Department of Microbiology

B.Sc. (Microbiology)

Eligibility crteria: Bachelor of Science (B.Sc.)

Sr.No	Course	Required Qualifications
1	B.Sc. Microbiology	12th Pass with PCB
2	B.Sc. Chemistry	12th Pass with PCB/PCM
3	B.Sc. Physics	12th Pass with PCB/PCM
4	B.Sc. Mathematics	12th Pass with PCM

Sr.No	Major	Minor
1	Microbiology	Chemistry
2	Chemistry	Microbiology: G-1 /Physics: G-2
3	Physics	Mathematics/Chemistry
4	Mathematics	Physics

GUJARAT VIDYAPITH: AHMEDABAD
Faculty of Science
Department of Microbiology
Program Structure For B.Sc. Microbiology (3-years UG)
Effective from June 2024*
Summary

Broad Category of Course	**Sem-1**	**Sem-2**	**Sem-3**	**Sem-4**	**Sem-5**	**Sem-6**	**Total**	**Required**
Major (Core)	3+2= **05**	3+2= **05**	3+3= **06**	3 3 06 + 2(P) = 08	3 3 3 =9+5(P) =14	3+2=05 3+2=05 3+2=05 3+2=05 20	**60**	**60**
DSE (Discipline Specific Elective)	**-**	**-**	**-**	**-**	**2** **14+2= 16**	**-**		
Minor	3+2= **05**	3+2= **05**	3+3= **06**	3 3 **06 +2(P)= 08**	**-**	**-**	**24**	**24**
Multidisciplinary	**03**	**03**	**03**	**-**	**-**	**-**	**09**	**09**
Ability Enhancement course	**02**	**02**	**02**	**02**	**-**	**-**	**08**	**08**
Skill Enhancement Course	**03**	**03**	**03**	**-**	**-**	**-**	**09**	**09**
Value added Courses	**02**	**02**	**-**	**02**	**-**	**-**	**06**	**06-08**
Internship/In-house	**-**	**-**	**-**	**-**	**04**		**04**	**02-04**
Total	**20**	**20**	**20**	**20**	**20**	**20**	**120**	**120**

GUJARAT VIDYAPITH: AHMEDABAD
Faculty of Science
Department of Microbiology
Program Structure For B.Sc Microbiology (Semester I to VI) Effective from June 2024

Availability of time for direct teaching in each semester = 15weeks = **517.5 hours** (15weeks × 34.5 hours)
Monday to Friday (excluding prayer and recess)= 30 hours (6 hours × 5 days)
Saturday (excluding prayer and recess) = 4.5 hours
Therefore 1week = 34.5 hours

B.Sc. Semester-1							
Sr. No.	**Broad Category of Course**	**Subject Name**	**Semester**	**Hours**		**Credits**	
				Theory	**Practical**	**Theory**	**Practical**
1	Major (Core)	Microbiology	First	45	60	3	2
2	Minor	G1:Chemistry G2:Physics	First	45	60	3	2
3	Multidisciplinary		First	45	-	3	-
4	Ability Enhancement course		First	30	-	2	-
5	Value added Courses		First	30	-	2	-
6	Skill Enhancement Course		First	-	90	-	3
Total				**195**	**210**	**13**	**07**

Available Total Credits= 20 Total required hours per semester=405
Total available hours per semester=517.5 hours
Available hours per week= 34.5 hours
Calculation of required hours per week
13 credits for theory**=13 hours**
07 credits for practicals**=14 hours**
Total required hours per week=27.0 hours, Extra hours =7.5 hours (we can arrange tutorial class, remedial class, library class and other co-curricular activities during these hours).

B.Sc. Semester-2							
Sr. no	**Broad Category of Course**	**Subject Name**	**Semester**	**Hours**		**Credits**	
				Theory	**Practical**	**Theory**	**Practical**
1	Major(Core)	Microbiology	Second	45	60	3	2
2	Minor	G1:Chemistry G2:Physics	Second	45	60	3	2
3	Multidisciplinary		Second	45	-	3	-
4	Ability Enhancement course		Second	30	-	2	-
5	Value added Courses		Second	30	-	2	-
6	Skill Enhancement Course		Second	-	90	-	3
Total				**195**	**210**	**13**	**07**

Available Total Credits= 20 Total required hours per semester=405
Total available hours per semester=517.5 hours
Available hours per week= 34.5 hours
Calculation of required hours per week
13 credits for theory**=13 hours**
07 credits for practicals**=14 hours**
Total required hours per week=27.0 hours, Extra hours =7.5 hours (we can arrange tutorial class, remedial class, library class and other co-curricular activities during these hours).

UG Certificate: Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate **if, in addition, they complete one vocational course or internship / Apprenticeship of 4 credits during the summer vacation of the first year**. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.

B.Sc. Semester-3							
Sr. No.	**Broad Category of Course**	**Subject Name**	**Semester**	**Hours**		**Credits**	
				Theory	**Practical**	**Theory**	**Practical**
1	Major (Core)	Microbiology	Third	45	90	3	3
2	Minor	G1:Chemistry G2:Physics	Third	45	90	3	3
3	Multidisciplinary		Third	45	-	3	-
4	Ability Enhancement course		Third	30	-	2	-
5	Skill Enhancement Course		Third	-	90	-	3
Total				**165**	**270**	**11**	**9**

Available Total Credits= 20 Total required hours per semester=435
Total available hours per semester=517.5 hours
Available hours per week= 34.5 hours
Calculation of required hours per week
11 credits for theory**=11 hours**
9 credits for practicals**=18 hours**
Total required hours per week= 29 hours
Extra hours =5.5 hours (we can arrange tutorial class, remedial class, library class and other co-curricular activities during these hours).

B.Sc. Semester-4							
Sr. No.	**Broad Category of Course**	**Subject Name**	**Semester**	**Hours**		**Credits**	
				Theory	**Practical**	**Theory**	**Practical**
1	Major (Core)	Microbiology	Fourth	45	-	3	-
2	Major (Core)	Microbiology	Fourth	45	-	3	-
3	Major (Core)	Microbiology	Fourth	-	60	-	2
4	Minor	G1:Chemistry G2:Physics	Fourth	45	-	3	-
5	Minor	G1:Chemistry G2:Physics	Fourth	45	-	3	-
6	Minor	G1:Chemistry G2:Physics	Fourth	-	60	-	2
7	Ability Enhancement course		Fourth	30	-	2	-
8	Value added Courses		Fourth	30	-	2	-
Total				**240**	**120**	**16**	**4**

Available Total Credits= 20 Total required hours per semester= 360
Total available hours per semester=517.5 hours
Available hours per week= 34.5 hours
Calculation of required hours per week
16 credits for theory**=16 hours**
4 credits for practicals**=8 hours**
Total required hours per week=24 hours
Extra hours =10.5 hours (we can arrange tutorial class, remedial class, library class and other co-curricular activities during these hours).

UG Diploma: Students who opt to exit after completion of the second year and have secured 80 credits will be awarded the UG diploma **if, in addition, they complete one vocational course or internship / Apprenticeship of 4 credits during the summer vacation of the second year.** These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

B.Sc. Semester-5							
Sr. no	**Broad Category of Course**	**Subject Name**	**Semester**	**Hours**		**Credits**	
				Theory	**Practical**	**Theory**	**Practical**
1	Major(Core)	Microbiology	Fifth	45	-	3	-
2	Major(Core)	Microbiology	Fifth	45	-	3	-
3	Major(Core)	Microbiology	Fifth	45	-	3	-
4	Major(Core)	Microbiology	Fifth	-	150	-	5
5	Major (DSE)	Microbiology	Fifth	30	-	2	-
6	Internship	Internship/ 20 days Workshop (Own Institute)	Fifth	-	120	-	4
Total				**165**	**270**	**11**	**09**

Available Total Credits= 20.0 Total required hours per semester=435
Total available hours per semester=517.5 hours
Available hours per week= 34.5 hours
Calculation of required hours per week
11 credits for theory=**11 hours**
9 credits for practicals=**18 hours**
Total required hours per week=29 hours
Extra hours =5.5 hours (we can arrange tutorial class, remedial class, library class and other co-curricular activities during these hours).

B.Sc. Semester-6							
Sr. no	**Broad Category of Course**	**Subject Name**	**Semester**	**Hours**		**Credits**	
				Theory	**Practical**	**Theory**	**Practical**
1	Major (Core)	Microbiology	Sixth	45	60	3	2
2	Major (Core)	Microbiology	Sixth	45	60	3	2
3	Major (Core)	Microbiology	Sixth	45	60	3	2
4	Major (Core)	Microbiology	Sixth	45	60	3	2
Total				**180**	**240**	**12**	**8**

Available Total Credits= 20.0 Total required hours per semester=420
Total available hours per semester=517.5 hours
Available hours per week= 34.5 hours
Calculation of required hours per week
12 credits for theory**=12 hours**
8 credits for practicals**=16 hours**
Total required hours per week=28 hours
Extra hours =6.5 hours (we can arrange tutorial class, remedial class, library class and other co-curricular activities during these hours).

PROGRAMME OUTCOMES (POs) FOR BACHELOR OF SCIENCE (B.Sc.)

Our program prepares graduates to achieve the following POs within three years of graduation.

POs	Integrated Justification
PO1: Discipline-Specific Knowledge	The program develops a strong foundation in scientific principles through interdisciplinary learning, enabling students to apply Natural Sciences and Mathematics to real-world problems. It builds core competencies that prepare graduates for higher education and professional careers.
PO2: Problem Analysis	Graduates develop critical thinking and analytical skills by integrating knowledge from Natural Sciences and Mathematics. They apply scientific methodologies and quantitative techniques to independently solve complex issues.
PO3: Experimental Skills	Students gain hands-on experience in designing, conducting, and analyzing experiments using modern scientific tools. This fosters accuracy, reproducibility, and practical application across various domains.
PO4: Environment and Sustainability	The curriculum promotes ecological awareness and sustainable practices. By linking Natural Sciences with global environmental issues, students develop a scientific approach to sustainability and social responsibility.
PO5: Ethics and Values	Graduates uphold Gandhian values, professional ethics, and integrity. The program fosters responsible application of scientific knowledge within ethical frameworks, encouraging social accountability.
PO6: Communication	Students acquire strong oral and written communication skills, enabling them to articulate scientific concepts, write technical reports, and engage in interdisciplinary dialogue effectively.
PO7: Modern Tool Usage	The program familiarizes students with advanced scientific instruments, IT tools, and analytical software. Graduates can ethically and effectively apply these tools across research and industry sectors.
PO8: Teamwork and Leadership	Graduates are prepared to contribute meaningfully to multidisciplinary teams, demonstrating leadership and collaboration in diverse scientific and professional environments.

