DSC – 21 (2)	DSC - 23(2)	Choose one from pool of courses GE - 2 (2)**		Env. Sc. and Sustainable Dev. (2)		Choose one from a pool of courses (0)	22 credits
	DSC-20 (2)	DSC – 22 (2)	DSC – 24 (2)						
	DSCP (2)	DSCP (2)	DSCP (2)						
	Students on exit shall be awarded Undergraduate Diploma in Science after securing the requisite 84 credits on completion of Semester IV								***84+4***
V	Choose two from pool of courses. DSE – 1 (2)	Choose two from pool of courses. DSE – 3 (2)	Choose two from pool of courses. DSE – 5 (2)			Mental ability & reasoning (2)		Choose one from a pool of courses (0)	20 credits
	DSE – 2 (2)	DSE – 4 (2)	DSE – 6 (2)						
	DSEP (2)	DSEP (2)	DSEP (2)						
VI	Choose two from pool ofcourses. DSE - 7 (2)	Choose two from pool of courses. DSE – 9 (2)	Choose two from pool of courses. DSE – 11 (2)			Anandam-Joy of giving (2) or NCC/NSS/Rovers and Rangers/ Red Ribbon Club/ Sports/ Extra-curricular and co-curricular activities (2)		Choose one from a pool of courses (0)	20 credits
	DSE - 8 (2)	DSE – 10 (2)	DSE – 12 (2)						
	DSEP (2)	DSEP (2)	DSEP (2)						

Abbreviations Used

Course Category

DSC: Discipline Specific Core
DSCP: Discipline Specific Core Practical
DSE: Discipline Specific Elective
DSEP: Discipline Specific Elective Practical
GE : General Elective
AEC: Ability Enhancement Course
AECC: Ability Enhancement Compulsory Course
SEC: Skill Enhancement Course
SEM: Seminar PRJ: Project Work
RP: Research Publication

Contact Hours

L: Lecture
T: Tutorial
P: Practical or Other
S: Self Study

The medium of instruction and examination shall be Hindi/English.

Duration: 6 Semesters (3 Years)

Semester-I	Name of Paper	Credits	Total Credits
Paper I	Introduction to Microbiology and Microbial Diversity	2	6
Paper II	Molecular Biology	2	
Lab	Practical	2	
Semester-II			
Paper I	Bacteriology and Virology	2	6
Paper II	Bioinstrumentation and Microbial Techniques	2	
Lab	Practical	2	
Semester-III			
Paper I	Microbial Biochemistry and Physiology	2	6
Paper II	Immunology	2	
Lab	Practical	2	
Semester-IV			
Paper I	Microbial Genetics	2	6
Paper II	Medical Microbiology	2	
Lab	Practical	2	
Semester-V	**Any two from elective A/B/C**		
Elective A	Environmental Microbiology	2	6
Elective B	Food and Dairy Microbiology	2	
Elective C	Bioethics, Biosafety and IPR	2	
Lab	Practical	2	
Semester-VI	**Any two from elective A/B/C**		
Elective A	Soil and Agriculture Microbiology	2	6
Elective B	Industrial Microbiology	2	
Elective C	Bioinformatics and Computer Applications	2	
Lab	Practical	2	

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

****Department will offer theory elective papers for the students based on options submitted by the students and availability of Faculty to teach the course.**

Marks Break up: End Semester Exam 35 Marks + Internal Assessment 15 Marks = 50 Marks per paper.

Practical Marks: External Practical's 30 Marks + Internal Practical 20 marks = 50

Theory Classes: Three hrs per week for each of the paper: end semester exam duration of 3 hrs for each of the papers

Practicals Classes: Four hrs practical classes per week: End semester Practical examination of Four hrs duration

B. Sc. Semester I

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			ESE Duration (Hrs.)	
					L	T	P	Theory	P
1.		Introduction to Microbiology and Microbial Diversity	DSC	2	2	-	-	3	-
2.		Molecular Biology	DSC	2	2	-	-	3	-
3.		Microbiology Practical	DSCP	2		-	2	-	4

B. Sc. Semester -II

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			ESE Duration (Hrs.)	
					L	T	P	Theory	P
1.		Bacteriology and Virology	DSC	2	2	-	-	3	-
2.		Bioinstrumentation and Microbial Techniques	DSC	2	2	-	-	3	-
3.		Microbiology Practical	DSCP	2	-	-	2	-	4

B. Sc. Semester -III

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			ESE Duration (Hrs.)	
					L	T	P	Theory	P
1.		Microbial Biochemistry and Physiology	DSC	2	2	-	-	3	-
2.		Immunology	DSC	2	2	-	-	3	-
3.		Microbiology Practical	DSCP	2	-	-	2	-	4

B. Sc. Semester -IV

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			ESE Duration (Hrs.)	
					L	T	P	Theory	P
1.		Microbial Genetics	DSC	2	2			3	
2.		Medical Microbiology	DSC	2	2			3	
3.		Microbiology Practical	DSCP	2			2		4

In Fifth Semester and Sixth Semester, students can choose any two electives. Departments will offer two theory elective courses for the semester based on options submitted by students and availability of Faculty to teach the course.

B. Sc. Semester -V

S.No.	Subject Code	Course Title (Any two from A/B/C)	Course Category	Credit	Contact Hours Per Week			ESE Duration (Hrs.)	
					L	T	P	Theory	P
1.		A. Environmental Microbiology	DSE	2	2	-	-	3	-
2.		B. Food and Dairy Microbiology	DSE	2	2	-	-	3	-
3.		C. Bioethics, Biosafety & IPR	DSE	2	-	-	2	-	4
4.		Microbiology Practical	DSEP	2	-	-	4	-	4

B. Sc. Semester -VI

S.No.	Subject Code	Course Title (Any two from A/B/C)	Course Category	Credit	Contact Hours Per Week			ESE Duration (Hrs.)	
					L	T	P	Theory	P
1.		A. Soil and Agriculture Microbiology	DSC	2	2	-	-	3	-
2.		B. Industrial Microbiology	DSC	2	2	-	-	3	-
3.		C. Bioinformatics and Computer Applications	DSC	2	-	-	2	-	4
4.		Microbiology Practical	DSCP	2	-	-	4	-	4

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

4. Course outcome

- 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.

