Curriculum Framework

Bachelor of Science in Microbiology

As per NEP 2020 and Learning Outcomes-based National Curriculum Framework
(Aligned with NCrF and NHEQF)

Effective From Academic Year 2025-2026

Founded by Mahatma Gandhi in 1920

Gujarat Vidyapith
Ahmedabad

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(Microbiology)

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(Updated on 26-12-2025)

GUJARAT VIDYAPITH: AHMEDABAD

Curriculum Framework of Bachelor of Science (Microbiology)

Published by:

Dr. Himanshu Patel

Registrar

Gujarat Vidyapith

Near Income Tax Office, Ashram Road, Ahmedabad - 380009.

From the Desk of Vice Chancellor…

Dear All,

Any curriculum, at any level, must be firmly grounded in the objectives and goals that an educator or an educational institution aspires to achieve for its students. A course that trains students to solve mathematical equations must be very different from one that teaches them how to play a musical instrument, practice yoga, or conduct social research. Each subject requires its own methods, activities, and learning goals, which is why curriculum design is so important.

Therefore, curriculum is of utmost importance, as it determines how teachers and students will spend their time—in laboratories, in clinical practice, in creative endeavors, or in interactive lectures. It also reflects what a class, a department, a school, or an institution values; what it defines as its mission; and what it expects its graduates to accomplish. In this sense, the curriculum is the map that guides the essentials of learning from the classroom level to the institutional level.

The true success of any curriculum must be judged by its ability to achieve its intended objectives. It is a test of how well an institution—or an individual teacher—understands and articulates those objectives, and how effectively a pathway is created for students to attain success as defined by them. Curriculum is, in fact, a continuous chain of activities designed to translate broad educational goals into concrete practices, learning materials, and observable changes in behavior. A lesson plan, for instance, is curriculum at the classroom level, answering the critical questions: *What do I want my students to know? How can I engage them meaningfully? How will I measure what they have learned?*

For a society to achieve its educational aspirations, the curriculum must be both functional and relevant to its needs. Through careful management of curriculum, effective use of resources, and policies that bring systemic improvements, education can move society toward a more promising future. Indeed, curriculum is the very foundation of any academic institution—without it, the institution would lose its purpose and direction.

At Gujarat Vidyapith, established by Mahatma Gandhi in 1920 with its rich cultural and educational heritage, we remain committed to these ideals and we work with well-defined objectives to prepare our students for a brighter academic and social future.

It gives me immense pride and joy to announce the unveiling of the latest curriculum of Gujarat Vidyapith. This curriculum has been carefully designed in alignment with the objectives and guiding principles of the National Education Policy (NEP) 2020. I take this opportunity to place on record my deep appreciation for the efforts of the teaching faculty of Gujarat Vidyapith, the Members of the Board of Studies, and the Members of the Academic Council. Their dedication and vision have given shape to this comprehensive neo-curriculum, which will guide our students and our institution toward continued excellence.

With best wishes,

Dr. Harshad Patel
Vice Chancellor
Gujarat Vidyapith

Curriculum Framework

Bachelor of Science (Microbiology)

Effective From Academic Year 2025-2026

(Updated on 26-12-2025)

Department of Microbiology

Faculty of Science

Gujarat Vidyapith

Board of Studies

Chairperson:

Dr. Nikhil S. Bhatt
Professor & Dean, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

External Experts:

1) **Dr. Shailesh R. Dave**
   Professor & Director, Xavier's Research Foundation, Ahmedabad.

2) **Dr. Rakesh Patel**
   Retired Faculty, R.G. Shah Science college, Microbiology Department, Ahmedabad.

Members from the Department:

1) **Dr. Mayur C. Shah**
   Professor & Head, Department of Microbiology, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

2) **Dr. Srinivas Duggirala**
   Professor, Department of Microbiology, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

3) **Dr. Niraj T. Sheth**
   Professor, Department of Microbiology, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

4) **Dr. Prateek G. Shilpkar**
   Professor, Department of Microbiology, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

5) **Mrs. Preeti K. Shukla**
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6) **Dr. Kaushik R. Patel**
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7) **Mr. Arvind B. Dungrechiya**
   Assistant Professor, Department of Microbiology, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

PROGRAMME STRUCTURE							
Course Code	Course Name	Hours			Credit	Evaluations	
		Theory	Practical	Total		CCE	TEE
SEMESTER-1							
254510338001	Introduction to Microbial World	45	0	45	3	40	60
254510238002	Introduction to Microbial World Practical	0	60	60	2	40	60
254510337001	Physical Chemistry	45	0	45	3	40	60
254510237002	Physical Chemistry Practical	0	60	60	2	40	60
-	Multidisciplinary Course (MDC) **Annexure-1**	45	0	45	3	40	60
-	Ability Enhancement Course (AEC) **Annexure-2**	30	0	30	2	40	60
-	Value added Course (VAC) **Annexure-3**	30	0	30	2	40	60
-	Skill Enhancement Course (SEC) **Annexure-4**	0	90	90	3	40	60
Total		**195**	**210**	**405**	**20**	**280**	**420**
SEMESTER-2							
254510338003	Basic Bacteriology	45	0	45	3	40	60
254510238004	Basic Bacteriology Practical	0	60	60	2	40	60
254510337003	Inorganic Chemistry	45	0	45	3	40	60
254510237004	Inorganic Chemistry Practical	0	60	60	2	40	60
-	Multidisciplinary Course (MDC) **Annexure-1**	45	0	45	3	40	60
-	Ability Enhancement Course (AEC) **Annexure-2**	30	0	30	2	40	60
-	Value added Course (VAC) **Annexure-3**	30	0	30	2	40	60
-	Skill Enhancement Course (SEC) **Annexure-4**	0	90	90	3	40	60
Total		**195**	**210**	**405**	**20**	**280**	**420**
SEMESTER-3							
255010338005	Microbial Physiology	45	0	45	3	40	60
255010338006	Microbial Physiology Practical	0	90	90	3	40	60
255010337005	Organic Chemistry	45	0	45	3	40	60
255010337006	Organic Chemistry Practical	0	90	90	3	40	60
-	Multidisciplinary Course (MDC) **Annexure-1**	45	0	45	3	40	60
-	Ability Enhancement Course (AEC) **Annexure-2**	30	0	30	2	40	60
-	Skill Enhancement Course (SEC) **Annexure-4**	0	90	90	3	40	60
Total		**165**	**270**	**435**	**20**	**280**	**420**
SEMESTER-4							
255010338007	Microbial diversity	45	0	45	3	40	60
255010338008	Applied Microbiology	45	0	45	3	40	60
255010238009	Microbial Biodiversity and Applied Microbiology Practical	0	60	60	2	40	60
255010337007	Organic Chemistry	45	0	45	3	40	60
255010337008	Analytical Chemistry	45	0	45	3	40	60
255010237009	Organic and Analytical Chemistry Practical	0	60	60	2	40	60
-	Ability Enhancement Course (AEC) **Annexure-2**	30	0	30	2	40	60
-	Value added Course (VAC) **Annexure-3**	30	0	30	2	40	60
Total		**240**	**120**	**360**	**20**	**320**	**480**