PO9: Lifelong Learning	The program instills motivation for lifelong learning and adaptability. Students are equipped to independently explore and incorporate new knowledge and skills in a rapidly changing world.
PO10: Project Management	Graduates develop organizational and economic skills essential for managing scientific research projects and investigations. The curriculum emphasizes planning, execution, and evaluation of scientific work.
PO11: Innovation and Entrepreneurship	The program fosters creative thinking, problem-solving, and entrepreneurial mindset. Students are encouraged to develop innovative scientific solutions with societal impact.
PO12: Societal Contribution	Graduates understand the role of science in society and apply their knowledge for the public good. Emphasis is placed on rural development, informed public discourse, and Gandhian ideals of service and self-reliance.

PROGRAMME SPECIFIC OUTCOMES (PSOs) FOR BACHELOR OF SCIENCE (B.Sc.- Microbiology)

After successful completion of "Three Year Degree Program" in Microbiology, a student will be able to:

PSO Number	Programme Specific Outcomes (PSOs)	Justification
PSO1	Apply the knowledge of core concepts in microbiology including microbial physiology, genetics, immunology, molecular biology, and biotechnology to solve scientific problems and conduct research.	This PSO supports the development of **discipline-specific knowledge (PO1)** and **problem analysis (PO2)** while fostering an understanding of microbial roles in **environmental sustainability (PO4)**.
PSO2	Demonstrate proficiency in laboratory techniques such as microscopy, culturing, isolation, staining, biochemical testing, and aseptic handling of microorganisms.	This PSO is grounded in **experimental skills (PO3)**, enhances familiarity with **modern tools (PO7)**, and prepares students for basic **project management (PO10)** in scientific settings.
PSO3	Integrate microbiological knowledge with allied disciplines such as chemistry, biochemistry, molecular	This outcome aligns with **ethics and values (PO5),**

	biology, environmental science, and medicine to address complex biological problems and promote innovative applications in health, industry, and the environment.	**communication (PO6), teamwork (PO8), lifelong learning (PO9), and societal contribution (PO12)** by fostering responsible citizenship and public health awareness.

CO Attainment Matrix

Benchmark (Target attainment) is 60% for all courses of B.Sc. Program

Attainment Criteria	Level	Description
≥ 60% students scored ≥ Benchmark	Level 3	**High Attainment** – Most students achieved the expected outcome.
50–59% students scored ≥ Benchmark	Level 2	**Moderate Attainment** – Outcome partially achieved.
40–49% students scored ≥ Benchmark	Level 1	**Low Attainment** – Minimal outcome achieved.
< 40% students scored ≥ Benchmark	Level 0	**Not Attained** – Remedial action required

B.Sc. (Microbiology) Semester-1	BMIC-101 – Introduction to Microbial World	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to:

CO1: get an insight into the world of microorganisms.

CO2: State the historical developments and major milestones leading to the development of microbiology as a separate discipline of science.

CO3: acquire a broad perspective of the scope of microbiology

CO4: be familiar with techniques like microscopy and staining procedures used to study microorganisms

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	2	–	2	–	–	–	–	3	-	–	2	2.4	3	1	2	2.0
CO2	3	2	1	2	3	–	–	–	3	–	–	2	2.3	2	1	1	1.3
CO3	3	3	–	3	2	–	–	–	3	–	–	3	2.8	3	1	2	2.0
CO4	2	3	3	2	-	–	-	–	3	-	-	2	2.5	2	3	2	2.3
PO Avg	2.8	2.5	2.0	2.3	2.5	–	–	–	3.0	–	–	2.3		2.5	1.5	1.8	

(1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

UNIT 1	Microbial World	11 Hrs
1.1	Introduction: microbes in our lives	01
1.2	Distribution of microorganisms in nature	01
1.3	Introduction to taxonomy	02
	Binomial system of nomenclature	
	Carl Woese's three domain, kingdom, Whittaker's five kingdom concept of classification	
1.4	Major Groups of Microorganism	03
	Difference between prokaryotic and eukaryotic microorganisms	
	Prokaryotic microbes: Eubacteria and Archeobacteria	
	Eukaryotic microbes: fungi (yeasts and molds), protozoa, algae	

	Acellular microbes: viruses	
1.5	Introduction to methods of classifying Bacteria	04
	Taxonomic groups (Taxa)	
	The Goals of classification	
	A) Intuitive method	
	B) Numerical taxonomy	
	C) Genetic relatedness	
UNIT 2	**History of Microbiology**	**12 Hrs**
2.1	The discovery of microorganisms	05
	Microbiology and the origin of life	
	Contribution of A. V. Leeuwenhoek in the discovery of microscope	
	Spontaneous generation vs. Biogenesis	
2.2	Golden age of microbiology	07
	Germ theory of fermentation	
	Pure culture technique and Koch's Postulates	
	Contribution of Joseph Lister in Antisepsis	
	Contribution of Edward Jenner and Louis Pasteur in immunology	
	Birth of modern chemotherapy: contribution of Paul Ehrlich,Alexander Fleming and Selman A. Waksman	
UNIT 3	**Scope and Relevance of Microbiology**	**11Hrs**
3.1	Microbiology as a field of biology	02
3.2	Widening horizons	05
	Medical microbiology	
	Agricultural microbiology: Contributions of Sergei N.Winogradsky and Martinus W. Beijerinck and development of enrichment culture technique	
	Public health microbiology	
	Microbial ecology	
	Food and dairy microbiology	
	Industrial microbiology	
3.3	Microbiology and modern biology: molecular biology	02
3.4	Future of microbiology	02
Unit-4	**Microscopy and Specimen Preparation**	**11**
4.1	Light microscopy	04
	Principle of bright-field microscopy: resolving power, numerical aperture, limit of resolution and magnification	
	Component parts of the compound light microscope	
	Principle, working and applications of dark-field, fluorescence, and phase-contrast microscopy	
4.2	Preparation of specimens for light microscopy	04
	Wet-mount and hanging-drop techniques	
	Microbiological stains: acidic, basic, and neutral dyes	
	Smear preparation, fixation, use of mordents, intensifiers, decolorizers	
	Simple staining of the smear: positive and negative staining	
4.3	Electron microscopy: principle, working and applications of transmission and scanning electron microscopy	03

Assessment Method

Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1.Microbiology: An Introduction G. J. Tortora, B. R. Funke, C. L. Case, 13th Edition (Indian Edition)(2018). Pearson India Education Services Pvt. Ltd., Noida (UP), India

2.Microbiology Pelczar JR., Chan ECS, Krieg NR, 5th Edition (1993), McGraw-Hill Book Company,NY

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

4.Prescott L, Harley J P, and Klein D A, (2019), Microbiology, 11th edn. Wm C. Brown - McGrawHill, Dubuque, IA

B.Sc. (Microbiology) Semester-1	BMIC-101P Introduction to Microbial World	MAJOR

Credit - 2, Teaching Hours - 60

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1Analyze and apply proper sterilization, glassware preparation, aseptic techniques, and safety protocols (GLP)

CO2: Identify microorganisms through microscopic examination and staining techniques.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CO Avg**	**1**	**2**	**3**	**CO Avg**
CO1	3	3	3	2	3	–	3	2	2	–	–	2	2.6	2	2	2	2.0
CO2	3	3	3	2	2	–	3	2	2	–	–	2	2.5	2	3	2	2.3
PO / PSO Avg	3	3.0	3.0	2.0	2.5	–	3.0	2.0	2.0	–	–	2.0		2	2.5	2	

(1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1.Constructivism
2.Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Discussion
3. Experiments
4. Hands-on activities
5. Team work
6. Demonstration method

Practicals

1	Microbiology Good Laboratory Practices (GLP): rules and safety	02
2	Introduction to size, shape, labeling (if required) and uses of laboratory glasswares/plastic wares: test tube, pipette, conical flask, volumetric flask, petri dish,measuring cylinder, coplin jar, burette, beaker, glass spreader	05
3	Cleaning and preparation of glassware for sterilization	04
4	Disposal of laboratory waste and cultures	03
5	Study of principle, component parts and operation of the compound light microscope	03
6	Study of principles and working of laboratory instruments: autoclave, hot airoven, incubator, water bath, bacteriological filters, centrifuge, rotary shaker, pH meter, colorimeter	15

7	pH adjustment of solution by use of pH strip and pH meter	04
8	Study of hay infusion by hanging drop method	04
9	Simple staining of bacteria: positive, curd (simple staining) and negative staining	13
10	Study of permanent slides/photomicrographs of different groups of microorganisms A) Permanent slides of prokaryotic microbes (bacteria): Staphylococci, Bacilli, Spirochetes, Actinomycetes B) Permanent slides of eukaryotic microbes: • Fungi: Yeast, Mucor, Penicillium • Algae: Diatoms, Spirogyra, Chlamydomonas • Protozoa: Amoeba, Paramecium, Euglena C) Photomicrographs of acellular microbes (viruses): HIV, TMV, Bacteriophage T2	17

Assessment Method	
Internal/Online Assessment (40%)	Internal Practical Examination
External Assessment (60%)	Term End Practical examination

B.Sc. (Microbiology) Semester-2	BMIC-201 – Basic Bacteriology	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: examine and interpret the cellular organization and external structures of bacterial cell

CO2: explore and describe the cellular organization and internal structures of bacterial cell.