POs	Program Outcomes (POs)
PO1:	**Sound Domain and Disciplinary Knowledge:** Extensive understanding of the discipline required for a postgraduate program. Execute strong theoretical and practical knowledge produced for the specific program in the field of work. Developing a solid foundation in evolution and diversity in the practical discipline of microbiology.
PO2:	**Research-related (Laboratory) skills and Scientific temper:** To acquire strong laboratory skills using advanced equipment, sophisticated instruments, and novel approaches to handle growing problems from a scientific standpoint. Collect scientific literature, develop a spirit of enquiry, and be able to design, test, evaluate, and establish hypothesis and research questions. 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.
PO3:	**Academic, Scientific and Trans-disciplinary Endeavour:** Students will learn a cognitive-innovative approach, technical maneuvering, innovative, and management skills in order to launch a new venture. Create new conceptual, theoretical, and methodological knowledge of challenges that combines and transcends discipline-specific approaches.
PO4:	**Personal, professional and Social aptitude:** Perform independently and collectively as a team member to fulfil stated goals and carry out work across diverse domains. Execute interpersonal interactions, self-motivation, and versatility, while adhering to professional ethics. 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.
PO5:	**Eco-friendly Environment and Sustainable Approach:** Futuristic strategy to create environmentally friendly management practices to improve socioeconomic conditions. Know how scientific advancements affect societal and environmental issues, and be able to articulate the benefits of the necessity for sustainable growth.
PO6:	**Effective Citizenship and Ethical Awareness:** To improve students' sensitivity to ethical issues in research and publishing. 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.
PO7:	**Self-directed or as Team Work Towards Life-long learning:** 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. Develop the ability to engage in independent learning and the spirit of teamwork.
PO8:	**Goal of life:** 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.

PSO	Program Specific Outcomes (PSOs) After completion of this programme
PSO1:	**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.
PSO2:	**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.
PSO3:	**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.
PSO4:	**Hygiene practices and Environmental Consciousness**: A. Develops healthy hygiene practices into habits. B. Encourages students to engage in eco-consciousness and trash management.
PSO5:	**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. B. Apply advanced approaches to standardize detection and quantification procedures while incorporating biological and physical scientific principles.
PSO6:	**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.

5. 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.

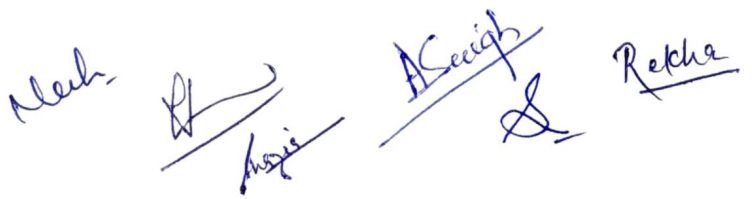
Microbiology course primarily focuses on the microorganisms and their applications in the field of Research with Genetic engineering, Molecular biology, Biochemistry, Biotechnology, Bioinformatics and Medical Microbiology and hence holds the central position in the curriculum of these subjects. While 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**.

Course Objectives:

Following objectives have been considered while formulation of the curriculum:

1. To provide an updated, feasible and modern syllabus to the students, with equal emphasis on Knowledge and skill, to build up their valuable college educational and job-oriented career.
2. To frame syllabus in accordance with the semester system and in consultation with all stakeholders.
3. To familiarize students with essential concept of basic techniques and their applications.
4. It is expected that the knowledge gained through this course will make students competent to meet the challenges of academic and professional courses.
5. To train the student in various aspects related to applied microbiology and medical microbiology.



B. Sc. [illegible] 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
Paper - II: Molecular Biology
Practical: Based on Theory Papers

Semester II

Paper - I: Bacteriology and Virology
Paper - II: Bioinstrumentation and Microbial Techniques
Practical: Based on Theory Papers

Semester III

Paper - I: Microbial Biochemistry and Physiology
Paper - II: Immunology
Practical: Based on Theory Papers

Semester IV

Paper - I: Microbial Genetics
Paper - II: Medical Microbiology
Practical: Based on Theory Papers

Semester V (Any Two from A/B/C)

Paper - A: Environmental Microbiology
Paper - B: Food and Dairy Microbiology
Paper - C: Bioethics, Biosafety and IPR
Practical: Based on Theory Papers

Semester VI (Any Two from A/B/C)

Paper - A: Soil and Agriculture Microbiology
Paper - B: Industrial Microbiology
Paper - C: Bioinformatics and Computer Applications
Practical: Based on Theory Papers

Marking Scheme for CBCS Curriculum

B.Sc. Semester-I

Max. Marks : Theory- 100
Practical- 50

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
	Paper I	Introduction to Microbiology and Microbial Diversity	35	15	50	20
	Paper II	Molecular Biology	35	15	50	20
					100	
	Lab	Microbiology Practical	30	20	50	20

B.Sc. Semester-II

Max. Marks : Theory- 100
Practical- 50

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
	Paper I	Bacteriology and Virology	35	15	50	20
	Paper II	Bioinstrumentation and Microbial Techniques	35	15	50	20
					100	
	Lab	Microbiology Practical	30	20	50	20

B.Sc. Semester-III

Max. Marks : Theory- 100
Practical- 50

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
	Paper I	Microbial Biochemistry and Physiology	35	15	50	20
	Paper II	Immunology	35	15	50	20
					100	
	Lab	Microbiology Practical	30	20	50	20

B.Sc. Semester-IV

Max. Marks : Theory- 100
Practical- 50

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
	Paper I	Microbial Genetics	35	15	50	20
	Paper II	Medical Microbiology	35	15	50	20
					100	
	Lab	Microbiology Practical	30	20	50	20