SEMESTER-5							
255510338010	Molecular Genetics of Prokaryotes	45	0	45	3	40	60
255510338011	Bacterial Metabolism	45	0	45	3	40	60
255510338012	Immunology	45	0	45	3	40	60
255510538013	Molecular Genetics of Prokaryotes Bacterial Metabolism and Immunology Practical	0	150	150	5	40	60
255510438014	Internship	0	120	120	4	40	60
255510238015	Bio-Safety (Discipline Specific Elective)	30	0	30	2	40	60
255510238016	Blood Banking (Discipline Specific Elective)						
Total		**165**	**270**	**435**	**20**	**240**	**360**
SEMESTER-6							
255510338017	Genetic Engineering and Biotechnology	45	0	45	3	40	60
255510238018	Genetic Engineering and Biotechnology Practical	0	60	60	2	40	60
255510338019	Virology and Mycology	45	0	45	3	40	60
255510238020	Virology and Mycology Practical	0	60	60	2	40	60
255510338021	Medical Microbiology	45	0	45	3	40	60
255510238022	Medical Microbiology Practical	0	60	60	2	40	60
255510338023	Fermentation Technology	45	0	45	3	40	60
255510238024	Fermentation Technology Practical	0	60	60	2	40	60
Total		**180**	**240**	**420**	**20**	**320**	**480**
GRAND TOTAL		**1140**	**1320**	**2460**	**120**	**1720**	**2580**

***CCE- Continuous Comprehensive Evaluation; **TEE- Term End Evaluation**

Program 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**	6+2= **08**	9+5= **14**	12+8= **20**	**60**	**60**
DSE (Discipline Specific Elective)	**-**	**-**	**-**	**-**	**2**	**-**		
Minor	3+2= **05**	3+2= **05**	3+3= **06**	6+2= **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	-	-	-	-	**04**		**04**	**02-04**
Total	**20**	**20**	**20**	**20**	**20**	**20**	**120**	**120**

Programme Outcomes (POs)

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

PO-1	**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.
PO-2	**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.
PO-3	**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.
PO-4	**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.
PO-5	**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.
PO-6	**Communication**	Students acquire strong oral and written communication skills, enabling them to articulate scientific concepts, write technical reports, and engage in interdisciplinary dialogue effectively.
PO-7	**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.
PO-8	**Teamwork and Leadership**	Graduates are prepared to contribute meaningfully to multidisciplinary teams, demonstrating leadership and collaboration in diverse scientific and professional environments.
PO-9	**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.
PO-10	**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.
PO-11	**Innovation and Entrepreneurship**	The program fosters creative thinking, problem-solving, and entrepreneurial mindset. Students are encouraged to develop innovative scientific solutions with societal impact.
PO-12	**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)

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

PSO Number	Programme Specific Outcomes (PSOs)	Justification
PSO-1	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)**.
PSO-2	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.
PSO-3	Integrate microbiological knowledge with allied disciplines such as chemistry, biochemistry, molecular biology, environmental science, and medicine to address complex biological problems and promote innovative applications in health, industry, and the environment.	This outcome aligns with **ethics and values (PO5), communication (PO6), teamwork (PO8), lifelong learning (PO9), and societal contribution (PO12)** by fostering responsible citizenship and public health awareness.

CO Attainment Levels (OBE & NEP 2020 Aligned)

COs Attainment Levels	**Level**	**Description**	**Attainment Criteria**			
	Level 3	High	≥ 60% students scored ≥ Benchmark			
	Level 2	Moderate	50–59% students scored ≥ Benchmark			
	Level 1	Low	40–49% students scored ≥ Benchmark			
	Level 0	Not Attained	< 40% students scored ≥ Benchmark			
Target Attainment (Benchmark)	**COs**			**CO-1**	**CO-2**	**CO-3**	**CO-4**
	Target Level (%)			**55**	**55**	**55**	**55**

Program – B.Sc. (Microbiology) Semester- 1		
Course Code **254510338001**	**Name of Course** **Introduction to Microbial World**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

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

CO-1: get an insight into the world of microorganisms.

CO-2: State the historical developments and major milestones leading to the development of microbiology as a separate discipline of science.

CO-3: acquire a broad perspective of the scope of microbiology

CO-4: be familiar with techniques like microscopy and staining procedures used to study microorganisms

Detailed Syllabus

Unit-1. Microbial World (11h)

1.1. Introduction: microbes in our lives **(1h)**

1.2. Distribution of microorganisms in nature **(1h)**

1.3. Introduction to taxonomy; Binomial system of nomenclature; Carl Woese's three domain, kingdom, Whittaker's five kingdom concept of classification **(2h)**

1.4. Major Groups of Microorganism; Difference between prokaryotic and eukaryotic microorganisms; Prokaryotic microbes: Eubacteria and Archeobacteria, Eukaryotic microbes: fungi (yeasts and molds), protozoa, algae; Acellular microbes: viruses **(3h)**

1.5. Introduction to methods of classifying Bacteria; Taxonomic groups (Taxa); The Goals of classification; A) Intuitive method, B) Numerical taxonomy, C) Genetic relatedness **(4h)**

Unit-2. History of Microbiology (12h)

2.1. The discovery of microorganisms; Microbiology and the origin of life; Contribution of A. V. Leeuwenhoek in the discovery of microscope; Spontaneous generation vs. Biogenesis **(5h)**

2.2. Golden age of microbiology; 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 **(7h)**

Unit-3. Scope and Relevance of Microbiology (11h)

3.1. Microbiology as a field of biology **(2h)**

3.2. Widening horizons; 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 **(5h)**

3.3. Microbiology and modern biology: molecular biology **(2h)**

3.4. Future of microbiology **(2h)**

Unit-4. Microscopy and Specimen Preparation (11h)