CO3: identify the nutritional needs of bacteria and evaluate various cultivation techniques of bacteria

CO4: apply methods to isolate and identify bacterial species from mixed cultures.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	3	2	2	2	2	2	1	2	1	1	2	2.4	3	2	2	2.0
CO2	3	2	2	2	2	2	2	1	2	1	1	2	2.3	3	2	2	1.3
CO3	3	3	3	2	2	2	3	1	2	2	2	2	2.8	3	3	2	2.0
CO4	3	3	3	2	2	2	3	2	2	2	2	2	2.5	3	3	2	2.3
PO Avg	3.0	3.0	2.5	2.0	2.0	2.0	2.5	1.3	2.0	1.5	1.5	2.0		3.0	2.5	2.0	

(1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1.Constructivism
2.Social Constructivism
3.Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

UNIT 1	Cellular Organization and External Structures of Bacterial cell	11 Hrs
1.1	Cellular organization: size, shape and arrangement of bacterial cells	2.5
1.2	External structures of bacterial cell	2.5
1.3	Structure and chemical composition of cell wall of Gram-positive and Gramnegative bacteria / Archaebacteria, Acid fast bacteria	2
1.4	Cell wall less bacteria, protoplast, spheroplast	1
1.5	Flagella of Gram-positive bacteria and Gram-negative bacteria , endo-flagella (axial filaments), bacterial motility	1
1.6	Capsules, slime layer, pili and fimbriae, sheaths, prosthecae and stalks	2

UNIT 2	Internal Structures of Bacterial cell	12 Hrs
2.1	Cytoplasmic membrane of Eubacteria and Archaebacteria	2
2.2	Structural differences between eubacteria and archaebacteria	2
2.3	Mesosomes	0.5
2.4	Cytoplasm and nuclear material (bacterialchromosome), bacterial plasmids	1.5
2.5	Ribosomes of Eubacteria and Archaebacteria	2
2.6	Inclusion bodies (cellular reserve food materials)	2
2.7	Bacterial spores and cyst: spore structure, types of spores, sporogenesis and germination of spore, bacterial cyst	2
UNIT 3	**Nutrition and Cultivation of Bacteria**	**11Hrs**
3.1	Nutritional and chemical requirements of bacteria: carbon, oxygen, nitrogen, sulfur, phosphorus, trace elements, vitamins, growth factors, water	2
3.2	Nutritional diversities in bacteria	2
	Based on source of energy: Phototrophs, Chemotrophs	
	Based on source of electro donor: Lithotrophs, Organotrophs	1.5
	Based on source of carbon: Autotrophs, Heterotrophs, Mixotrophs, Obligate parasites	1.5
3.3	Culture media: media ingredients, preparation of media, general cultivation media (N.broth and N.agar)	3
3.4	Cultivation of anaerobic bacteria	1
Unit-4	**Pure Culture Techniques**	**11 Hrs**
4.1	Pure culture, mixed culture, selective methods to obtain pure cultures: chemical, physical, and biological methods	2.5
4.2	Isolation methods of pure culture: aseptic technique , streak plate , spread plate and pour plate techniques	2.5
4.3	Cultural characteristics: colony characteristics , characteristics of broth cultures	2
4.4	Maintenance and preservation of pure cultures	2
4.5	Culture collection centers and their role	2

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1.Microbiology: An Introduction G. J. Tortora, B. R. Funke, C. L. Case, 13th Edition (Indian Edition)(2018). Pearson India Education Services Pvt. Ltd., Noida (UP), India

2.Microbiology Pelczar JR., Chan ECS, Krieg NR, 5th Edition (1993), McGraw-Hill Book Company,NY

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

4.Prescott L, Harley J P, and Klein D A, (2019), Microbiology, 11th edn. Wm C. Brown - McGrawHill, Dubuque, IA

B.Sc. (Microbiology) Semester-2	BMIC-201P Basic Bacteriology Practical	MAJOR

Credit - 2, Teaching Hours - 60

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Prepare, culture, and isolate bacterial strains using appropriate media and aseptic techniques

CO2: Demonstrate microbial identification and study structural/physiological traits through staining, pigment analysis, and environmental tolerance assays.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CO Avg**	**1**	**2**	**3**	**CO Avg**
CO1	3	3	3	2	3	2	3	2	2	3	2	2	2.5	3	3	2	2.6
CO2	3	3	3	2	2	2	3	2	2	2	2	2	2.3	3	3	2	2.6
PO / PSO Avg	3.0	3.0	3.0	2.0	2.5	2.0	3.0	2.0	2.0	2.5	2.0	2.0		3.0	3.0	2.0	

(1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1.Constructivism
2.Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Discussion
3. Experiments
4. Hands-on activities
5. Team work
6. Demonstration method

Experiments

1	Preparation of bacteriological media: Nutrient broth and Nutrient agar	5
2	Cultivation and isolation of bacteria	10
	a) Broth culture method	
	b) Agar plate methods: Streak plate method, Pour plate method, Spread plate method Method: Gram's stain of mixed bacterial culture, isolation of bacteria, colony (cultural) characteristics, morphological characteristics (Gram's stain)	
	c) Agar slant (slope) method for pure culture	
3	Cultivation of anaerobic bacteria by use of a. Robertson's cooked meat media b. Thioglycollate broth c. Anaerobic jar (Demonstration)	5

4	Preservation of microbial cultures a) Periodic sub culturing and storage at refrigeration temperature b) Preservation of bacteria in soil (nitrogen fixers)	3
5	Study of pigmented bacteria a. *Staphylococcus aureus* b. *Staphylococcus epidermidis* c. *Micrococcus luteus* d. *Serratia marscescens* e. *Pseudomonas aeruginosa*	5
6	Differential staining of bacteria: Gram stain method	7
7	Study of bacterial structure by structural staining a. Endospore by Dorner's method b. Cell wall by Dyar's method c. Capsule by Hiss's method d. Granule by Albert's method	16
8	Use of special staining technique to study bacteria a. Spirocheates by Fontana's method	4
9	Study of effect of various physical agents on growth of bacteria a. Effect of pH b. Effect of temperature c. Effect of osmotic pressure (NaCl and Sucrose) d. Oligodynamic action of heavy metals	5
	References	

Assessment Method	
Internal/Online Assessment (40%)	Internal Practical Examination
External Assessment (60%)	Term End Practical examination

B.Sc. (Microbiology) Semester-3	BMIC-301 – Microbial Physiology	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: examine the essential nutrients for bacterial growth and various parameters affecting bacterial growth

CO2: explore enzyme classification, and the impact of various factors on enzyme activity

CO3: analyze bacterial growth phases and the effects of antimicrobial agents on microbial populations

CO4: study the structure and function of key biomolecules and their involvement in metabolic processes

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	3	2	2	2	2	2	1	2	1	1	2	2.0	3	1	2	2.0
CO2	3	3	2	2	2	2	2	1	2	1	1	2	2.0	3	1	2	2.0
CO3	3	3	3	2	2	2	3	1	2	2	2	2	2.4	3	2	2	2.3
CO4	3	3	3	2	2	2	3	1	2	2	2	2	2.4	3	1	3	2.3
PO Avg	3.0	3.0	2.5	2.0	2.0	2.0	2.5	1.0	2.0	1.5	1.5	2.0		3.0	1.3	2.3	

(1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1.Constructivism
2.Social Constructivism
3.Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
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6. Projector
7. Power point Presentation

UNIT 1. Microbial Nutrition and Factors Affecting		11
1.1	Culture media: Types of culture media: Routine and specialized media; Selective media, differential media, enriched media, enrichment media, enumeration media, assay media and maintenance media	4
1.2	Modes of nutritional uptake	4
	Entry of nutrition in the cell, passive diffusion, facilitated diffusion and active transport,	

	Utilization of nutrients that cannot enter the cell	
1.3	Classification of bacteria on the basis of growth supporting environmental factors such as oxygen, temperature, pH, osmotic pressure, salt and hydro static pressure.	3
UNIT 2. Enzymes		**11**
2.1	General introduction	5
	Physical and chemical properties Structure of enzymes: Prosthetic group, apoenzyme, coenzymes, cofactors Localization of enzymes: Extra cellular and intra cellular Nomenclature and classification of enzymes, lUB system of enzyme classification	
2.2	Enzyme action	6
	Active sites of enzymes Mechanism of enzyme action Factors affecting enzyme activity Inhibition of enzyme activity: Competitive and non-competitive	
UNIT 3. Microbial growth		**12**
3.1	Methods of reproduction in bacteria and new cell formation	3
3.2	Growth	5
	Introduction to growth rate, generation time Criteria for growth measurement: Cell mass and cell number, methods of their measurement Normal growth curve of bacteria Continuous growth and synchronous growth	
3.3	Chemotherapeutic agents as growth inhibitors	4
	Principles of chemotherapy General mode of action of various chemotherapeutic agents: Sulfonamides, antibiotics (penicillin, streptomycin, Polymixin)	
UNIT 4. Biomolecules and metabolism		**11**
4.1	Biomolecules: Chemical structure, properties, classification and biological significance of carbohydrates, proteins, lipids and nucleic acids	6
4.2	Introduction to metabolism	5
	Anabolism, catabolism, primary and secondary metabolism Role of reducing power, precursor metabolites and energy rich compounds in cell Metabolism	

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Pelczar Jr, M J, Chan E C S., Krieg N R, (1986) Microbiology, 5th edn, McGraw-Hill Book Company, NY
2. Ingraham J L, and Ingraham, C L, (2000) Introduction to Microbiology, 2nd edn, Brooks/Cole, Singapore
3. Black J G, (2002) Microbiology: Principles and Explorations, 5th edn, John Wiley and Sons, Inc. NY

B.Sc. (Microbiology) Semester-3	BMIC-301P Microbial Physiology Practical	MAJOR

Credit - 3, Teaching Hours - 90

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Select, prepare, and utilize various microbiological media and perform qualitative biochemical and spectrophotometric analyses.

CO2: Assess microbial responses to antibiotics and nutrient substrates via antibiotic sensitivity assays and comprehensive biochemical reactions.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CO Avg**	**1**	**2**	**3**	**CO Avg**
CO1	3	3	3	2	3	2	3	2	2	2	2	2	2.5	3	3	2	2.6
CO2	3	3	3	2	2	2	3	2	2	2	2	2	2.4	3	3	2	2.6
PO / PSO Avg	3	3	3	2	2.5	2	3	2	2	2	2	2		3	3	2	2.6

(1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1.Constructivism
2.Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Discussion
3. Experiments
4. Hands-on activities
5. Team work
6. Demonstration method

Experiments

1	Study of different types of media and their ingredients. Selective media: Rose Bengal agar medium Differential media: Mac Conkey's medium, EMB agar medium, triple sugar iron agar medium Enrichment media: Selenite broth Enriched media: Blood agar medium, glucose yeast extract agar medium Natural media: Soil extract agar, potato dextrose agar medium	08
2	Qualitative analysis of biomolecules: Carbohydrates: Iodine test, Molisch's test, Benedict's test, Barfoed test, Bial's test and Saliwanoff s test	15

	Proteins: Biurate test, Ehrlich's test, glyoxilic acid test, xanthoproteic test.	

3	Determination of absorption maxima of a colored solution (use methylene blue 1:20,000 dilution)	15
4	Study of effect of antibiotics on bacteria Study of sensitivity spectrum of antibiotic against the test organism by use of paper disc method Determination of spectrum of activity of an antibiotic by use of agar ditch method	15
5	Study biochemical reaction of bacteria A. Based on carbon source i. Oxidative and fermentative breakdown of glucose ii. Fermentation of sugars and sugar alcohol: glucose, xylose, mannitol, lactose, maltose and sucrose iii. Glucose breakdown product: Methyl red test, Voges-Proskauer's test iv. Citrate utilization test v. Starch utilization test vi. Lipid utilization test B. Based on nitrogen source C. Other tests- Catalase test, Dehydrogenase test, Oxidase test	37

Assessment Method	
Internal/Online Assessment (40%)	Internal Practical Examination
External Assessment (60%)	Term End Practical examination

B.Sc. (Microbiology) Semester-4	BMIC-401 – Microbial diversity	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: explore the origins of microbial life examining the evolutionary processes that have led to the vast diversity of microorganisms on Earth

CO2: practical knowledge of different approaches to studying microbial diversity

CO3: investigate the diversity of prokaryotic life forms, focusing on the distinct characteristics and ecological roles of bacteria and archaea.