B.Sc. Semester-V

Max. Marks : Theory- 100
Practical- 50

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
	Paper A	Environmental Microbiology	35	15	50	20
	Paper B	Food and Dairy Microbiology	35	15	50	20
	Paper C	Bioethics, Biosafety and IPR	35	15	50	20
					100	
	Lab	Microbiology Practical	30	20	50	20

B.Sc. Semester-VI

Max. Marks : Theory- 100
Practical- 50

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
	Paper A	Soil and Agriculture Microbiology	35	15	50	20
	Paper B	Industrial Microbiology	35	15	50	20
	Paper C	Bioinformatics and Computer Applications	35	15	50	20
					100	
	Lab	Microbiology Practical	30	20	50	20

SEMESTER –I

Paper-I

Introduction to Microbiology and Microbial Diversity

Course Code:

Max. Marks: 35

30 Hrs. (3 hrs/week)

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks

Learning outcome

- Students will gain a holistic concept on history, development, scope and aspects of Microbiology. They will also study about the contributions of Microbiologists.
- Students acquire a fairly good knowledge about the microbial world, diversity of organisms. Understanding the diversity of organisms and about the kingdom and domain concept and they will gain knowledge on General characteristics of Protozoa.
- Students will achieve knowledge on habitat, distribution, nutritional requirements, ultra-structure of algae and fungi.

UNIT-I

History of Microbiology: Theory of Spontaneous generation, Contributions of Anton Von Leeuwenhoek, Francesco Reddi, Spallanzani, John Needham, Louis Pasteur, Robert Koch (Germ Theory of disease), Joseph Lister, Alexander Fleming. Establishment in the field of medical microbiology: Paul Ehrlich, Elie Metchnikoff and 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. **(8 hours)**

UNIT –II

Bacteria: Bacterial shapes and arrangement, cell wall of bacteria, chemical composition of cell wall of Gram positive and Gram negative bacteria. Internal structure of bacterial call- cell membrane, nucleoid, ribosomes, mesosome, inclusion bodies, flagella, capsule, slime, fimbriae, pili and Bacterial endospores (structure, formation and germination) and economic importance of bacteria.

Protozoa: General characteristics. **(7 hours)**

UNIT –III

Algae (Phycology): Classification proposed by Smith and Fritsch, General characteristics of Algae including habitat and cell ultrastructure. *Chlamydomonas*, *Nostoc* and *Oscillatoria* **(8 hours)**

UNIT –IV

Fungi (Mycology): Classification proposed by Alexopoulos. General characteristics of fungi including habit, habitat, nutritional requirements, thallus organization and aggregation, asexual reproduction, sexual reproduction and Economic importance of fungi. **(7 hours)**

Suggested Readings:

- Ananthanarayan, R. *et al.*, (2020). Textbook of Microbiology. 11th Edition. University Press (India) Pvt. Ltd.
- Atlas, R.M. (1997). Principles of Microbiology, 2nd Edition. McGraw-Hill Publication.
- Boone, D.R. and Castenholz, R.W. (2012). Bergey's Manual of Systematic Bacteriology: Volume I: The Archaea and the Deeply Branching and Phototrophic Bacteria (Bergey's Manual of Systematic Bacteriology. Springer.
- Cappucino, J.G. and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
- Jordan, E.O. (2010). A Text-Book of General Bacteriology. Nabu Press.

- Madigan, M.T.*et al.* (2014). Brock's Biology of Microorganisms. 14th edition. Pearson International Edition.
- Parks, R. (2018). Textbook of Bacteriology. Syrawood Publishing House.
- Pelczar, M.J. *et. al.* (2006). Microbiology. 5th Edition Tata Mc Graw Publication.
- Schlegel, H.S. *et al.* (2006). General Microbiology, 7th Edition, Cambridge University Press.
- Sharma, P.D. (2019). Microbiology. Rastogi Publication.
- Stanier, R.Y., *et al.* (2000). General Microbiology, 5th Edition. Tata-McGraw Hill Publication.
- Tortora, G.J. *et. al.* (2019). Microbiology: An Introduction. 4th Edition. Pearson Publication
- Wiley, J.M. *et. al.* (2013). Prescott's Microbiology. 9th Revised Edition. McGraw Hill Higher Education.

SEMESTER –I
Paper-II
Molecular Biology
Course Code:

Max. Marks: 35
30 Hrs. (3 hrs/week)

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Students will learn about the discovery, structure & organization of cell. Structure and functions of major cell organelles and their Correlations, characterization of cell wall, plasma membrane, mitochondrion, chloroplast etc. and also the knowledge about Nucleus, Chromosome and special types of chromosomes.
- This paper would enable students to have an overall knowledge about DNA structure and replication, types of RNA, transcription, post-transcriptional processing and translation of prokaryotes and eukaryotes. They will learn about regulation of gene expression. Students will learn about DNA damage and repair mechanism.

UNIT- I

Cell as a Basic unit of Living Systems: Discovery of cell, The Cell Theory, General characteristics of cell. Ultrastructure of prokaryotic and eukaryotic cell. Structure and functions of various cell organelles of eukaryotic cell (Plasma membrane, Nucleus, chloroplast, mitochondria, Endoplasmic Reticulum, ribosome, Golgi body). **(8 hours)**

UNIT- II

Chromosome: morphology and structural organization, Euchromatin and Heterochromatin. Special types of chromosomes: Salivary gland and Lampbrush chromosomes.

Cell Cycle: An overview of cell cycle.

DNA Structure and Replication: Structure of DNA and RNA, Types of DNA and RNA, Replication in prokaryotes and eukaryotes: Semiconservative nature of DNA replication. **(7 hours)**

UNIT- III

Transcription in prokaryotes: Prokaryotic RNA polymerase, Initiation, elongation and termination of RNA.

Transcription in eukaryotes: Eukaryotic RNA polymerases, mechanism of transcription initiation, elongation and termination of RNA. **(8 hours)**

UNIT-IV

Translation & Regulation of Gene Expression: Genetic code, Prokaryotic and eukaryotic Translation: Regulation of gene expression in prokaryotes, lac operon.