4.1. Light microscopy; 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 **(4h)**

4.2. Preparation of specimens for light microscopy; 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 **(4h)**

4.3. Electron microscopy: principle, working and applications of transmission and scanning electron microscopy **(3h)**

Mapping Matrix of POs, PSOs, and COs																	
COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	–	2	–	–	–	–	3	–	–	2	2.4	2.4	3	1	2
CO-2	3	2	1	2	3	–	–	–	3	–	–	2	2.3	2.3	2	1	1
CO-3	3	3	–	3	2	–	–	–	3	–	–	3	2.8	2.8	3	1	2
CO-4	2	3	3	2	–	–	–	–	3	–	–	2	2.5	2.5	2	3	2
Avg	2.8	2.5	2.0	2.3	2.5	–	–	–	3.0	–	–	2.3		2.5	1.5	1.8	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
	COs	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
Continuous Comprehensive Evaluation 40 Marks	**CO-1**	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An introduction* (13th ed., Indian ed.). Pearson India Education Services Pvt. Ltd.
2. Pelczar, J. R., Chan, E. C. S., & Krieg, N. R. (1993). *Microbiology* (5th ed.). McGraw-Hill Book Company.
3. Atlas, R. M. (2015). *Principles of microbiology* (2nd ed., Indian ed.). McGraw Hill Education (India) Private Limited.
4. Prescott, L., Harley, J. P., & Klein, D. A. (2019). *Microbiology* (11th ed.). Wm. C. Brown/McGraw-Hill.

Online Resources & Tools:

- SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Microbiology) Semester- 1		
Course Code **254510238002**	**Name of Course** **Introduction to Microbial World Practical**	**Major**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

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

CO1: Analyze and apply proper sterilization, glassware preparation, aseptic techniques, and safety protocols (GLP)

CO2: Identify microorganisms through microscopic examination and staining techniques.

Detailed Syllabus

1) Microbiology Good Laboratory Practices (GLP): rules and safety **(2h)**
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 **(5h)**
3) Cleaning and preparation of glassware for sterilization **(4h)**
4) Disposal of laboratory waste and cultures **(3h)**
5) Study of principle, component parts and operation of the compound light microscope **(3h)**
6) Study of principles and working of laboratory instruments: autoclave, hot airoven, incubator, water bath, bacteriological filters, centrifuge, rotary shaker, pH meter, colorimeter **(15h)**
7) pH adjustment of solution by use of pH strip and pH meter **(4h)**
8) Study of hay infusion by hanging drop method **(4h)**
9) Simple staining of bacteria: positive, curd (simple staining) and negative staining **(13h)**
10) Study of permanent slides/photomicrographs of different groups of microorganisms **(17h)**
    - **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

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	3	2	3	–	3	2	2	–	–	2	2.6	2	2	2	2.0
CO-2	3	3	3	2	2	–	3	2	2	–	–	2	2.5	2	3	2	2.3
Avg	3	3.0	3.0	2.0	2.5	–	3.0	2.0	2.0	–	–	2.0		2	2.5	2	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

Assessment Method			
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Microbiology) Semester- 2		
Course Code **254510338003**	**Name of Course** **Basic Bacteriology**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**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.

Detailed Syllabus

Unit-1. Cellular Organization and External Structures of Bacterial cell (11h)

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

Unit-2. Internal Structures of Bacterial cell (12h)

2.1. Cytoplasmic membrane of Eubacteria and Archaebacteria **(2h)**
2.2. Structural differences between eubacteria and archaebacteria **(2h)**
2.3. Mesosomes **(0.5h)**
2.4. Cytoplasm and nuclear material (bacterialchromosome), bacterial plasmids **(1.5)**
2.5. Ribosomes of Eubacteria and Archaebacteria **(2h)**
2.6. Inclusion bodies (cellular reserve food materials) **(2h)**
2.7. Bacterial spores and cyst: spore structure, types of spores, sporogenesis and germination of spore, bacterial cyst **(2h)**

Unit-3. Nutrition and Cultivation of Bacteria (11h)

3.1. Nutritional and chemical requirements of bacteria: carbon, oxygen, nitrogen, sulfur, phosphorus, trace elements, vitamins, growth factors, water **(2h)**
3.2. Nutritional diversities in bacteria
- Based on source of energy: Phototrophs, Chemotrophs **(2h)**
- Based on source of electro donor: Lithotrophs, Organotrophs **(1.5h)**
- Based on source of carbon: Autotrophs, Heterotrophs, Mixotrophs, Obligate parasites **(1.5h)**

3.3. Culture media: media ingredients, preparation of media, general cultivation media (N.broth and N.agar) **(3h)**
3.4. Cultivation of anaerobic bacteria **(1h)**

Unit-4. Pure Culture Techniques (11h)

4.1. Pure culture, mixed culture, selective methods to obtain pure cultures: chemical, physical, and biological methods **(2.5h)**
4.2. Isolation methods of pure culture: aseptic technique , streak plate , spread plate and pour plate

techniques **(2.5h)**

4.3. Cultural characteristics: colony characteristics , characteristics of broth cultures **(2h)**

4.4. Maintenance and preservation of pure cultures **(2h)**

4.5. Culture collection centers and their role **(2h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	2	2	2	2	1	2	1	1	2	2.4	3	2	2	2.0
CO-2	3	2	2	2	2	2	2	1	2	1	1	2	2.3	3	2	2	1.3
CO-3	3	3	3	2	2	2	3	1	2	2	2	2	2.8	3	3	2	2.0
CO-4	3	3	3	2	2	2	3	2	2	2	2	2	2.5	3	3	2	2.3
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**	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An introduction* (13th ed., Indian ed.). Pearson India Education Services Pvt. Ltd.
2. Pelczar, J. R., Chan, E. C. S., & Krieg, N. R. (1993). *Microbiology* (5th ed.). McGraw-Hill Book Company.
3. Atlas, R. M. (2015). *Principles of microbiology* (2nd ed., Indian ed.). McGraw Hill Education (India) Private Limited.
4. Prescott, L., Harley, J. P., & Klein, D. A. (2019). *Microbiology* (11th ed.). Wm. C. Brown/McGraw-Hill.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 2		
Course Code **254510238004**	**Name of Course** **Basic Bacteriology Practical**	**Major**
Credit: 02	**Teaching Scheme: Practical (60)**	**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.