CO4: study the variety of eukaryotic microorganisms as well as acellular entities like viruses

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	3	2	3	2	2	2	1	2	1	1	2	2.1	3	1	3	2.0
CO2	3	3	3	3	2	2	3	1	2	2	2	2	2.4	2	2	2	2.0
CO3	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3	2	3	2.6
CO4	3	2	2	3	1	2	2	1	2	1	1	2	1.9	3	1	2	2.0
PO Avg	3	2.8	2.5	3.0	1.8	2.0	2.5	1.3	2.0	1.5	1.5	2.0		2.8	1.5	2.5	

(1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1.Constructivism
2.Social Constructivism
3.Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

UNIT 1	Introduction	
1.1	What is biodiversity?	4
1.2	Origin of life, evolution and origin of biodiversity,species concept	4
1.3	Evolutionary tree of microorganisms	
1.4	Value of biodiversity, microbial biodiversity as index of environmental	3

	change	
UNIT 2	**Unit 2. Methods ofAssessing Biodiversity**	**11**
2.1	Microscopic methods	5
2.2	Cultural methods	
2.3	Molecular and genomic methods: Molecular context of microbial diversity, importance of DNA and r RNA sequence comparison, determination of GC content	6
UNIT 3	**Unit 3. Biodiversity among Bacteria & Archaea**	12
3.1	Morphological and cellular diversity	04
	Diversity in major cell shape and grouping b. Diversity in ultra structure of cell with reference to cell envelope, cell membrane, cell wall, surface appendages, other cell organelles and spore	
3.2	Physiological and metabolic diversity- Diversity in photosynthetic, heterotrophic and autotrophic metabolism	04
3.3	Ecological diversity- Diversity in major ecosystems b. Diversity in aquatic, marine and extreme environment	04
Unit 4.	**Biodiversity among Eukaryotic and Acellular Microorganisms**	**11**
4.1	Eucarya: Morphological, cellular, physiological, metabolic and ecological characteristicsof- Protozoans, Slime molds, Fungi, Algae, Lichens as consortium of algae and fungi	6
4.2	Acellular organisms: Viruses and prions	5

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1.Cambell R., (1983), Microbial Ecology, 2nd edn. Blackwell Scientific Publications,London
2.Ogunseitan O., (2005) Microbial Diversity: Form and Function in Prokaryotes, Blackwell Publishing, Malden, MA, Oxford,Victoria
3.Atlas R M, Bartha R., (1998), Microbial Ecology: Fundamentals & Applications. 4th edn. Pearson Education.

B.Sc. (Microbiology) Semester-4	BMIC-402– Applied Microbiology	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: examine the role of soil microflora in nutrient cycling and their impact on soil health

CO2: analyze the microflora present in drinking water and evaluate wastewater management strategies.

CO3: investigate the microflora associated with foods, identify sources of contamination, assess factors affecting microbial growth, and explore spoilage mechanisms and preservation methods.

CO4: explore various fermented foods, evaluate food preservation techniques, assess foodborne diseases, and apply the principles of HACCP.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	3	2	3	2	2	2	1	2	1	1	2	2.0	3	2	3	2.6
CO2	3	3	3	3	2	2	3	1	2	2	2	2	2.4	3	2	3	2.6
CO3	3	3	3	2	2	2	3	1	2	2	2	2	2.3	3	2	3	2.6
CO4	3	3	3	2	2	3	3	2	2	2	2	2	2.4	3	2	3	2.6
PO Avg	3	3	2.8	2.5	2.0	2.3	2.8	1.3	2.0	1.8	1.8	2.0		3.0	2.0	3.0	

(1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1.Constructivism
2.Social Constructivism
3.Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

	Unit 1 Microbiology of Soil	**11**
1.1	Physico-chemical characteristics of soil, soil microflora: Diversity insoilmicroflora	02
1.2	Methods of studying soilmicroflora:	03

	(i)Direct microscopic method, agar plate technique, enrichment culture technique, and buried slide method (ii)Use of Winogradsky column in studying microbial diversity insoil	
1.3	Soil fertility: Role of microorganisms in soilfertility	02
1.4	Biogeochemical Cycles (i)Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin. (ii)Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. (iii)Phosphorus cycle: Phosphate immobilization and solubilisation	04
	Unit 2. Microbiology of DrinkingWater	**11**
2.1	Natural waters: Sources of contamination	01
2.2	Water-bornediseases	02
2.3	Purification of drinking water: Sedimentation, filtration and disinfection	03
2.4	Waste Management (i)Types of wastewater, chemical and microbiological characteristics of waste water (ii)Methods of waste water treatment- a) Primary treatment and secondary treatment: Principles and role of microorganisms in septic tank, Imhoff tank, trickling filters, activated sludge process, oxidation ponds b)Advanced treatment and final treatment c)Solid waste processing: Anaerobic sludge digestion and composting	05
	Unit 3. : FOOD AND DAIRY MICROBIOLOGY -I	**11**
3.1	Foods as a substrate for microorganisms- Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.	02
3.2	Microbial spoilage of various foods- Principles, Spoilage of vegetables, fruits, meat, eggs, milk and canned foods.	04
3.3	Principles and methods of food preservation a. Physical methods of food preservation: temperature (low, high), irradiation, and aseptic packaging. b. Chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics	05
	Unit 4 FOOD AND DAIRY MICROBIOLOGY -II	**12**
4.1	Fermented dairy products: a.Dairy starter cultures, b.fermented dairy products: yogurt, acidophilus milk, kefir, dahi and cheese, c.Introduction to Probiotics, Prebiotics and Synbiotics	04
4.2	Indian fermented food products: Pickles, sauerkrautandbread	02
4.3	Microbes as food: Mushrooms, spirulinaandyeasts	02
4.4	Food borne diseases (causative agents, foods involved, symptoms and preventive measures) (i)Food intoxications: *Staphylococcus aureus, Clostridium botulinum* (ii)Food infections: *Bacillus cereus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni.*	03
4.5	HACCP	01

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

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

Alexander M, (1977), Soil Microbiology, 2nd edn. Krieger Publ. Co., Melbourne, FL

Atlas R M., (1997), Principles of Microbiology. 2nd edn. Wm. C. Brown Pub., Iowa, USA

Frazier W C and Westhoff D C (1988), Food Microbiology, 4th edn. McGraw-Hill Book Company, NY.

Prescott L, Harley J P, and Klein D A, (2008), Microbiology, 7th edn. Wm C. Brown – McGraw Hill, Dubuque,IA.

B.Sc. (Microbiology) Semester-4	BMIC- 403P Microbial Biodiversity and Applied Microbiology Practical	MAJOR

Credit - 2, Teaching Hours -60

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Evaluate microbial diversity and adaptive capacities in extreme and natural environments through cultivation, morphological and biochemical characterization of diverse prokaryotic and eukaryotic microorganisms.

CO2: Perform comprehensive microbiological analyses of soil, water, food, and dairy products to assess microbial quality, identify pathogens, and understand microbial dynamics in various environments.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CO Avg**	**1**	**2**	**3**	**CO Avg**
CO1	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3	3	2	2.5
CO2	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3	3	3	3.0
PO / PSO Avg	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3.0	3.0	2.5	

(1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1.Constructivism
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3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
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Practicals

1	Study of ecological diversity amongst bacteria at extreme conditions: Cultivation of acidotolerant (pH-4), alkalitolerant (pH-8), halotolerant (NaCl 10%), thermotolerant (temp:50 °C) bacteria [Cultivation using nutrient broth (as basal medium) at different environmental variable(s), results to be observed in form of turbidity followed by Gram's staining. Use routine nutrient broth as control tube. Soil sample to be used for cultivation].	10
2	Study of microbial diversity in soil by using Winogradsky Column (Demonstration only)	01

3	Study of morphological and cultural diversity of *Escherichia coli, Enterobacter aerogenes, Staphylococcus aureus, Bacillus subtilis, Bacillus megaterium and Bacillus cereus.* Study of morphological diversity by performing Gram's staining, capsule staining and spore staining. Study of cultural / growth diversity using nutrient broth and nutrient agar media	10
4	Study of metabolic diversity amongst bacteria: *Escherichia coli, Enterobacter aerogenes, Proteus vulgaris, Staphylococcus aureus, and Bacillus subtilis* by performing various biochemicaltests: **Based on carbon metabolism** I. Methyl Red Test ii. Voges-Proskauer (V-P)test II. Fermentation of sugars and sugar alcohol: glucose, xylose, mannitol, lactose, maltose and sucrose III. Citrate utilization test IV. Starch utilization test V. Lipid utilization test **Based on nitrogen metabolism** I. Indole production test II. H_2S production test III. Urea utilization test IV. Casein hydrolysis test V. Gelatin hydrolysis test **Presence of respiratory enzymes** I. Catalasetest II. Dehydrogenase test III. Oxidase test	15
5	Study of diverse groups of eukaryotic microorganisms Fungi: Cultural and microscopic characters of Mucor, Rhizopus, Aspergillus, Penicillium andyeast Algae: Study of algae present in pond water; study of permanent slides of spirogyra anddiatoms Protozoa: Study of presence of protozoa in pond water; study of permanent slides of Amoeba, Euglena and Paramecium	04
6	Microbiological analysis of soil Enumeration of organisms from soil (standard plate count fromsoil) Isolation of symbiotic & non-symbiotic nitrogen fixing bacteria & actinomycetes from soil	10
7	Microbiological analysis of drinking water Standard plate count of drinking water Detection of fecal pollution of water by performing presumptive test, confirmed test and completed test	10
8	Determination of MPN of coliforms in water	02
9	Microbiological analysis of Food Standard plate count of Food sample Isolation of spoilage microorganisms from spoiled vegetables/fruits. Isolation of spoilage microorganisms from bread.	15
10	Microbiological analysis of milk a.Standard plate count of milk sample b.Determination of microbial load of milk by use of MBRT of raw milk, boiled	13

	milk and pasteurized milk. c.Preparation of Yogurt/Dahi. d.Detection of acid-fast organisms in milk sample	

Assessment Method	
Internal/Online Assessment (40%)	Internal Practical Examination
External Assessment (60%)	Term End Practical examination

B.Sc. (Microbiology) Semester-5	BMIC-501– Molecular Genetics of Prokaryotes	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: explain the structure and function of gene and DNA replication

CO2: illustrate the processes of gene expression and its regulation

CO3: assess the causes and consequences of genetic mutations and its effects and mechanisms to repair the damages in the DNA