Mutation, DNA Damage and Repair: Spontaneous and Induced mutations, Mutagens, mechanism of mutation, Forward and Reverse mutation, Transition, Transversion. Mechanism of DNA damage and repair. **(7 hours)**

Suggested Readings:

- Alberts *et al.*, (2019). Essential Cell Biology 5th Edition, W.W. Norton & Company
- Buchanan, B. B. and Gruissem, W. (2015). Biochemistry and Molecular Biology of Plants. Wiley Publisher.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C. Sinauer Associates, MA.
- De Robertis, E. D. P. and De Robertis, E. M. F. (2006). Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.

- Elliot, D. C. and Elliott, W. H. (2005). Biochemistry and Molecular Biolgoy, 4th Edition, Oxford University press.
- Hardin, J. *et. al*., (2017). Becker's World of The Cell. Pearson Publication.
- Karp, G. (2018). Karp's Cell Biology. Global Edition. Wiley Publication.
- Malacinski, G. M. (2015). Freifelders essentials of Molecular Biology, 3rd edition. Jones and Bartlett Publishers.
- Malathi, V. (2012). Essential of Molecular Biology. 1st Edition, Pearson Education, India.
- Rastogi, V.B. (2021). Cell Biology. Medtech Publication.
- Watson, J. D. *et. al*., (2022). Molecular Biology of the Gene 7th Edition. Cold Spring Harbour Lab. Press, Pearson Pub.
- Wilson, K. and Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology, 8th edition. Cambridge University Press.

SEMESTER –I
Microbiology Practical

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

Learning 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.
- Student will gain information through slides preparation of plant and animal cell, study of Cyanobacteria and free-living protozoa, cell division and special chromosome through slide preparation and microscopic examination and use of instruments to perform basic molecular biology experiments 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. Bacterial smear preparation and identification of common morphological forms of bacteria through simple staining.
5. Study of different microbes.
6. Simple staining.
7. Negative staining.
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. Study of a plant and animal cell by microscopy.
12. Study of the structure of cell organelles through electron micrographs.
13. Cell division: Mitotic and meiotic studies in onion root tips, grasshopper testes or flowerbuds.
14. Preparation and staining of polytene chromosomes from Drosophila salivary gland.
15. Study of different types of DNA and RNA using micrographs and model/schematic representations.
16. Study of bar body from buccal epithelial cells.
17. Isolation of genomic DNA.

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

SEMESTER –II
Paper-I
Bacteriology and Virology
Course Code:

Max. Marks: 35
30 Hrs.

Scheme of Examination:
There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Students get a prominent knowledge on detailed cell organization, arrangement and other characteristic features of a bacterial cell and distinguish different forms of bacteria and a fairly good understanding of isolation techniques of bacteria & virus.
- Students will learn about bacterial growth, nutrition, motility and reproduction processes.
- Students will have a thorough understanding on structure, capsid symmetry, isolation, purification and cultivation of viruses and about lytic and lysogenic cycle of T4/T2 phage.

UNIT-I

Microbial diversity- General idea about Bergeys classification of Bacteria.

Proteobacteria: alphaproteobacteria (*Rickettsia*), betaproteobacteria (*Thiobacillus*), Gamma-proteobacteria (*E. coli*), Delta-proteobacteria (*Myxococcus*) and Epsilon-proteobacteria (*Campylobacter*).

Non proteobacteria: Gram negative bacteria (purple and green photosynthetic bacteria), Gram positive bacteria: firmicutes (*Mycoplasma and Streptococcus*), Actinobacteria (*Mycobacterium*).

Archaebacteria: General characteristics, cell wall, Types of Archaebacteria (Methanogens, Thermophiles and Halophiles). **(8 hours)**

UNIT-II

Reproduction in Bacteria: Asexual and sexual reproduction, phases of growth.

Bacterial nutrition and Growth: Nutritional requirements in bacteria: Autotrophic and heterotrophic bacteria. Definition of growth, growth curve, Environmental Factors affecting growth-Temperature, pH, Oxygen and water availability. **(7 hours)**

UNIT-III

Virus: Discovery, nature and general properties. Baltimore classification of viruses. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. General properties of viroids, virusoids and prions. Bacteriophage: General characteristics, morphology, life cycles, lytic and lysogenic phages (lambda phage). **(8 hours)**

UNIT-IV

Plant Viruses: General characteristics and structure of Tobacco Mosaic Virus and Yellow Mosaic virus. Modes of transmission of plant viruses.

Animal Viruses: General characteristics and structure of Herpes virus and Papilloma virus. Modes of transmission of animal viruses. **(7 hours)**

Suggested Readings:

- Alcamo, I.E. ((2001)). Laboratory fundamentals of microbiology, Jones and Barlett Publishers.
- Baron, S. Medical Microbiology. 4th edition, Galveston (TX).
- Brown A., 1996, Benson's Microbiological Applications Complete Version. (Kindle edition).
- Cappuccino, J.G. and Sherman, N. (2006). Microbiology-A Laboratory Manual, 6th edition, Addison Wesley, Pearson Education, Inc.
- Dubey, H.C. (2019). A Textbook of Fungi, Bacteria and Viruses. Agrobios Publisher.