Detailed Syllabus

1) Preparation of bacteriological media: Nutrient broth and Nutrient agar **(5h)**

2) Cultivation and isolation of bacteria **(10h)**

- **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; Anaerobic jar (Demonstration) **(5h)**

4) Preservation of microbial cultures **(3h)**

- **a)** Periodic sub culturing and storage at refrigeration temperature
- **b)** Preservation of bacteria in soil (nitrogen fixers)

5) Study of pigmented bacteria **(5h)**

- **a)** *Staphylococcus aureus*
- **b)** *Staphylococcus epidermidis*
- **c)** *Micrococcus luteus*
- **d)** *Serratia marscescens*
- **e)** *Pseudomonas aeruginosa*

6) Differential staining of bacteria: Gram stain method **(7h)**

7) Study of bacterial structure by structural staining **(16h)**

- **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

8) Use of special staining technique to study bacteria **(4h)**

- **a)** Spirocheates by Fontana's method

9) Study of effect of various physical agents on growth of bacteria **(5h)**

- **a)** Effect of pH
- **b)** Effect of temperature
- **c)** Effect of osmotic pressure (NaCl and Sucrose)
- **d)** Oligodynamic action of heavy metals

Mapping Matrix of POs, PSOs, and COs																
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	3	3	2	3	2	3	2	2	3	2	2	2.5	3	3	2	2.6
CO-2	3	3	3	2	2	2	3	2	2	2	2	2	2.3	3	3	2	2.6
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

Assessment Method			
Continuous Comprehensive Evaluation 40 Marks	COs	Marks	Exam Component
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	COs	Marks	Exam Component
	CO-1	30	Term End Examination
	CO-2	30	

References

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Microbiology) Semester- 3		
Course Code **255010338005**	**Name of Course** **Microbial Physiology**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

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

CO1: examine 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 effects of antimicrobial agents on microbial populations

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

Detailed Syllabus

Unit-1. Microbial Nutrition and Factors Affecting (11h)

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 **(4h)**

1.2 Modes of nutritional uptake **(4h)**

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 **(3h)**

Unit-2. Enzymes (11h)

2.1. General introduction **(5h)**

a) Physical and chemical properties
b) Structure of enzymes: Prosthetic group, apoenzyme, coenzymes, cofactors
c) Localization of enzymes: Extra cellular and intra cellular
d) Nomenclature and classification of enzymes, lUB system of enzyme classification

2.2. Enzyme action **(6h)**

a) Active sites of enzymes
b) Mechanism of enzyme action
c) Factors affecting enzyme activity
d) Inhibition of enzyme activity: Competitive and non-competitive

Unit-3. Microbial growth (12h)

3.1. Methods of reproduction in bacteria and new cell formation **(3h)**

3.2. Growth **(5h)**

- 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 **(4h)**

- Principles of chemotherapy
- General mode of action of various chemotherapeutic agents: Sulfonamides, antibiotics (penicillin, streptomycin, Polymixin)

Unit-4. Biomolecules and metabolism (11h)

4.1. Biomolecules: Chemical structure, properties, classification and biological significance of carbohydrates, proteins, lipids and nucleic acids **(6h)**

4.2. Introduction to metabolism: Anabolism, catabolism, primary and secondary metabolism, role of reducing power, precursor metabolites and energy rich compounds in cell Metabolism **(5h)**

Mapping Matrix of POs, PSOs, and COs																
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	3	2	2	2	2	2	1	2	1	1	2	2.4	3	2	2	2.0
CO-2	3	2	2	2	2	2	2	1	2	1	1	2	2.3	3	2	2	1.3
CO-3	3	3	3	2	2	2	3	1	2	2	2	2	2.8	3	3	2	2.0
CO-4	3	3	3	2	2	2	3	2	2	2	2	2	2.5	3	3	2	2.3
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**	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method					
			Exam Component		
	COs	Marks	Written Test	Assignment/Seminar	Quiz/Discussion
Continuous Comprehensive Evaluation 40 Marks	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	COs	Marks	Exam Component		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

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

Online Resources & Tools:

- SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Microbiology) Semester- 3		
Course Code **255010338006**	**Name of Course** **Microbial Physiology Practical**	**Major**
Credit: 03	**Teaching Scheme: Practical (90)**	**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.

Detailed Syllabus

1) Study of different types of media and their ingredients: **(8h)**
   - **a)** Selective media: Rose Bengal agar medium
   - **b)** Differential media: Mac Conkey's medium, EMB agar medium, triple sugar iron agar medium
   - **c)** Enrichment media: Selenite broth
   - **d)** Enriched media: Blood agar medium, glucose yeast extract agar medium
   - **e)** Natural media: Soil extract agar, potato dextrose agar medium
2) Qualitative analysis of biomolecules: **(15h)**
   - **a)** Carbohydrates: Iodine test, Molisch's test, Benedict's test, Barfoed test, Bial's test and Saliwanoff s test
   - **b)** 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) **(15h)**
4) Study of effect of antibiotics on bacteria: **(15h)**
   - **a)** Study of sensitivity spectrum of antibiotic against the test organism by use of paper disc method
   - **b)** Determination of spectrum of activity of an antibiotic by use of agar ditch method
5) Study biochemical reaction of bacteria: **(37h)**
   - **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)** Citrate utilization test
     - **vi)** Lipid utilization test
   - **B.** Based on nitrogen source
   - **C.** Other tests- Catalase test, Dehydrogenase test, Oxidase test

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	3	2	3	2	3	2	2	2	2	2	2.5	3	3	2	2.6
CO-2	3	3	3	2	2	2	3	2	2	2	2	2	2.4	3	3	2	2.6
Avg	3	3	3	2	2.5	2	3	2	2	2	2	2		3	3	2	2.6

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

Assessment Method			
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Microbiology) Semester- 4		
Course Code **255010338007**	**Name of Course** **Microbial Diversity**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**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

Detailed Syllabus

Unit-1. Introduction (11h)

1.1 What is biodiversity? **(4h)**

1.2 Origin of life, evolution and origin of biodiversity, species concept, Evolutionary tree of microorganisms **(4h)**

1.3 Value of biodiversity, microbial biodiversity as index of environmental change **(3h)**

Unit-2. Methods ofAssessing Biodiversity (11h)

2.1. Microscopic methods **(3h)**

2.2. Cultural methods **(2h)**

2.3. Molecular and genomic methods: Molecular context of microbial diversity, importance of DNA and r RNA sequence comparison, determination of GC content **(6h)**

Unit-3. Biodiversity among Bacteria & Archaea (12h)

3.1. Morphological and cellular diversity **(4h)**

a) 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 **(4h)**

3.3. Ecological diversity- Diversity in major ecosystems b. Diversity in aquatic, marine and extreme environment **(4h)**

Unit-4. Biodiversity among Eukaryotic and Acellular Microorganisms (11h)