CO4: compare and contrast the mechanisms of gene transfer mechanisms in bacteria.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	3	2	2	2	2	2	1	2	1	1	2	2.0	3	2	2	2.3
CO2	3	3	3	2	2	2	3	1	2	2	2	2	2.3	3	2	3	2.3
CO3	3	3	3	2	2	2	3	2	2	2	2	2	2.4	3	2	3	2.3
CO4	3	3	3	2	2	3	3	2	2	2	2	2	2.5	3	2	3	2.3
PO Avg	3	3	2.8	2	2	2.3	2.8	1.5	2.0	1.8	1.8	2.0		3.0	2.0	2.8	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technol
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

Unit Wise Detailed Syllabus

UNIT1.Fundamentals		11
1.1	Nature ofGenetic material Understanding of terms: Gene, allele, genotype, phenotype, intron, exon, cistron, recon, muton, plasmid, chromosome, genome, zygote, merozygote Experimental proof for DNA as genetic material: Work of Griffith;Avery, McCarty and MacLeod; Hershey and Chase	03

1.2	Gene structure and function Chemistry of DNA, Watson and Cricks model of DNAstructure Typical gene structure, functions ofgene	03
1.3	DNAreplication Semi conservative nature, Meselson and Stahl'sexperiment Molecular mechanism: Strand separation, formation of leading and lagging strand, formation of Okazaki fragments and their removal, proofreading Post-replicative modifications and their significance	05
	UNIT 2. Gene Expression and its Regulation	**11**
2.1	Transcription Initiation, role of enzyme, sigma factor, promoter,operator Elongation Termination: Rho dependent and Rho independent	03
2.2	Genetic code: Triplet nature, polarity, degeneracy, near universality and Wobble Phenomenon	02
2.3	Translation Initiation, 70 S initiation complex, Elongation: recognition, peptidyl transfer, translocation Termination Fate of ribosomes, polysome system, polycistronic RNA	03
2.4	Regulation of gene expression Negative inducible control - lacoperon Negative repressible control - trp operon Positive regulation - lacoperon	03
	UNIT 3. DNA Damages and their Repair	**12**
3.1	Introduction Spontaneous and induced mutations, proof for spontaneity of mutation by replica plate method Effect at DNA level, transition, transversion, insertion, deletion,development of A-PSites	03
3.2	Molecular basis of mutation Chemical mutagenesis: 5-bromouracil, nitrous acid and acridineorange Physical mutagenesis: Ultravioletradiations Biological Mutagenesis: Phage Mu,	03
3.3	Consequencesof mutation- Forward - silent, missense, nonsense, frameshift Reverse – true reversion, suppressions (intragenic and extrageniconly) Classes of bacteria mutants; Nutritional, resistant, morphological and conditional mutants	03
3.4	Repair mechanisms Direct repair: Photoreactivation, removal of A-Psites Indirect repair: Excision repair, mismatch repair SOS regulatory system	03
	UNIT 4. Gene Transfer among Bacteria	**11**
4.1	Fundamentals: Horizontal and vertical gene transfer, merozygotic system	01
4.2	Transformation: Competence, DNA uptake in Gram positive and Gram negative bacteria,transfection	03
4.3	Transduction: Generalized andrestrictedtransduction	02

4.4	Conjugation: Role of sex factor, transfer of genes during F + x F-, Hfr x F-and sexduction	02
4.5	Bacterial plasmids andtransposableelements- General properties, compatibility groups, maintenance of plasmids Types of plasmids Transposable elements: their nature, insertion sequences (IS) and Tn elements	03

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Prescott L, Harley J P, and Klein D A, (2008). Microbiology, 7th edn. WmC. Brown - McGraw Hill, Dubuque,IA.
2. Atlas R M, (1997), Principles of Microbiology. 2nd edn. Wm. C.Brown Pub., Iowa.
3. Benjamin Lewin (2004), Gene VIII, Pearson Prentice Hall, Pearson Education, Inc. Upper Saddle, NT 07458.
4. Snyder L and Champness W (2007) Molecular Genetics of Bacteria, 3rd edition, ASM Press Washington DC, USA.
5. Stanier RY, Ingraham JL, Wheelis ML and Painter PR (2005) General Microbiology 5th edition, McMillan.
6. Tortora GJ, Funke BR and Case CL (2008) Microbiology: An Introduction. 9th edition, Pearson Education.
7. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2004) Molecular Biology of Gene 5th edition, Pearson Publication.
8. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication 2. Becker WM, Kleinsmith LJ.
9. Willey JM, Sherwood LM and Woolverton CJ (2008) Prescott, Harley andKlein's Microbiology, 7th edition, McGraw Hill Higher Education.
10. Snyder L and Champness W (2007) Molecular Genetics of Bacteria, 3rd edition, ASM Press Washington DC, USA.

B.Sc. (Microbiology) Semester-5	BMIC-502 Bacterial Metabolism	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1 describe the structure, function, and regulation of enzymes, and analyze the factors affecting enzyme activity

CO2: explain the pathways of catabolism and anabolism of carbohydrates, lipids, and proteins, and evaluate their metabolic interconnections.

CO3: differentiate between chemoautotrophic and phototrophic modes of metabolism

CO4: illustrate the biosynthetic pathways for major cellular components such as amino acids, nucleotides, and lipids

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	3	2	2	2	2	2	1	2	1	1	2	2.0	3	2	3	2.6
CO2	3	3	3	2	2	2	3	1	2	2	2	2	2.3	3	2	3	2.6
CO3	3	2	2	2	1	2	2	1	2	1	1	2	1.8	3	2	3	2.6
CO4	3	3	3	2	2	2	3	1	2	2	2	2	2.3	3	2	3	2.6
PO Avg	3	2.75	2.5	2.0	1.75	2.0	2.5	1.0	2.0	1.5	1.5	2.0		3.0	2.0	3.0	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

Unit Wise Detailed Syllabus

	Unit 1. Enzymes and Energy	**11**
1.1	Enzyme kinetics Michaelis-Menten equation, Lineweaver-Burk plot & its significance	03

1.2	Metabolic regulation Significance of metabolic regulation Types of regulatory mechanisms: Feedback inhibition, energy linked control, precursor activation, zymogen activation, covalent modification and allosterism	03
1.3	Energy: its generation & conservation Laws of thermodynamics, free energy change, redox potential, exothermic and endothermic reactions Energy rich compounds and theirrole Modes of ATP generation- Substrate level phosphorylation Role of electron transport chain: Components of electron transport chain in bacteria Generation of proton motive force and its conversion in to ATP by role of ATP phosphohydrolase, chemiosmosis, inhibitors and uncouplers Anaerobic respiration and fermentation.	05
	UNIT 2.Chemoheterotrophic Metabolism	**11**
2.1	Utilizable substrates	02
2.2	Catabolism of glucose Pathways of glucose degradation: EMP, ED & PP pathway Fate of pyruvate under aerobic as well as anaerobic conditions	03
2.3	Tricarboxylic acid (TCA)cycle Catabolic role of TCA cycle Anabolic role of TCA cycle: Glyoxalate by pass and its significance	03
2.4	Catabolism of fatty acids and proteins β-oxidation of fatty acids Catabolism of amino acids: Deamination, decarboxylation, transamination, stickl and reaction	03
	UNIT 3. Chemoautotrophic andPhototrophicmetabolism	**11**
3.1	Physiological groups of chemolithotrophs	02
3.2	Generation of ATP & reducing power in chemoautotrophs (forward and reverse etc)	03
3.3	Phototrophic metabolism Physiological groups of phototrophs Photosynthetic apparatus in photosynthetic eubacteria, cyclic and noncyclic photophosphorylation Photophosphorylation in halobacteria Pathways for CO_2 fixation- Calvin cycle, Reductive TCAcycle	06
	UNIT4.Biosynthesis	**12**
4.1	Principles governing biosynthesis Role of precursor metabolites, ATP, reducing power and their role Anaplerotic reactions and their role in biosynthesis	02
4.2	Assimilation of ammonia, nitrate, molecular nitrogen and sulfate	02
4.3	Biosynthesis of saturated and unsaturated fatty acids	02
4.4	Polymerization of- Amino acids into polypeptides Nucleotides into polynucleotide Fatty acids into lipids Biosynthesis of peptidoglycan	04
4.5	Methods of study in biosynthesis- Use of biochemical mutants, isotopes, pulse labeling	02

	and metabolic inhibitors	

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Stanier RY, Adelberg EA and Ingrahm JL,(1991), General Microbiology,5th edn. Mac Millan Press Inc
2. Prescott L, Harley J P, and Klein D A, (2008), Microbiology, 7th edn. WmC. Brown – McGraw Hill, Dubuque,IA

B.Sc. (Microbiology) Semester-5	BMIC-503 Immunology	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1describe the components and functions of the immune system.

CO2: explain the structure and types of antigens and antibodies, and analyze antigen-antibody interactions

CO3: identify and classify major immune disorders, and discuss their immunological basis.

CO4: explain the principles of blood grouping, blood banking, and vaccination, and evaluate their clinical significance.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	2	2	2	-	2	-	-	-	-	-	-	**2.2**	3	1	2	2.0
CO2	3	3	2	-	-	2	2	-	-	-	-	-	2.4	3	2	3	2.6
CO3	3	3	2	2	2	2	-	-	-	-	-	2	**2.3**	3	1	3	2.3
CO4	3	3	3	2	2	2	3	-	-	-	-	3	**2.25**	3	2	3	2.6
PO Avg	3	3	2.3	2.0	2.0	2.0	2.5	-	-	-	-	2.5		3.0	1.5	2.8	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

Unit Wise Detailed Syllabus

	UNIT 1. Immunity and Immune response	**11**
1.1	Immunity- Concept of innate (native) and acquired (adaptive) immunity	02

	Types of immunity Innate immunity: species, racial and individual Acquired immunity: active and passive; natural andartificial Concept of herd immunity	
1.2	Immuneresponse (IR) Concept and basic functions of IR, two arms (branches) of IR:Antibody mediated (humoral) and cell mediated immune(CMI). Characteristics of IR: Discrimination, diversity, specificity, memory and transferability Primary and secondary IR	03
1.3	Cells and organs of immune system Lymphocytes as main actors; Types of lymphocytes, B-cells, T-cells and Null cells Importance of antigen presenting cells in IR An introduction to the primary (central) and secondary (peripheral) lymphoid organs	03
1.4	Introduction to the advanced concept of immunology MHC and HLA Clonal selection Monoclonal antibodies	03
	UNIT 2. Antigens, Antibodies and their Reaction	**11**
2.1	Antigens- Concept of antigen, immunogen andhapten Physico-chemical and biological properties ofantigens Various types ofantigens Antigens occurring in bacterialcell	02
2.2	Antibodies- Concept of antibody, immunoglobulin and myelomaproteins Basic structure ofantibodies Classes of immunoglobulins: Physicochemical and biological properties Antibody diversity	04
2.3	Antigen-antibody reactions (serological reactions) & other immunologicaltests-	05
	Mechanism of antigen-antibody reactions (zone phenomenon); Concept of lattice formation	
	Principles and applications antigen-antibody reactions- i. Precipitin reaction ii. Agglutination reaction iii. Complement fixation reaction iv.Immunofluorescence v. Enzyme Linked Immunosorbant Assay(ELISA) vi. Radio Immunoassay (RIA); Radio-Allergo-Sorbent test (RAST) vii. Western blottechnique	
	Various skin tests	
	Measurement of cell mediated immune response (CMI)	
	UNIT 3.ImmuneDisorders	**11**
3.1	Concept of hyper and hypo functioning of immune system	04
3.2	Types immune disorders- Hypersensitivity Autoimmunity and auto immune disorders Immuno deficiency Tumor immunity Transplantation immunity, concept of immune suppression	07