- Holt, J.G. (1993). Bergey's Manual of Bacteriology 9th Edition. Wolters Kluwer Publisher.
- Lehmann K.B. Atlas and Principles of Bacteriology and Text-Book of Special Bacteriologic Diagnosis. (Karl Berhard) Andesite Press.
- Madigan, M.T. *et al.*, (2010). Brock's Biology of Microorganisms, 10th Edition, Pearson Education, Inc.
- Morrey C.B. The Fundamentals of Bacteriology.
- Pelczar, M. J.*et al.* (2006). Microbiology 5th edition, Tata McGraw Publication.
- Purohit, S. S. (2012). Microbiology: Fundamentals and Applications, 7th Edition, Student Edition Publication.
- Rohilla, A. (2010). Handbook of Bacteriology. Oxford Publisher.
- Salle, A. J. (2007). Fundamental Principles of Bacteriology. Dodo Press Publication.
- Sequeira, M. G. (2019). An Introduction to Microbiology. New Age International Publishers.
- Sharma, P. D. (2019). Microbiology. Rastogi Publication.
- Singh, V. *et al.*, (2018). Microbiology and Phycology. 1st Edition. Rastogi Publication.
- Snyder L, Joseph E. Peters, Tina M. Henkin, Wendy Champness, 2007. Molecular Genetics of Bacteria. 4th edition. ASM Press.
- Tortora, G. J. (2007). Microbiology-an introduction, 9th edition Pearson Education, Inc.
- Willey, J. *et. al.* (2017). Prescott's Microbiology, 6th Edition, Mc Graw Hill Companies.

SEMESTER –II

Paper-II

Bioinstrumentation and Microbial Techniques

Course Code:

Max. Marks: 30
30 Hrs. (3 hrs/week)

Scheme of Examination

There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry 1 mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Students will learn about different culture techniques, bacterial growth curve, different methods of microbial growth measurement, physical and chemical methods in microbial control.
- Students will understand the principle and working of pH meter, colorimeter, light microscope, paper, thin layer and column chromatography. Features of dark field, phase contrast and electron microscopes. Students will be acquainted with ultra-modern instruments and Biotechniques.

UNIT-I

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

Culture techniques: Culture media preparation solid, liquid and semi-solid media, Special Media. Enriched, selective, transport, differential, maintenance and enrichment media. **(8 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, Fluorescent microscopy and Phase contrast microscopy. Electron Microscope-Principles and applications of Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM). **(7 hours)**

UNIT-III

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

Spectroscopy: Beer-Lambert law and its limitations. Basic design of photoelectric colorimeter and spectrophotometer. Applications of UV-visible spectroscopic techniques. **(8 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. **(7 hours)**

Suggested Readings:

- 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.

SEMESTER –II

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 gather practical skills of handing bacteria & viruses in the laboratory for study and learn about simple and differential staining process, Serial dilution technique, Media preparation, pure culture and inoculation techniques - isolation of microorganisms by streak plate, Spread plate and pour plate method and will learn to perform pure cultures techniques to isolate, study, identify and preserve bacterial strains.
- 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. Identification of common morphological forms of bacteria through simple staining.
3. Gram's staining, flagella and endospore staining.
4. Serial dilution technique.
5. Media preparation and their types-liquid and solid media (PDA and NA).
6. Culture inoculation techniques - spread plate, streak plate, pour plate method and preparation of slants.
7. Study of bacterial growth curve.
8. Determination of size of a given microorganism using micrometry.
9. Observation of motility in bacteria using: Hanging drop method and swarming growth method.
10. Study of common morphological forms of viruses through charts.
11. Study of common morphological forms of bacteriophage through charts.
12. Determination of pH of a given sample.
13. Separation of serum and cells from blood sample using centrifuge.
14. Demonstration of Agarose Gel electrophoresis.
15. Perform Paper chromatography.
16. Perform Thin layer chromatography.

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

SEMESTER –III
Paper-I
Microbial Biochemistry and Physiology
Course Code:

Max. Marks: 35
30 Hrs. (3 hrs/week)

Scheme of Examination:
There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Cognize the regulation of biochemical pathway and possible process modifications for improved control over microorganisms for microbial product synthesis.
- In depth knowledge of the energetic and regulation of different metabolic processes in microorganisms.

UNIT-I

Chemical and Molecular Interaction: Chemical bonding: Ionic bond, covalent bond, hydrogen bond, Vander walls forces. Nature of biochemical reactions- reversible and irreversible reaction.

Fundamentals of Carbohydrates: Classification, Basic chemical structure of monosaccharide's, Disaccharides and polysaccharides.

Lipids: General properties, Structure and Classification of major lipids.

Protein: General properties, Structure and Classification based on structure and functions. **(8 hours)**

UNIT-II

Enzymes: Definition, Classification and Nomenclature of enzymes. Enzyme kinetics, Factors influencing enzyme activity (Enzyme inhibition). Isozymes and Allosteric enzymes. Coenzymes and co-factors.

Vitamins: Classification, Biochemical properties of water soluble and fat soluble vitamins. Functions of vitamins. **(7 hours)**

UNIT-III

Transport Mechanisms: Osmosis, Plasmolysis, Diffusion-passive and Facilitated Diffusion, concept of uniport, symport and antiport. Active transport.

Photosynthesis: Introduction to aerobic and anaerobic chemolithotrophy with example. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). **(8 hours)**

UNIT-IV

Introduction to phototrophic metabolism: Photosynthetic micorbes, anoxygenic vs. oxygenic photosynthesis.

Respiratory Pathways: Concept of aerobic respiration, anaerobic respiration and fermentation. Glycolysis, Oxidative pentose phosphate pathway, Krebs cycle, Electron Transport Chain (ETC).

Nitrogen fixation: Biological Nitrogen fixation in symbolic and free living systems; nitrogen fixation; nitrification, denitrification. **(7 hours)**

Suggested Readings

- 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.

SEMESTER – III

Paper-II

Immunology

Course Code:

Max. Marks: 35

30 Hrs. (3 hrs/week)

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Students will have fundamental concept on innate & adaptive immunity, immune cells and organs, epitopes, adjuvants, haptens, MHC.
- Students will have knowledge on types, structure, and functions of antibodies and will gain knowledge on Immunization, vaccine production and will able to perform advanced immunological Techniques.

UNIT –I

Immunity and Immune system: Immunity; Definition, Types of Immunity-Innate and adaptive immunity, immune response. Active and passive immunity.