4.1. Eucarya: Morphological, cellular, physiological, metabolic and ecological characteristicsof- Protozoans, Slime molds, Fungi, Algae, Lichens as consortium of algae and fungi **(6h)**

4.2. Acellular organisms: Viruses and prions **(5h)**

Mapping Matrix of POs, PSOs, and COs																	
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	3	2	3	2	2	2	1	2	1	1	2	2.1	3	1	3	2.0
CO-2	3	3	3	3	2	2	3	1	2	2	2	2	2.4	2	2	2	2.0
CO-3	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3	2	3	2.6
CO-4	3	2	2	3	1	2	2	1	2	1	1	2	1.9	3	1	2	2.0
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	

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Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
	COs	Marks	Written Test	Assignment/Seminar	Quiz/Discussion
Continuous Comprehensive Evaluation 40 Marks	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	COs	Marks	Exam Component		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Atlas, R. M., & Bartha, R. (1998). *Microbial ecology: Fundamentals & applications* (4th ed.). Pearson Education.
2. Campbell, R. (1983). *Microbial ecology* (2nd ed.). Blackwell Scientific Publications.
3. Ogunseitan, O. (2005). *Microbial diversity: Form and function in prokaryotes*. Blackwell Publishing.

Online Resources & Tools:

- SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Microbiology) Semester- 4		
Course Code **255010338008**	**Name of Course** **Applied Microbiology**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**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.

Detailed Syllabus

Unit-1. Microbiology of Soil (11h)

1.1 Physico-chemical characteristics of soil, soil microflora: Diversity in soil microflora **(2h)**

1.2 Methods of studying soilmicroflora: **(3h)**

- **i)** Direct microscopic method, agar plate technique, enrichment culture technique, and buried slide method
- **ii)** Use of Winogradsky column in studying microbial diversity in soil

1.3 Soil fertility: Role of microorganisms in soil fertility **(2h)**

1.4 Biogeochemical Cycles: **(4h)**

- **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

Unit-2. Microbiology of Drinking and Waste Water (11h)

2.1. Natural waters: Sources of contamination **(1h)**

2.2. Water-borne diseases **(2h)**

2.3. Purification of drinking water: Sedimentation, filtration and disinfection **(3h)**

2.4. Waste Management **(5h)**

- **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

Unit-3. FOOD AND DAIRY MICROBIOLOGY -I (11h)

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 **(2h)**

3.2. Microbial spoilage of various foods- Principles, Spoilage of vegetables, fruits, meat, eggs, milk and canned foods **(4h)**

3.3. Principles and methods of food preservation: **(4h)**

- **i)** Physical methods: temperature (low, high), irradiation, and aseptic packaging
- **ii)** Chemical methods: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics

Unit-4. FOOD AND DAIRY MICROBIOLOGY -II (12h)

4.1. Fermented dairy products: **(4h)**

- **i)** Dairy starter cultures
- **ii)** fermented dairy products: yogurt, acidophilus milk, kefir, dahi and cheese
- **iii)** Introduction to Probiotics, Prebiotics and Synbiotics

4.2. Indian fermented food products: Pickles, sauerkraut and bread **(2h)**

4.3. Microbes as food: Mushrooms, spirulina and yeasts **(2h)**

4.4. Food borne diseases (causative agents, foods involved, symptoms and preventive measures) **(3h)**

- **i)** Food intoxications: *Staphylococcus aureus, Clostridium botulinum*
- **ii)** Food infections: *Bacillus cereus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni.*

4.5. HACCP **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	3	2	2	2	1	2	1	1	2	2.0	3	2	3	2.6
CO-2	3	3	3	3	2	2	3	1	2	2	2	2	2.4	3	2	3	2.6
CO-3	3	3	3	2	2	2	3	1	2	2	2	2	2.3	3	2	3	2.6
CO-4	3	3	3	2	2	3	3	2	2	2	2	2	2.4	3	2	3	2.6
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method					
Continuous Comprehensive Evaluation 40 Marks	COs	Marks	Exam Component		
			Written Test	Assignment/Seminar	Quiz/Discussion
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	COs	Marks	Exam Component		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Alexander, M. (1977). *Soil microbiology* (2nd ed.). Krieger Publishing Co.
2. Atlas, R. M. (1997). *Principles of microbiology* (2nd ed.). Wm. C. Brown Publishers.
3. Frazier, W. C., & Westhoff, D. C. (1988). *Food microbiology* (4th ed.). McGraw-Hill Book Company.
4. Pelczar, M. J., Jr., Chan, E. C. S., & Krieg, N. R. (1986). *Microbiology* (5th ed.). McGraw-Hill Book Company.
5. Prescott, L., Harley, J. P., & Klein, D. A. (2008). *Microbiology* (7th ed.). Wm. C. Brown – McGraw-Hill.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 4		
Course Code **255010238009**	**Name of Course** **Microbial Biodiversity and Applied Microbiology Practical**	**Major**
Credit: 02	**Teaching Scheme: Practical (60)**	**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

Detailed Syllabus

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] **(6h)**

2) Study of microbial diversity in soil by using Winogradsky Column (Demonstration only) **(1h)**

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 **(3h)**

4) Study of metabolic diversity amongst bacteria: *Escherichia coli, Enterobacter aerogenes, Proteus vulgaris, Staphylococcus aureus, and Bacillus subtilis* by performing various biochemical tests: **(9h)**

Based on carbon metabolism

i) Methyl Red Test and 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

5) Study of diverse groups of eukaryotic microorganisms: **(3h)**
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 and diatoms
Protozoa: Study of presence of protozoa in pond water; study of permanent slides of Amoeba, Euglena and Paramecium

6) Microbiological analysis of soil: **(9h)**

Enumeration of organisms from soil (standard plate count from soil)
Isolation of symbiotic & non-symbiotic nitrogen fixing bacteria & actinomycetes from soil

7) Microbiological analysis of drinking water: **(9h)**
Standard plate count of drinking water
Detection of fecal pollution of water by performing presumptive test, confirmed test and completed test
8) Determination of MPN of coliforms in water **(2h)**
9) Microbiological analysis of Food: **(9h)**
Standard plate count of Food sample
Isolation of spoilage microorganisms from spoiled vegetables/fruits.
Isolation of spoilage microorganisms from bread
10) Microbiological analysis of milk: **(9h)**
i) Standard plate count of milk sample
ii) Determination of microbial load of milk by use of MBRT of raw milk, boiled milk and pasteurized milk.
iii) Preparation of Yogurt/Dahi.
iv) Detection of acid-fast organisms in milk sample