	UNIT 4. Immuno haematology and Immuno prophylaxis	12
4.1	Immuno haematology- Concept of immune haematology: Various blood group antigens and the blood groups Importance of blood groups in blood transfusion, inheritance & anthropology A brief introduction to the concept of blood banking An outline of blood constituents	06
4.2	Immuno prophylaxis- Concept of immune prophylaxis Types of vaccines Schedule of vaccination Hazards of vaccination	06

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Atlas R M, (1997), Principles of Microbiology. 2nd edn, Wm. C. BrownPub., Iowa,USA.
2. Prescott L, Harley J P, and Klein D A, (2008), Microbiology, 7th edn. WmC. Brown - McGraw Hill, Dubuque,IA.
3. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. 7th Edition. University Press Publication. (2005).
4. Roitt I. Essential Immunology. 10th Ed. Blackwell Science.
5. Kuby. Immunology. 4th edition. W. H. Freeman & company

B.Sc. (Microbiology) Semester-5	BMIC-504P Molecular Genetics of Prokaryotes Bacterial Metabolism and Immunology Practical	MAJOR

Credit - 02, Teaching Hours - 150

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: apply directed mutagenesis and selection techniques to generate and isolate specific bacterial mutants and interpret their genetic and phenotypic alterations to deepen understanding of mutation mechanisms, microbial genetics, and selection principles.

CO2: quantitatively analyze biomolecules—specifically glucose,proteins and streptomycin demonstrating proficiency in spectrophotometric techniques, standard curve construction, assay validation, and critical interpretation of biochemical data.

CO3: perform and interpret serological and immunological assays demonstrating competence in antigen–antibody interactions, titer determination, and accurate blood group identification within clinical microbiology**.**

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CO Avg**	**1**	**2**	**3**	**CO Avg**
CO1	3	3	3	2	-	2	2	2	2	2	2	2	2.3	3	3	2	2.6
CO2	3	3	3	-	-	2	3	2	2	2	2	-	2.4	3	3	2	2.6
CO3	3	3	3	-	-	2	3	2	2	2	-	2	2.4	3	3	3	3.0
PO / PSO Avg	3.0	3.0	3.0	2.0	-	2.0	2.6	2.0	2.0	2.0	2.0	2.0		3.0	3.0	2.3	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Discussion
3. Experiments
4. Hands-on activities
5. Team work
6. Demonstration method

Practical Syllabus		
Practicals		**Number of Teaching Hours(60)**
1	Isolation of lac$^-$ mutants of Escherichia coli using UV radiations as mutagen	
2	Isolation of pigmentless mutant of *Serratia marcescens* using UV radiations as mutagen	
3	Isolation of streptomycin resistant mutants of *Escherichia coli* by gradient plate method	
4	Isolation of DNA	
5	Estimation of glucose by Cole's method	
6	Estimation of glucose by Nelson-Somogy's method	
7	Estimation of protein by Folin-Lowry's method	
8	Estimation of streptomycin by sodium nitroprusside method	
9	Study of agglutination reaction: Widal test by slide agglutination and double dilution method	
10	Demonstration of agar gel immune diffusion precipitation reaction	
11	Determination of human blood group: ABO and Rh systems	

Assessment Method	
Internal/Online Assessment (40%)	Internal Practical Examination
External Assessment (60%)	Term End Practical examination

B.Sc. (Microbiology) Semester-5	BDSE-501 Bio-Safety	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1 explain the principles and components of biosafety programs in clinical and research laboratories

CO2: describe biosafety levels (BSL-1 to BSL-4) and apply appropriate safety measures for handling infectious agents.

CO3: discuss the roles and responsibilities of laboratory personnel and management in implementing biosafety protocols.

CO4: evaluate safe and effective methods for segregation, handling, and disposal of biomedical and laboratory waste.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	2	–	–	1	2	3	–	–	–	–	–	2.2	3	2	3	2.6
CO2	3	2	–	–	–	2	3	1	–	–	–	–	2.2	3	2	3	2.6
CO3	3	2	–	–	–	2	2	–	–	–	–	1	2.0	3	2	3	2.6
CO4	3	3	–	1	–	2	3	–	–	–	2	–	2.3	3	2	3	2.6
PO Avg	3	3	0	1	1	2	2.75	1	0	0	2	1		3.0	2.0	3.0	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

Unit Wise Detailed Syllabus		
	UNIT 1 Introduction to Bio-safety in Clinical Laboratory	**07**
1.1	Implementation of Laboratory Health and Safety Program	01
1.2	Safe Laboratory Premises and Personal Safety Measures	01
1.3	Importance of CDC and NIH	01
1.4	Universal Precautions for Laboratories by CDC	01
1.5	Importance of CDC and NIH Special	01
1.6	Precautions Against HBV and HIV	02
	Unit 2 Safe Methods For Managing Infectious Agents in Laboratory Environment	**08**
2.1	Safety Precaution against Infection	02
2.2	Containment	01
2.3	Bio-safety Levels	02
2.4	Bio-safety Levels of Infectious Agents Recommended by CDC	01
2.5	Biological Safety Cabinets	02
	UNIT 3 Bio-Safety Program	**07**
3.1	Responsibility for Safety	03
3.2	Responsibility of the Management	03
3.3	Responsibility of the Employee	01
	UNIT 4 Disposal of Medical Waste	**08**
4.1	Types of Bio-medical Waste	01
4.2	Major and Minor Sources of Bio-medical Waste	01
4.3	Hazards of Bio-medical Waste	02
4.4	Need for Disposal of Bio-medical Waste	02
4.5	Treatment and Disposal of Bio-medical Waste	02

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Ochei & Kolhatkar, (2000), *Medical Laboratory Science- Theory and Practice*, Tata McGraw-Hill Publishing Company Ltd., ISBN: 9780074632239
2. Monica Cheesbrough (2006), *District Laboratory Practice in Tropical Countries Part 1& 2*. 2nd Ed., Cambridge University Press, ISBN No. 9780521665469
3. Anantpreet Singh & Sukhjit Kaur (2012), *Biomedical Waste Disposal, JayPeePublication*, 1st Ed., ISBN No. 9789350255544.
4. WHO, (2004), *Laboratory safety Manual*, 3rd Ed., World Health Organization, ISBN 9789241544504

B.Sc. (Microbiology) Semester-5	BDSE-502 Blood Banking	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: describe the composition and physiological functions of blood and its components.

CO2: Explain blood grouping systems and evaluate methods used for blood typing and cross-matching.

CO3: Illustrate techniques for separation and preservation of blood components and their clinical applications.

CO4: Understand quality control measures in blood banks, and analyze haemagglutination and transfusion reactions

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO 1	3	2	2	-	-	2	2	-	-	-	-	2	2.1	3	2	2	2.3
CO 2	3	3	2	-	-	2	2	-	-	-	-	2	2.3	3	3	3	3.0
CO 3	3	2	3	2	-	2	2	2	2	2	2	2	2.2	3	3	3	3.0
CO 4	3	3	3	2	2	3	3	2	2	2	2	3	2.5	3	2	3	2.6
PO Avg	3.0	2.5	2.5	2.0	2.0	2.25	2.25	2.0	2.0	2.0	2.0	2.25		3.0	2.5	2.8	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

Unit Wise Detailed Syllabus

	Unit 1 Blood Cells	08
1	i. Blood cells – general characters of RBC, WBC and platelets;	

	production and maturation; haemoglobin ii. Haemostatis – role of blood vessels, role of platelets iii. Blood coagulation – factors, intrinsic and extrinsic pathway	
	Unit 2 Blood Groups	**07**
1	i. Human blood group systems, principles of immuno hematology ii. Blood collection – preparation for blood collection, criteria for the selection of donor, registration of donor and blood collection procedure	
	Unit 3 Preservation of Blood	**07**
1	Transport and storage of blood – organization in storage, changes in stored blood, preparation and use of blood components	
	Unit 4 Hematological tests	**08**
1	i. Significance of quality control in blood bank, specimen collection for blood bank, laboratory preparations in blood bank ii. Hemagglutination reactions – ABO grouping (slide and tube test), Rh blood typing (slide and tube test), Antihuman globulin (AHG) or Coombs test, compatibility testing (cross matching) – major and minor, emergency cross matching, Transfusion reactions and hemolytic disease of the new born	

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Introduction to Medical Laboratory Technology, (7^{th} Ed.) – F. J. Baker, R. E. Silverton,C. J. Pallister
2. Medical Laboratory Technology (Vol. I) – K .L.Mukherjee
3. Medical laboratory Technology –Godkar

B.Sc. (Microbiology) Semester-6	BMIC-601 Genetic Engineering and Biotechnology	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: explain the roles and mechanisms of DNA-modifying enzymes and vectors used in molecular biology

CO2: Execute protocols for extracting target DNA (genomic or cDNA), assembling them into suitable vectors and assessing their expression

CO3: perform in vitro techniques for culturing plant and animal cells.Use modern analytical methods to analyze biomolecules and gene expression

CO4: Analyze and evaluate real-world biotech applications in various field

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	2	2	-	2	-	-	-	2	-	-	2	2.1	3	2	3	2.6
CO2	3	3	2	-	-	2	3	-	2	-	-	2	2.4	3	3	3	3.0
CO3	3	3	3	-	-	2	3	-	2	-	-	2	2.5	3	3	3	3.0
CO4	3	3	-	2	2	3	2	-	3	-	-	3	2.6	3	2	3	2.6
PO Avg	3.0	2.8	2.3	2.0	2.0	2.3	2.6	-	2.3	-	-	2.3		3.0	2.5	3.0	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