Cells and organs of the immune system: B and T-lymphocytes, Macrophages, Dendritic cells, NK cells, Eosinophils, Neutrophils and Mast Cells. **(8 hours)**

UNIT –II

Antigen and Antibody: Antigenicity, Immunogenicity, antigen, immunogen, Adjuvants, Haptens and epitopes, Antibody: structure and types. Immunoglobulins: structure, classification and functions,

Antigen-antibody interaction: Precipitation, Agglutination, Neutralization, Opsonization. Complement fixing test, ELISA, Radial immunodiffusion. **(7 hours)**

UNIT –III

Antigen processing and Presentation: Structure, Types and Functions of Major histocompatibility complex (MHC) and Human leukocyte antigen (HLA).

Immune cells: B and T-Cell Receptor, T-cell maturation, activation and differentiation. B-cell maturation, activation and differentiation. **(8 hours)**

UNIT-IV

Diseases related to immune system: Deficiencies/defects of T cells, B cells, and phagocytic cells.

Hypersensitivity: Types of hypersensitivity reactions and their features.

Autoimmune diseases: rheumatoid arthritis.

Transplantation immunology: Organ transplant (Allograft, Xenograft, Autograft). **(7 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

Rekha

SEMESTER –III

Microbiology Practical

Maximum practical Marks	=	50 marks
Internal marks	=	20 Marks
External marks	=	30 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, various inorganic ions and micronutrients, confidently applying this learning to real-life quality assurance situations.

Suggested Practical Exercises:

1. Properties of water, 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. Identification of Blood Group and Rh factor.
9. Blood film preparation and identification of cells.
10. Counting of RBC and WBC by Hemocytometer.
11. Single Immunodiffusion.
12. Ouchterlony Double diffusion.
13. DOT- ELISA.
14. Agglutination tests (Widal test).

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

SEMESTER –IV
Paper-I
Microbial Genetics
Course Code:

Max. Marks: 35
30 Hrs. (3 hrs/week)

Scheme of Examination

There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Students will gain through knowledge on molecular aspects of cell, microbial genetics, and mechanisms of genetic exchange & transposable elements.

UNIT-I

General characteristics of Plasmids: Types of plasmids - F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmid. Yeast-2μ plasmid, Plasmid-replication, incompatibility, plasmid amplification, copy number, Applications of Plasmids. **(8 hours)**

UNIT -II

Gene transfer mechanisms in Bacteria: Recombination in bacteria- Site specific recombination, Holliday model for general recombination.

Bacterial Transformation- Discovery, mechanism of transformation, Transfection.

Transduction- Generalized transduction, specialized transduction, LFT & HFT lysates.

Conjugation- Discovery, mechanism of conjugation, F+, F-, Hfr and F' strains. **(7 hours)**

UNIT-III

Phage Genetics: Features of T4 genetics, Regulation of lytic *versus* lysogenic switch of phage lambda.

Transposable elements-I: Prokaryotic transposable elements –Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Cosmids. **(8 hours)**

UNIT-IV

Transposable elements-II: Eukaryotic transposable elements-Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds). Uses of Transposition, Barbara Mc. Clintok Experiment. **(7 hours)**

Suggested Readings:

- Chaudhari, K. (2012). Microbial Genetics. The Energy and Resources Institute, TERI.
- Gardener, E.J. (2005), Principles of Genetics, 8th edition, John Wiley and Sons Publications,
- Klug, W.S. *et al.* (2019). Concepts of Genetics, Global Edition, Pearson Publication.
- Krebs, J.E. *et al.*, (2020). Lewin's Essential GENES, 4th Edition. Jones and Bartlett Publishers, Inc.
- Krishnaiah, G.R. (2019). A Textbook of Microbial Genetics & Molecular Biology. Blue Rose Publishers.
- Maloy, S.R. *et al.*, (1994). Microbial Genetics, 2nd edition. Jones and Barlett Publishers.
- Pierce, B. (2016). Genetics: A Conceptual Approach, 4th Ed., W.H. Freeman Publisher.
- Rajan, S.R. (2003). Microbial Genetics. Anmol Publication Pvt. Ltd.
- Russell, P.J. (2016).Genetics- A Molecular Approach. 3rd Edition, Benjamin Cummings
- Watson, J. *et al.*, (2022). Molecular Biology of the Gene.7th Edition. Pearson Publication.

Paper-II
Medical Microbiology
Course Code:

Max. Marks: 35
30 Hrs. (3 hrs/week)

Scheme of Examination:
There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Students will gain through knowledge on various bacterial, viral, fungal & Protozoan diseases.
- Students will have knowledge on modes of action of Antibacterial, Antifungal and Antiviral agents. Students will carry out advanced diagnostic procedures.

UNIT- I

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. **(8 hours)**

UNIT- II

Epidemiology-The study of disease in population: Principles of epidemiology, reservoirs of pathogens, acquisition and transmission of infectious agents, nosocomial infections, measures for prevention of epidemics.

Fungal diseases: Mycoses, mycotoxicoses. **(7 hours)**

UNIT- III

Bacterial diseases: General idea of infections: symptoms, treatment and preventive measure of diseases caused by Gram positive bacteria: *Mycobacterium* (Tuberculosis and leprosy), *Corynebacterium* (Diphtheria). Gram negative bacteria: *Salmonella* (Typhoid), *Vibrio (cholera), Shigella (Dysentry), Neisseria* (Gonorrhea). **(8 hours)**

UNIT- IV

Viral diseases: Animal viruses: life cycle, pathogenicity, diagnosis, prevention and treatment of RNA viruses- Picorna virus- Poliomyelitis; Orthomyxoviruses-influenza virus. Paramyxovirus- Mumps, Measles; retroviruses-HIV, Rabies virus. DNA viruses- Hepatitis viruses- A and B. COVID-19. Immunization program in India. **(7 hours)**

Suggested Readings:

- 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.

SEMESTER –IV

MICROBIOLOGY PRACTICAL

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

Learning outcome:

- 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 can identify pathogenic bacteria on selective/differential media on the basis of cultural and biochemical characteristics and is able to perform blood testing and is acquainted with the resident microflora of skin.