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3	3	2	2.5
CO-2	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3	3	3	3.0
Avg	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3.0	3.0	2.5	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Microbiology) Semester- 5		
Course Code **255510338010**	**Name of Course** **Molecular Genetics of Prokaryotes**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**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

Detailed Syllabus

Unit-1. Fundamentals (11h)

1.1 Nature of Genetic material: **(3h)**
- **i)** Understanding of terms: Gene, allele, genotype, phenotype, intron, exon, cistron, recon, muton, plasmid, chromosome, genome, zygote, merozygote
- **ii)** Experimental proof for DNA as genetic material: Work of Griffith;Avery, McCarty and MacLeod; Hershey and Chase

1.2 Gene structure and function: **(3h)**
- **i)** Chemistry of DNA, Watson and Cricks model of DNA structure
- **ii)** Typical gene structure, functions of gene

1.3 DNAreplication **(5h)**
- **i)** Semi conservative nature, Meselson and Stahl'sexperiment
- **ii)** Molecular mechanism: Strand separation, formation of leading and lagging strand, formation of Okazaki fragments and their removal, proofreading
- **iii)** Post-replicative modifications and their significance

Unit-2. Gene Expression and its Regulation (11h)

2.1. Transcription: **(3h)**
- **i)** Initiation, role of enzyme, sigma factor, promoter,operator
- **ii)** Elongation
- **iii)** Termination: Rho dependent and Rho independent

2.2. Genetic code: Triplet nature, polarity, degeneracy, near universality and Wobble Phenomenon **(2h)**

2.3. Translation: **(3h)**
- **i)** Initiation, 70 S initiation complex,
- **ii)** Elongation: recognition, peptidyl transfer, translocation
- **iii)** Termination
- **iv)** Fate of ribosomes, polysome system, polycistronic RNA

2.4. Regulation of gene expression **(3h)**
- **i)** Negative inducible control – lac operon
- **ii)** Negative repressible control - trp operon
- **iii)** Positive regulation – lac operon

Unit-3. DNA Damages and their Repair (12h)

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 **(3h)**

3.2. Molecular basis of mutation **(3h)**
- **i)** Chemical mutagenesis: 5-bromouracil, nitrous acid and acridine orange
- **ii)** Physical mutagenesis: Ultraviolet radiations
- **iii)** Biological Mutagenesis: Phage Mu

3.3. Consequences of mutation: **(3h)**
- **i)** Forward - silent, missense, nonsense, frameshift
- **ii)** Reverse – true reversion, suppressions (intragenic and extragenic only)
- **iii)** Classes of bacteria mutants; Nutritional, resistant, morphological and conditional mutants

3.4. Repair mechanisms: **(3h)**
- **i)** Direct repair: Photoreactivation, removal of A-Psites
- **ii)** Indirect repair: Excision repair, mismatch repair
- **iii)** SOS regulatory system

Unit-4. Gene Transfer among Bacteria (11h)

4.1. Fundamentals: Horizontal and vertical gene transfer, merozygotic system **(1h)**

4.2. Transformation: Competence, DNA uptake in Gram positive and Gram negative bacteria, transfection **(3h)**

4.3. Transduction: Generalized and restricted transduction **(2h)**

4.4. Conjugation: Role of sex factor, transfer of genes during F^+ x F^-, Hfr x F^- and sexduction **(2h)**

4.5. Bacterial plasmids and transposable elements **(3h)**
- **i)** General properties, compatibility groups, maintenance of plasmids
- **ii)** Types of plasmids
- **iii)** Transposable elements: their nature, insertion sequences (IS) and Tn elements

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	2	2	2	2	1	2	1	1	2	2.0	3	2	2	2.3
CO-2	3	3	3	2	2	2	3	1	2	2	2	2	2.3	3	2	3	2.3
CO-3	3	3	3	2	2	2	3	2	2	2	2	2	2.4	3	2	3	2.3
CO-4	3	3	3	2	2	3	3	2	2	2	2	2	2.5	3	2	3	2.3
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method					
			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	COs	Marks	Written Test	Assignment/Seminar	Quiz/Discussion
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	COs	Marks	Exam Component		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Alexander, M. (1977). *Soil microbiology* (2nd ed.). Krieger Publishing Co.
2. Atlas, R. M. (1997). *Principles of microbiology* (2nd ed.). Wm. C. Brown Publishers.
3. Becker, W. M., Kleinsmith, L. J., & Hardin, J. (2006). *The world of the cell* (7th ed.). Pearson/Benjamin Cummings.
4. Frazier, W. C., & Westhoff, D. C. (1988). *Food microbiology* (4th ed.). McGraw-Hill Book Company.
5. Lewin, B. (2004). *Genes VIII*. Pearson Prentice Hall.
6. Pelczar, M. J., Jr., Chan, E. C. S., & Krieg, N. R. (1986). *Microbiology* (5th ed.). McGraw-Hill Book Company.
7. Prescott, L., Harley, J. P., & Klein, D. A. (2008). *Microbiology* (7th ed.). Wm. C. Brown – McGraw Hill.
8. Snyder, L., & Champness, W. (2007). *Molecular genetics of bacteria* (3rd ed.). ASM Press.
9. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (2005). *General microbiology* (5th ed.). Macmillan.
10. Tortora, G. J., Funke, B. R., & Case, C. L. (2008). *Microbiology: An introduction* (9th ed.). Pearson Education.
11. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2004). *Molecular biology of the gene* (5th ed.). Pearson Education.
12. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2008). *Molecular biology of the gene* (6th ed.). Cold Spring Harbor Laboratory Press; Pearson Education.
13. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2008). *Prescott, Harley, and Klein's microbiology* (7th ed.). McGraw Hill Higher Education.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 5		
Course Code **255510338011**	**Name of Course** **Bacterial Metabolism**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**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

Detailed Syllabus

Unit-1. Enzymes and Energy (11h)

1.1 Enzyme kinetics: Michaelis-Menten equation,Lineweaver-Burk plot & its significance **(3h)**

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 **(3h)**

1.3 Energy: its generation & conservation: Laws of thermodynamics, free energy change, redox potential, exothermic and endothermic reactions; Energy rich compounds and their role; 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 **(5h)**

Unit-2. Chemoheterotrophic Metabolism (11h)

2.1. Utilizable substrates **(2h)**

2.2. Catabolism of glucose: Pathways of glucose degradation: EMP, ED & PP pathway; Fate of pyruvate under aerobic as well as anaerobic conditions **(3h)**