4. Constructivism
5. Social Constructivism
6. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

Unit Wise Detailed Syllabus		
	Unit-1 Fundamentals of Genetic Engineering	**11**
1.1	Introduction	1
1.2	Tools Enzymes: Restriction endonuclease, reverse transcriptase, terminal transferase, alkaline phosphatase,ligases. Vectors: Definition, criteria for selection of DNA vectors, Types of vectors: plasmid vector (pBR 322), phage vector (λ), cosmid, shuttle vector-YEP & Ti plasmid Genetic probes Oligonucleotides	6
1.3	Site directed mutagenesis	2
1.4	Polymerase chain reaction	2
	UNIT 2. Construction of rDNA and its Transfer to Host Cell	**11**
2.1	Obtaining desired DNA fragment- Isolation from host, cDNA preparation and DNA synthesis.	2
2.2	Protocol for joining isolated DNA with vector.	1
2.3	Transfer of rDNA in to suitable host cell- transfection, gene gun, microinjection, protoplast fusion and electroporation.	4
2.4	Selection of recombinant population: Use of marker genes and X- gal dye, colony hybridization, Gene probe: Southern blot & Western blot technique	4
	UNIT 3. Biotechnology and Techniques Employed	**11**
3.1	Introduction to biotechnology	1
3.2	Tissue culture: Plant and animal tissue culture	3
3.3	Analytical methods: Chromatography, electrophoresis, spectroscopy, molecular hybridization, DNA microarrays, ELISA, RIA, RAST	7
	UNIT 4. Areas of Application of Biotechnology	**12**
4.1	Agricultural biotechnology: Biofertilizers, bioinsecticides, genetically modified/transgenic plants	3
4.2	Enzyme biotechnology: Analytical, industrial and therapeutic applications	2
4.3	Environmental biotechnology: Bioremediation, biofuels and bioleaching, MEOR	3
4.4	Intellectual property rights and biotechnology	2
4.5	Ethical issues of biotechnology	1
4.6	Recent development in tools and techniques- CRISPR, gene editing	1

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Trevan M D, Boffey S, Goulding K H and Standury S, (eds), (1987). Biotechnology:The Biological Principles,Tata McGraw-Hill, New Delhi. India
2. Prescott L, Harley J P and Klein D A, (2008), Microbiology, 7th edn. Wm C. Brown -McGraw Hill, Dubuque,IA
3. Atlas R M, (1997), Principles of Microbiology. 2nd edn., Wm. C. Brown Pub, Iowa,USA.

B.Sc. (Microbiology) Semester-6	BMIC-601P Genetic Engineering and Biotechnology Practical	MAJOR

Credit - 02, Teaching Hours - 60

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Demonstrate proficiency in fundamental biochemical and molecular biology techniques

CO2: explore Develop analytical skills to interpret biomolecular data and processes

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CO Avg**	**1**	**2**	**3**	**CO Avg**
CO1	3	3	3	-	-	-	3	-	2	-	-	1	**2.5**	3	3	2	2.6
CO2	3	3	2	-	-	-	2	-	2	-	-	1	**2.2**	3	3	2	2.6
PO / PSO Avg	3.0	3.0	2.5	-	-	-	2.5	-	2.0	-	-	1.0		3.0	3.0	2.0	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Discussion
3. Experiments
4. Hands-on activities
5. Team work
6. Demonstration method

Practical Syllabus

	Practicals	**Number of Teaching Hours**
1	Separation of amino acids by paper chromatography	**60**
2	Separation of amino acids by thin layer chromatography	
3	Demonstration of separation of components of India ink by paper electrophoresis	
4	Immobilization of cells by calcium-alginate entrapment method and demonstration of activity by methylene blue reduction test	
5	Isolation of DNA from *Escherichia coli*	

6	Estimation of DNA by Diphenylamine method	
7	Demonstration of Conjugation in *E.coli*	
8	Demonstration of transformation	

Assessment Method	
Internal/Online Assessment (40%)	Internal Practical Examination
External Assessment (60%)	Term End Practical examination

B.Sc. (Microbiology) Semester-6	BMIC-602 Virology and Mycology	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Describe and compare the structural organization of viruses and subviral agents—including viroids, virusoids, and prions—and explain the mechanisms by which latent and oncogenic viruses replicate. Demonstrate proficiency in virus cultivation techniques using laboratory methods.

CO2: Explain in detail the stages of both the lytic and lysogenic cycles of bacteriophages.

CO3:Characterize the taxonomy, and ecological importance of fungi; demonstrate cultivation protocols.

CO4: Differentiate asexual, sexual, and parasexual reproduction in fungi and classify major fungal groups based on morphological, physiological, and genetic characteristics.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	3	2	-	-	2	3	-	2	-	-	2	2.4	3	2	3	2.6
CO2	3	3	-	-	-	2	2	-	2	-	2	1	2.1	3	2	2	2.3
CO3	3	2	2	2	-	2	2	-	2	-	2	2	2.1	3	2	3	2.6
CO4	3	2	-	2	-	2	-	-	2	-	2	2	2.1	3	2	3	2.6
PO Avg	3.0	2.5	2.0	2.0	-	2.0	2.3	-	2.0	-	2.0	1.8		3.0	2.0	2.8	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

Unit Wise Detailed Syllabus

	Units	Number of

		Teaching Hours
	Unit-1 Viruses	**11**
1.1	General characteristics and structural organization of virus	1
1.2	Cultivation of viruses: 1. Animal cultivation 2. Cultivation in embryonated eggs. 3.In vitro culture: Cell Lines, primary and secondary cell lines, continuous cell lines, cytophathic effects 4.Cultivation of bacteriophage	4
1.3	Enumeration (assay) of viruses: Methods of enumeration of virus	1
1.4	Classification of viruses: PCNV, ICNV and Cryptogram system of viral classification	2
1.5	Sub-viral entities: Viroids, virusoids, prions, introduction to persistent, latent and slow viruses, oncogenic viruses	3
	Unit 2. Bacterial / Plant / Animal Viruses	**11**
2.1	Bacteriophage lytic cycle (T4 Phage) 1.One step growth curve experiment, burst size 2.Phage adsorption and penetration, intracellular development, early and late events,replication of phage chromosome, phage morphogenesis and release 3.Host induced modific Host induced modifications 4.Introduction to single stranded DNA and RNA phages ØX174 and MS2	3
2.2	Bacteriophage lysogenic cycle (lambda phage): Mechanism of establishment of lysogeny, induction of lysogeny, phage-conversion, replication of lambda phage	3
2.3	Plant Viruses: Introduction and replication of plant viruses (TMV)	2
	Unit-3 Fungi: General	**11**
3.1	General characters: Somatic structure, ultra-structure of fungal cell, hyphal modification	3
3.2	Cultivation of fungi 1. Principles of fungal nutrition. 2. Cultivation media and methods, slide culture technique, prevention of bacterial contamination. 3.Preservation of fungi	3
3.3	Importance of fungi 1. Primary and secondary metabolites of fungi and its importance 2. Diseases caused by fungi in plant	5
	Unit-4 Fungi: Reproduction and Classification	**12**
4.1	Reproduction in fungi: Asexual and sexual methods of reproduction, parasexuality among fungi, fruiting bodies in fungi	3
4.2	Fungal classification: Criteria used for classification, recent classification system	2
4.3	Brief outline of different classes of fungi: (Structure, habitat, reproduction/life cycle and economic importance in general) 1. Phycomycetes (Phycomycotina) 2. Ascomycetes (Ascomycotina)	7

	3. Basidiomycetes (Basiomycotina) 4. Deutromycetes (Duteromycotina) 5. Slime molds	

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Alexopoulos C J, Mims C W, Blackwell M, (1996), Introductory Mycology, 4th ed., Blackwell Publishing
2. Sharma O P, (1989), Textbook of Fungi, Tata McGraw-Hill Publishing Co. Ltd
3. Dube H C, (1990), An Introduction to Fungi, 2nd edn, Vikas Publishing House Pvt Ltd 4. Biswas S B, Biswas A, An Introduction to Viruses, 3rd ed., (1984), Vani Educational Books, New Delhi
4. Atlas R M, (1997), Principles of Microbiology. 2nd edn., Wm. C. Brown Pub., Iowa, USA.
6. Prescott L, Harley J P, and Klein D A, (2008), Microbiology, 7th edn. Wm C. Brown- McGraw Hill, Dubuque, I

B.Sc. (Microbiology) Semester-6	BMIC-602P Virology and Mycology Practical	MAJOR

Credit - 02, Teaching Hours - 60

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: isolate, culture, and microscopically characterize a diverse range of microorganisms—including bacteriophages from sewage, yeasts, and fungal genera

CO2: analyze growth, morphology, and disease symptoms responsible for diseases to assess microbial and plant health

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CO Avg**	**1**	**2**	**3**	**CO Avg**
CO1	3	3	3	2	-	2	3	-	2	-	-	1	**2.4**	3	3	2	2.6
CO2	3	3	2	2	-	3	2	-	2	-	-	2	**2.4**	3	3	3	3.0
PO / PSO Avg	3.0	3.0	2.5	2.0	-	2.5	2.5	-	2.0	-	-	1.5		3.0	3.0	2.5	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Discussion
3. Experiments
4. Hands-on activities
5. Team work
6. Demonstration method

Practical Syllabus

	Practicals	Number of Teaching Hours(60)
1	Isolation of bacteriophage from sewage	60
2	Isolation and cultivation of yeasts	
3	Cultivation of and microscopic examination of molds by slide culturetechnique	
4	Cultivation and microscopic examination of molds—N*eurospora, Fusarium, Alternaria, Curvularia and Helminthosporium*	
5	Study of plant diseases caused by Virus and Fungi—Mosaic, redrot, rust, smut, wilt, leaf curl, powdery mildew, downy mildew	

Assessment Method

Internal/Online Assessment (40%)	Internal Practical Examination
External Assessment (60%)	Term End Practical examination

B.Sc. (Microbiology) Semester-6	BMIC-603 Medical Microbiology	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Explain microbial pathogenesis, including host–pathogen interactions**.**

CO2: Describe the normal human microbiota, its development, protective roles, and participation in the epidemiology and transmission dynamics of infectious diseases.

CO3: Characterize various microbial diseases of humans.