Suggested Practical Exercises:

1. Plasmid Isolation from bacterial culture.
2. Study of phage morphology using photograph.
3. Study of Master and Replica Plates.
4. Isolation of bacterial DNA.
5. Demonstration of AMES test.
6. Estimation of DNA by diphenylamine.
7. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
8. Separation of serum from the blood sample (demonstration).
9. Estimation of blood hemoglobin.
10. Total Leukocyte Count of the given blood sample.
11. Identify bacteria - *E. coli, Pseudomonas, Staphylococcus, Bacillus,* using laboratory strains on the basis of cultural, morphological and biochemical characteristics.
12. Isolation of bacterial flora of skin by swab method.
13. 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.**

SEMESTER - V
Paper I
Environmental Microbiology
Course Code:

Max. Marks: 35
30 Hrs. (3 hrs/week)

Scheme of Examination:
There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Students will study the beneficial and harmful roles of microbes in air, water and soil as well as factors affecting their presence in environment, biogeochemical cycling & microbial interactions also gain advanced knowledge on Waste Management treatment.
- Student will understand the function and importance of biotic and abiotic environmental factors in the sustenance of plant life and the local ecology.

UNIT- I

Microbiology of Air, water & soil: Microbial population of air, water (drinking and potable) and soil.
Population interaction: Neutralism, Commensalism, Synergism, Mutualism, Competition, Ammensalism, Parasitism and Predation.
Aeromicrobiology: aeromicrobiological pathway, microbial survival in air, extramural and intramural aeromicrobiology. **(8 hours)**

UNIT- II

Terrestrial environment: microorganisms in surface soil, shallow and deep subsurface environment.
Biogeochemical Cycles: carbon cycle, nitrogen cycle, sulphur cycle, phosphorus cycle, iron cycle, hydrogen and oxygen cycle. **(7 hours)**

UNIT - III

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. **(8 hours)**

UNIT - IV

Biodegradation and Bioremediation: Basic ideas of biodegradation of natural compounds (cellulose, hemicelluloses, lignin), Biodegradation of environmental pollutants, Bioremediation of xenobiotics, Bioaccumulation and Biomagnification. **(7 hours)**

Suggested Readings:

- Bolger, A. (2010). Environmental Microbiology. Oxford Book Company.
- Buckley, R. G. (2019). Environmental Microbiology. CBS Publisher.
- 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.
- Mohapatra, P.K. (2006), Textbook of Environmental Biotechnology. I.K. International Publications, Mumbai.
- Ramesh, K.V. (2019). Environmental Microbiology. M.J.P. Publishers.
- Sharma, P.D. (2016). Environmental Microbiology, Rastogi Publication.
- Varnam, A. and Evans, M. G. (2018). Environmental Microbiology. CRC Press.

SEMESTER- V

Paper II

Food and Dairy Microbiology

Course Code:

Max. Marks: 35
30 Hrs. (3 hrs/week)

Scheme of Examination

There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice, each question will carry 7 marks.

Learning outcome:

- Students will study fermenting organisms from different foods and will gain knowledge and hands-on-training on preparation of fermented foods. Students will study microbial spoilage of various foods, intrinsic and extrinsic factors of microbial activity and knowledge on physical & chemical methods of food preservation.
- Students will have idea on beneficial role of gut probiotics, traditional fermented foods and their wide nutritional values. Students will study different food infections & intoxications.

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. **(8 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, Idly), fermented beverages (Wine and Beer). **(7 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. **(8 hours)**

UNIT – IV

Industrial Dairy fermentations: Classification of various groups of microorganisms associated with dairy industry. Production of fermented dairy products (Yoghurt, Cultured butter milk and Cheese) used microorganisms, enzymes and other additives. Cheese production: steps involved in manufacture of cheese, preservation, classification and nutritional aspects. **(7 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.

SEMESTER- V
Paper III
Bioethics, Biosafety & IPR
Course Code:

Max. Marks: 35
30 Hrs. (3 hrs/week)

Scheme of Examination

There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Students will gain Knowledge of working principles in a laboratory taking all safety measures, handling of experimental animals and get an insight into Biosafety guidelines.
- Analyze and Manage the Risks involved with GMOs.
- Gain Knowledge about Intellectual Property Rights, understand about different treaties, rights and duties of Patent owner and understand the process of patent application.

UNIT-I

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. **(8 hours)**

UNIT-II

Biosafety and risk assessment issues: Introduction. Different levels of Biosafety. Biosafety levels of specific Microorganisms; Recommended Biosafety levels for infectious agents and infected animals. Biological Safety Cabinets; Containments- Types. Quarantine regulations. **(7 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: Copyright and related rights, Patents, Trademarks, Trade Secrets, etc. **(8 hours)**

UNIT-IV

Intellectual Property Rights: Importance of IPR in developing world with special reference to India. IPRs in Biotechnology/Microbiology. Intellectual Property Management: Patent application process (national and International), specifications, claims, prior art and patent designs. Landmark cases in Indian patent history. WTO, TRIPS, International conventions, patents and copy rights, patent claims, methods of application of patents. **(7 hours)**

Suggested Readings:

- 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.

SEMESTER – V

MICROBIOLOGY PRACTICAL

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 (28°C & 45°C).
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. Proxy filing of Indian Product patent.
9. Study of components and design of a laboratory
10. Study of steps of patenting process
11. Process of primary applications for patents
12. Planning of establishing a hypothetical biotechnology industry in India.
13. Review study on clinical trials of drugs in India with emphasis on ethical issues.
14. Isolation of antibiotic producing microorganism from fruits (Papaya).
15. Methylene blue reductase time (MBRT) test for checking microbial quality of milk.
16. Milk adulteration test.
17. Isolation of milk fermenting organisms from milk.
18. Production of fermented food using microbial culture (sauerkraut production).
19. Quarantine regulations.
20. Field survey and educational visit.

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

SEMESTER - VI
Paper-I
Soil and Agricultural Microbiology
Course Code: 33623

Max. Marks: 35
30 Hrs.