2.3. Tricarboxylic acid (TCA) cycle: Catabolic role of TCA cycle; Anabolic role of TCA cycle: Glyoxalate by pass and its significance **(3h)**

2.4. Catabolism of fatty acids and proteins: β-oxidation of fatty acids; Catabolism of amino acids: Deamination, decarboxylation, transamination, stickl and reaction **(3h)**

Unit-3. Chemoautotrophic and Phototrophic metabolism (11h)

3.1. Physiological groups of chemolithotrophs **(2h)**

3.2. Generation of ATP & reducing power in chemoautotrophs (forward and reverse ETC) **(3h)**

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 TCA cycle **(6h)**

Unit-4. Biosynthesis (12h)

4.1. Principles governing biosynthesis; Role of precursor metabolites, ATP, reducing power and their role Anaplerotic reactions and their role in biosynthesis **(2h)**

4.2. Assimilation of ammonia, nitrate, molecular nitrogen and sulfate **(2h)**

4.3. Biosynthesis of saturated and unsaturated fatty acids **(2h)**

4.4. Polymerization of: Amino acids into polypeptides; Nucleotides into polynucleotide; Fatty acids

into lipids; Biosynthesis of peptidoglycan **(4h)**

4.5. Methods of study in biosynthesis: Use of biochemical mutants, isotopes, pulse labeling and metabolic inhibitors **(2h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	2	2	2	2	1	2	1	1	2	2.0	3	2	3	2.6
CO-2	3	3	3	2	2	2	3	1	2	2	2	2	2.3	3	2	3	2.6
CO-3	3	2	2	2	1	2	2	1	2	1	1	2	1.8	3	2	3	2.6
CO-4	3	3	3	2	2	2	3	1	2	2	2	2	2.3	3	2	3	2.6
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
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CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Stanier, R. Y., Adelberg, E. A., & Ingraham, J. L. (1991). *General microbiology* (5th ed.). Macmillan Press.
2. Prescott, L., Harley, J. P., & Klein, D. A. (2008). *Microbiology* (7th ed.). Wm. C. Brown – McGraw Hill.

Online Resources & Tools:

- SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Microbiology) Semester- 5		
Course Code **255510338012**	**Name of Course** **Immunology**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to….
CO1: describe the components and functions of the immune system.
CO2: explain structure and types of antigens, 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.

Detailed Syllabus

Unit-1. Immunity and Immune response (11h)

1.1 Immunity: Concept of innate (native) and acquired (adaptive) immunity; Types of immunity; Innate immunity: species, racial and individual; Acquired immunity: active and passive; natural and artificial; Concept of herd immunity **(2h)**

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 **(3h)**

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 **(3h)**

1.4 Introduction to the advanced concepts of immunology: MHC and HLA; Clonal selection; Monoclonal antibodies **(3h)**

Unit-2. Antigens, Antibodies and their Reaction (11h)

2.1. Antigens: Concept of antigen, immunogen and hapten; Physico-chemical and biological properties of antigens; Various types of antigens; Antigens occurring in bacterial cell **(2h)**

2.2. Antibodies: Concept of antibody, immunoglobulin and myeloma proteins; Basic structure of Abs; Classes of Igs: Physicochemical and biological properties; Antibody diversity **(4h)**

2.3. Antigen-antibody reactions (serological reactions) & other immunological tests: 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 CMIR **(5h)**

Unit-3. Immune Disorders (11h)

3.1. Concept of hyper and hypo functioning of immune system **(4h)**

3.2. Types immune disorders: Hypersensitivity; Autoimmunity and auto immune disorders; Immuno deficiency; Tumor immunity; Transplantation immunity, concept of immune suppression **(7h)**

Unit-4. Immuno haematology and Immuno prophylaxis (12h)

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 **(6h)**

4.2. Immuno prophylaxis: Concept of immune prophylaxis; Types of vaccines; Schedule of vaccination; Hazards of vaccination **(6h)**

Mapping Matrix of POs, PSOs, and COs																
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	2	2	-	2	-	-	-	-	-	-	2.2	3	1	2	2.0
CO-2	3	3	2	-	-	2	2	-	-	-	-	-	2.4	3	2	3	2.6
CO-3	3	3	2	2	2	2	-	-	-	-	-	2	2.3	3	1	3	2.3
CO-4	3	3	3	2	2	2	3	-	-	-	-	3	2.25	3	2	3	2.6
Avg	3	3	2.3	2.0	2.0	2.0	2.5	-	-	-	-	2.5		3.0	1.5	2.8	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
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CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method					
			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	COs	Marks	Written Test	Assignment/Seminar	Quiz/Discussion
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	COs	Marks	Exam Component		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Atlas, R. M. (1997). *Principles of microbiology* (2nd ed.). Wm. C. Brown Publishers.
2. Prescott, L., Harley, J. P., & Klein, D. A. (2008). *Microbiology* (7th ed.). Wm. C. Brown–McGraw Hill.
3. Ananthanarayan, R., & Paniker, C. K. J. (2005). *Textbook of microbiology* (7th ed.). University Press.
4. Roitt, I. (2001). *Essential immunology* (10th ed.). Blackwell Science.
5. Kuby, J. (2000). *Immunology* (4th ed.). W. H. Freeman & Company.

Online Resources & Tools:

- SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Microbiology) Semester- 5		
Course Code **255510538013**	**Name of Course** **Molecular Genetics of Prokaryotes Bacterial Metabolism and Immunology Practical**	**Major**
Credit: 05	**Teaching Scheme: Practical (150)**	**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.

Detailed Syllabus

1. Isolation of lac$^-$ mutants of Escherichia coli using UV radiations as mutagen **(9h)**
2. Isolation of pigmentless mutant of *Serratia marcescens* using UV radiations as mutagen **(36h)**
   - **i)** Effect of cell density
   - **ii)** Inoculation before and after exposure
   - **iii)** Effect of photoreactivation
   - **iv)** Effect of different exposure times
3. Isolation of streptomycin resistant mutants of *Escherichia coli* by gradient plate method **(9h)**
4. Isolation of DNA (demonstration) **(1h)**
5. Estimation of glucose by Cole's method **(12h)**
6. Estimation of glucose by Nelson-Somogy's method **(9h)**
7. Estimation of protein by Folin-Lowry's method **(9h)**
8. Estimation of streptomycin by sodium nitroprusside method **(9h)**
9. Study of agglutination reaction: Widal test by slide agglutination and double dilution method **(6h)**
10. Demonstration of agar gel immune diffusion precipitation reaction **(6h)**
11. Determination of human blood group: ABO and Rh systems **(6h)**
12. Estimation of hemoglobin by Sahli's method **(9h)**
13. Total count of RBCs **(9h)**
14. Total count of WBCs **(9h)**
15. Differential count of WBCs: Field's staining and Leishman staining **(11h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	3	2	-	2	2	2	2	2	2	2	2.3	3	3	2	2.6
CO-2	3	3	3	-	-	2	3	2	2	2	2	-	2.4	3	3	2	2.6
CO-3	3	3	3	-	-	2	3	2	2	2	-	2	2.4	3	3	3	3.0
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