CO4: Demonstrate competency in clinical microbiology laboratory techniques

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	3	2	-	-	2	2	-	2	-	2	2	**2.25**	3	2	3	2.6
CO2	3	2	-	2	-	2	2	-	2	-	2	2	**2.1**	3	1	3	2.3
CO3	3	3	2	-	-	2	2	-	2	-	2	2	**2.25**	3	1	3	2.3
CO4	3	2	2	-	-	2	2	2	2	-	-	2	**2.1**	3	2	2	2.3
PO Avg	3.0	2.5	2.0	2.0	-	2.0	2.0	2.0	2.0	-	2.0	2.0		3.0	1.5	2.8	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

Unit Wise Detailed Syllabus

	Units	Number of Teaching Hours
	Unit-1 Host-Parasite Relationship	**11**
1.1	Concept of host- parasite Relation	2

1.2	Microbial pathogenicity 1. Overview of bacterial and viral pathogenicity 2. Factors affecting the process of infection 3. Pathogenicity I Invasiveness: Role of structures and secretions of bacteria II Toxigenicity: Protein and LPS toxins; their properties and mode of Action	5
1.3	Non-specific host defences 1. First line of (primary) defense: Physical and mechanical defense; role of skin and mucus membrane 2. Second line of (secondary) defense: cellular and chemical	4
	Unit-2 Microbiota of Human Body and Epidemiology	**11**
2.1	Normal microbiota of human body 1. Importance, origin and establishment. 2. Microbiota of various body parts. 3. Gnotobiotic life and gnotobiosis.	5
2.2	Epidemiology of infectious disease 1.Concept of Epidemiology 2. Epidemiological types of infections and emerging diseases 3. Techniques used to study epidemiology 4. Epidemiological markers 5. Disease cycle F. Nosocomial infections: sources, transmission and their control	6
	Unit 3. Microbial Diseases of Human Being	**11**
3.1	Airborne infections: Tuberculosis, inf	2
3.2	Food and waterborne infections: Typhoid fever, food poisoning,hepatitis	2
3.3	Contagious diseases: Syphilis, AIDS	2
3.4	Arthropod borne diseases: Plague, yellow fever, malaria	2
3.5	Zoonoses: Rabies, anthrax	3
	Unit 4. Clinical Microbiology	**12**
4.1	Specimen: Types of specimen, method of collection, storage and transport	6
4.2	Methods used for diagnosis and identification of pathogen 1. Microscopy 2. Growth and biochemical characteristics 3. Clinical immunology 4. Pathological changes in blood, body fluids and tissues 5. Significance of computer and possible use of biosensors	6

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Prescott L, Harley J P, and Klein D A, (2008), Microbiology, 7th edn. WmC. Brown – McGraw Hill, Dubuque, IA.
2. Baker F J, Silverton R E, Pallister C J, (1998), Baker and Silverton's Introduction to Medical Laboratory Technology, 7th edn, Butterworths- Heinemann, Oxford, UK.
3. Tortora G J, Funke B R, Case C L, (2008), Microbiology: An Introduction, 8thedn, Benjamin Cummings.
4. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. 7th Edition. University Press Publication. (2005).
5. Roitt I. Essential Immunology. 10th Ed. Blackwell Science.
6. Kuby. Immunology. 4th edition. W. H. Freeman & company.

B.Sc. (Microbiology) Semester-6	BMIC-603P Medical Microbiology Practical	MAJOR
Credit - 02, Teaching Hours - 60		

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: develop proficiency in isolating, culturing, and identifying a range of clinically significant Gram-negative bacteria

CO2: acquire hands-on experience in conducting various diagnostic tests relevant to clinical microbiology.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CO Avg**	**1**	**2**	**3**	**CO Avg**
CO1	3	3	3	2	1	2	3	2	2	2	2	1	2.2	3	3	2	2.6
CO2	3	3	2	2	1	3	2	2	2	2	2	2	2.3	3	3	3	3.0
PO / PSO Avg	3.0	3.0	2.5	2.0	1.0	2.5	2.5	2.0	2.0	2.0	2.0	1.5		3.0	3.0	2.5	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Discussion
3. Experiments
4. Hands-on activities
5. Team work
6. Demonstration method

Practical Syllabus

	Practicals	Number of Teaching Hours(60)
1	Isolation, cultivation and identification of gram-negative and gram-positive bacteria—*Escherichia coli, Enterobacter aerogenes, Proteus vulgaris, Pseudomonas aeruginosa, Salmonella typhi, Salmonella paratyphi A, Salmonella paratyphi B, Staphylococcus aureus*	1 2 3

2	Demonstration of characterization of Gram-negative bacteria based on biochemical reactions using rapid identification kit	4 5
3	Study of antibiogram (using multidisk)	
4	Physical and chemical analysis of urine	
5	Estimation of blood urea by diacetyl monoxime method (DAM)	
6	Study of permanent slides A. Insect vectors: Female anopheles mosquito, head louse, tick, flea, mite. B. Microorganisms: Actinomycetes, yeast, bacteroids, acid-fast bacilli, spirochetes, *Streptococcus pneumoniae*, *Clostridium tetani* and *Plasmodium vivax*	6

Assessment Method	
Internal/Online Assessment (40%)	Internal Practical Examination
External Assessment (60%)	Term End Practical examination

B. Sc. (Microbiology) Semester-6	BMIC-604 Fermentation Technology	MAJOR

Credit - 3, Teaching Hours - 45

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Apply principles of microbial screening and fermentation media formulation
CO2: Analyze bioreactor systems and control strategies
CO3: Implement downstream processing techniques
CO4: Evaluate fermentation product formation processes

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	CO Avg	1	2	3	CO Avg
CO1	3	3	2	2	1	2	2	2	2	2	2	2	**2.1**	3	2	3	2.6
CO2	3	3	2	1	1	2	3	2	2	2	3	2	**2.2**	3	2	3	2.6
CO3	3	3	2	1	1	2	3	2	2	2	3	2	**2.2**	3	2	3	2.6
CO4	3	3	2	2	1	2	2	2	2	2	3	3	**2.2**	3	2	3	2.6
PO Avg	3.0	3.0	2.0	1.5	1.0	2.0	2.5	2.0	2.0	2.0	3.0	3.0		3.0	2.0	3.0	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Use of Information Communication Technology
3. Use of Internet
4. Discussion
5. Use of Multimedia
6. Projector
7. Power point Presentation

Unit Wise Detailed Syllabus		
	Units	Number of Teaching Hours
	Unit-1 Introduction toBioprocess & Fermentation media	12
1.1	Concept of fermentation and changing phases in industrial microbiology	01
1.2	Range of fermentation processes	02
1.3	Screening of industrially important organisms- 1. Characteristics of an industrially ideal organism 2. Primary screening of amylase, organic acid, antibiotics and aminoacid producers 3. Introduction to secondary screening	02
1.4	Introduction to Fermentation media 1. Principles of media formulation 2. Media ingredients: Water, carbon sources, nitrogen sources, minerals, growth factors, buffers, precursors, inducers, inhibitors, antifoam agents	02
1.5	Sterilization of media 1. Use of high-pressure steam: Principle, batch and continuous sterilization process 2. Use of filtration: Principle, types of filters	02
1.6	Inoculum development: General principles for development of seed culture	02
1.7	Introduction to strain improvement	01
	Unit-2 Bioreactor Design, Fermentation Economics, Modes of Operations and Control parameters	12
2.1	Stirred tank Bioreactor Essential features of a bioreactor (basic functions) Body construction Devices for aeration and agitation, pH, temperature, foam and dissolved oxygen Bioreactor for specialized purposes: Airlift, Tower & Biocatalytic Reactors	03
2.2	Design of batch fermenter and continuous fermenter	03
2.3	Introduction tofermentation economics	02
2.4	Modes of Operations: Open and closed fermentation, surface culture fermentation, submerged culture (batch, fed-batch & continuous) fermentation, solidsubstrate fermentation	02
2.5	Operating parameters and their control: Aseptic operation, mass transferof oxygen, foam, pH & temperature	02
	Unit-3 Downstream Processing and Quality Assurance and Safety Measurement	12
3.1	Introduction to downstream processes: Problems and designing	01

3.2	Removal of microbial cells and suspended solids 1. Foam separation 2. Precipitation 3. Filtration 4. Centrifugation	02
3.3	Cell disruption methods 1.Introduction 2.Physico-mechanical methods 3.Chemical methods	02
3.4	Product concentration and purification 1. Liquid-liquid extraction 2. Chromatography 3. Membrane processes	02
3.5	Finishing stages 1.Drying 2.Crystallization	02
3.6	Quality assurance of products 1.Bioassay 2.Sterility testing 3.Pyrogen testing	1.5
3.7	Manufacturing and environment safety 1.Containment 2.Clean room environment 3.Effluent treatment	01
3.8	Introduction to scale-up	0.5
	Unit- 4 Typical Fermentation Processes	9
4.1	Penicillin fermentation	02
4.2	Citric acid fermentation	02
4.3	Ethanol fermentation	01
4.4	Vitamin B12 fermentation	02
4.5	Lysine fermentation	01
4.6	Amylase fermentation	01

Assessment Method	
Internal/Online Assessment (40%)	1. Written test (20 Marks) 2 .Quiz / Group Discussion (10 Marks) 3. Assignments / Seminar (10 Marks)
External Assessment (60%)	Term End Theory examination (Written test 60 Marks)

References-

1. Stanbury P F, Whitaker A, and Hall S J, (1995). Principles of Fermentation Technology, 2nd edn, Pergamon Press, London,UK
2. Waites M J, and Morgam N L,(2002). Industrial Microbiology:An Introduction Blackwell Science

3. Crueger W and Crueger A, (2000), Biotechnology: A Text Book of Industrial Microbiology, 2nd edn, Panima Publishing Corporation,New Delhi,India
4. Trevan M D, Boffey S, Goulding K H, and Standury S, (eds), (1987), Biotechnology: The Biological Principles, Tata McGraw-Hill, New Delhi, India.
Casida L E, Jr. (1968). Industrial Microbiology, Wiley Eastern Ltd,New Delhi,India

B.Sc. (Microbiology) Semester-6	BMIC-604P Fermentation Technology Practical	MAJOR

Credit - 02, Teaching Hours - 60

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: critically conduct primary screenings and identify microbial producers demonstrating proficiency in aseptic techniques and interpreting results.

CO2: Perform quantitative and qualitative microbial production and assay procedures.

Mapping matrix of POs , PSOs and COs

	POs													PSOs			
CO \ PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CO Avg**	**1**	**2**	**3**	**CO Avg**
CO1	3	3	3	2	1	2	3	2	2	2	2	2	2.3	3	3	2	2.6
CO2	3	3	3	2	1	3	3	2	2	2	2	2	2.4	3	3	3	3.0
PO / PSO Avg	3.0	3.0	3.0	2.0	1.0	2.5	3.0	2.0	2.0	2.0	2.0	2.0		3.0	3.0	2.5	

(0-no correlation,1-weak correlation; 2-medium correlation; 3-strong correlation)

Teaching Pedagogy

1. Constructivism
2. Social Constructivism
3. Behaviorism

Teaching Methods and Tools

1. Direct teaching using Black Board and Chalk
2. Discussion
3. Experiments
4. Hands-on activities
5. Team work
6. Demonstration method

Practical Syllabus

	Practicals	Number of Teaching Hours(60)
1	Primary screening of amylase producers	15
2	Primary screening of organic acid producers	5
3	Primary screening of antibiotic producers by crowded plate method	15
4	Determination of OTR under static, sparging and shake flask condition by sulfite oxidation method	
5	Fermentative production of amylase and its activity check	15
6	Bioassay of antibiotics using *Bacillus subtilis*	
7	Sterility testing of pharmaceutical product	10

Assessment Method

Internal/Online Assessment (40%)	Internal Practical Examination
External Assessment (60%)	Term End Practical examination