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

- Students will learn about microbes for sustainable development of agriculture, will have knowledge on biofertilization, phytostimulation, bioinsecticides, biomanure, biogas, biofuels and on GM crops.
- microbial products of commercial value in the field of food, industrial, pharmaceutical, agricultural and environmental Microbiology.

UNIT –I

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. **(8 hours)**

UNIT- II

Organic matter decomposition: Composition of litter (cellulose, hemicelluloses, lignin and proteins). Carbon assimilation and immobilization, microorganisms associated with organic matter decomposition, factors affecting decomposition. **(7 hours)**

UNIT- III

Microbial inoculants, production of bacterial biofertiliser: Green manuring; algae and other biofertilisers; mass cultivation of cyanobacteria

Biofertiliser: Biofertilisers aiding phosphorus nutrients: production of mycorrhizal biofertilizers.

(8 hours)

UNIT –IV

Crop protection: Microbial herbicides; Bacterial insecticides; *Pseudomonas, Bacillus* sp. as bacterial insecticides; Virus insecticides; Entomopathogenic fungi- *Verticillium*, *Hirsutella.* **(7 hours)**

Suggested Readings:

- Aneja, K.R. (2017). Fundamental Agricultural Microbiology. New Age International Pvt.Ltd.
- Kumar, A. and Sharma, S. (2020). Microbes and Enzymes in Soil Health and Bioremediation: (Microorganism for Sustainability). Springer Link Publishers.
- Mishra, R.R. (2014). Soil Microbiology. CBS Publishers.
- 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).
- Subba Rao, N.S. (2020). Soil Microbiology. Oxford & IBH Publishing.
- Trivedi, P.C. (2010). Agricultural Microbiology. Pointer Publishers.
- Vendan, R. (2021). Soil Microbiology. New India Publishing Agency NIPA.
- Yogranjan, *et. al.*, (2020). Essentials of Agricultural Microbiology. IP Innovative Publication Pvt. Ltd.

SEMESTER - VI
Paper-II
Industrial Microbiology
Course Code:

Max. Marks: 35
30 Hrs.

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks

Learning outcome:

- Students will understand the fundamentals of screening methods, microbiological culture, preservation techniques, etc.
- Understand the principles of media sterilization and inoculum formation.
- Students will learn more about synchronous growth, different types of fermentation processes, and the general structure and components of a fermenter. knowledge of the specific downstream processes involved in the fermentation of significant microbial products

UNIT- I

Industrial Practices: Culture and media for fermentation, criteria for selection of industrial organisms, screening from natural habitat and strain improvement. Inoculums development for bacteria, yeast and fungi. Raw material: Molasses Hydrocarbons, antifoams and agriculture waste. Sterilization: Bioreactor, media, air exhaust and waste. **(8 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- butanol and vitamin B12. **(7 hours)**

UNIT –III

Fermentative production of Primary metabolites: Secondary metabolism and its control. Product survey. Overproduction of Antibiotics by Strain improvement program, Polyketide biosynthesis pathway. Application of biotechnology in pharmaceutical. **(8 hours)**

UNIT- IV

Quality control and quality assurance in food and pharmaceutical industries: concept of good manufacturing practices in pharmaceutical industry, role of biotechnology to improve food quality food production and assessment of microbiological quality of various foods Fermentation, cultures of microorganisms, solid or semisolid cultures, batch culture, continuous culture, fed batch culture. **(7 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 in Bioprocess 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.

SEMESTER - VI

Paper-III

Bioinformatics and Computer Applications

Course Code:

Max. Marks: 35

30 Hrs.

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

Learning outcome:

Students will be highly benefitted by using different software & tools for analysis of biological data.

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. **(8 hours)**

UNIT-II

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

Data banks: Gen Bank, PubMed, BLAST, FASTA, NCBI and Protein Data Bank (PDB).

Multiple sequence alignment: Methods of multiple sequence alignment.

Applications of bioinformatics. **(7 hours)**

UNIT-III

Basic Computers Introduction: Characteristics of Computers, Classification of Computers, Binary Number System .Computer Software, Computer languages, Concept of assembler, interpreter, linker and compiler. Uses of MS DOS commands: Basic Concept of internal & external Commands, File commands, copying, erasing, renaming and displaying files. **(8 hours)**

UNIT-IV

Microsoft Excel: Introduction to Microsoft Excel, Features of MS Excel, Manage Data Cells and Ranges, Benefits of Using MS Excel, create table, Format cells and ranges, types of formula and its applications, Create Spreadsheet and its Application, Types of graphs, Create Charts & Graphs, Modify charts and its applications.

Microsoft power point: slide presentation. Slide layout & design, custom animation and slide transition.

Data Communications and Computer Networks: Basic Elements of a Communication System.

The Internet: Brief History, Its basic Services, WWW & browsers, internet search engines, introduction to internet. **(7 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.

SEMESTER – VI

MICROBIOLOGY PRACTICAL

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 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 and identification of bacteria and fungi from soil.
2. Enumeration and identification of rhizosphere microflora.
3. Isolation of *Rhizobium* from root nodules.
4. Observation description of any three bacterial and fungal plant diseases.
5. Isolation and identification of fungi from leaves, stems and other aerial parts of the plants.
6. Mushroom cultivation.
7. Identification of edible and poisonous mushrooms.
8. Study of mycorrhizal biofertilizer.
9. Study of Microbes that can be used as biopesticides.
10. Applications of computers in biology using MS-Office. A] MS-Word B] Excel C] PowerPoint.
11. Creating an e-mail account, sending and receiving mails. Search engines, websites, browsing and Downloading. Searching research articles in Medline and Pub med.
12. Demonstrate the BLAST and FASTA.
13. Sauerkraut production.
14. Production of alcohol.
15. Estimation of lactic acid in curd.
16. Isolation of industrially important microorganisms.
17. Production of grapes wine.
18. Production of citric acid using *Aspergillus* in batch culture.
19. Effect of pH and temperature on citric acid production.
20. Industrial visit.

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