<table>
<tr><th colspan="4">Teaching Pedagogy</th></tr>
<tr><td>CO-1</td><td colspan="3">Discussion, Experiments, Hands-on activities, Team work, Demonstration method</td></tr>
<tr><td>CO-2</td><td colspan="3">Discussion, Experiments, Hands-on activities, Team work, Demonstration method</td></tr>
<tr><td>CO-3</td><td colspan="3">Discussion, Experiments, Hands-on activities, Team work, Demonstration method</td></tr>
<tr><th colspan="4">Assessment Method</th></tr>
<tr><td rowspan="4">Continuous Comprehensive Evaluation 40 Marks</td><td>COs</td><td>Marks</td><td>Exam Component</td></tr>
<tr><td>CO-1</td><td>13</td><td rowspan="3">Continuous Evaluation</td></tr>
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<tr><td>CO-3</td><td>13</td></tr>
<tr><td rowspan="4">Term-End Evaluation 60 Marks</td><td>COs</td><td>Marks</td><td>Exam Component</td></tr>
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<tr><th colspan="4">References</th></tr>
<tr><td colspan="4">• Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).</td></tr>
</table>

Program – B.Sc. (Microbiology) Semester- 5		
Course Code **255510438014**	**Name of Course** **Internship**	**Major**
Credit: 04	**Teaching Scheme: Experiential Learning (120)**	**Teaching Hours: 120**

Course Outcomes (COs)

After studying this course, the student will be able to….
CO1: understand the workflow of microbiology-related industries, labs, or research institutions.
CO2: enhance professional skills like documentation, communication, discipline, and ethics.
CO3: bridge the gap between theoretical knowledge and its practical application in microbiology
CO4: provide practical exposure to microbiological techniques in real-world settings

Detailed Syllabus

In-house as well as Institutional work carried out by students in the supervision of suitable guide. A bound copy of Internship report is necessary for evaluation.

- Student should develop an understanding about the workflow of microbiology-related industries, labs, or research institutions.
- Students should develop professional skills like documentation, communication, discipline, and ethics.
- The work undertaken should bridge the gap between theoretical knowledge and its practical application in microbiology.

Stages of Internship course

Orientation and Induction, Laboratory/Field Training/Project Work / Case Study, Report Writing, Presentation & Viva.

Suggested Areas of Internship

Student should undertake work aligned with the any field of microbiology to gain practical exposure to microbiological techniques in real-world settings.

- Medical Microbiology: Diagnostics, Pathogen testing, Antimicrobial resistance

- Food & Dairy Microbiology: Quality control, spoilage detection, Probiotic culture

- Environmental Microbiology: Water/wastewater analysis, Bioremediation

- Industrial Microbiology: Fermentation, Enzyme production

- Agricultural Microbiology: Biofertilizers, Soil microbiota

- Molecular Techniques: DNA extraction, PCR, Gel electrophoresis

Activities & Deliverables

- Maintain a daily work log

- Conduct experiments or observations

- Attend team meetings or field visits

- Submit a final internship report (10–15 pages)

- Give a presentation to internal faculty

Mapping Matrix of POs, PSOs, and COs																
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	1	2	2	3	2	2	2	1	2	**2.1**	3	2	3	2.7
CO-2	2	2	2	1	3	3	2	3	2	2	1	2	2.1	2	2	2	2
CO-3	3	3	3	1	2	2	3	2	3	2	2	2	**2.3**	3	3	3	3
CO-4	3	2	3	1	2	2	3	2	3	2	2	2	**2.3**	3	3	3	3
Avg	2.8	2.3	2.8	1	2.3	2.3	2.8	2.3	2.5	2	1.5	2		2.8	2.5	2.8	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Project-Based Learning (PBL)
CO-2 (Unit: 2)	Mentored Apprenticeship/Coaching
CO-3 (Unit: 3)	Reflective Practice/Journaling
CO-4 (Unit: 4)	Collaborative Problem-Solving

Assessment Method			
			Exam Component
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Continuous Evaluation**
	CO-1	10	
	CO-2	10	
	CO-3	10	
	CO-4	10	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	15	Term End Examination
	CO-2	15	
	CO-3	15	
	CO-4	15	

Program – B.Sc. (Microbiology) Semester- 5		
Course Code **255510238015**	**Name of Course** **Bio-Safety**	**Major**
Credit: 02	**Teaching Scheme: Theory (30)**	**Teaching Hours: 30**

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.

Detailed Syllabus

Unit-1. Introduction to Bio-safety in Clinical Laboratory (7h)

1.1 Implementation of Laboratory Health and Safety Program **(1h)**

1.2 Safe Laboratory Premises and Personal Safety Measures **(1h)**

1.3 Importance of CDC and NIH **(1h)**

1.4 Universal Precautions for Laboratories by CDC **(1h)**

1.5 Importance of CDC and NIH Special **(1h)**

1.6 Precautions Against HBV and HIV **(2h)**

Unit-2. Safe Methods For Managing Infectious Agents in Laboratory Environment (8h)

2.1. Safety Precaution against Infection **(2h)**

2.2. Containment **(1h)**

2.3. Bio-safety Levels **(2h)**

2.4. Bio-safety Levels of Infectious Agents Recommended by CDC **(1h)**

2.5. Biological Safety Cabinets **(2h)**

Unit-3. Bio-Safety Program (7h)

3.1. Responsibility for Safety **(3h)**

3.2. Responsibility of the Management **(3h)**

3.3. Responsibility of the Employee **(1h)**

Unit-4. Disposal of Medical Waste (8h)

4.1. Types of Bio-medical Waste **(1h)**

4.2. Major and Minor Sources of Bio-medical Waste **(1h)**

4.3. Hazards of Bio-medical Waste **(2h)**

4.4. Need for Disposal of Bio-medical Waste **(2h)**

4.5. Treatment and Disposal of Bio-medical Waste **(2h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	–	–	1	2	3	–	–	–	–	–	2.2	3	2	3	2.6
CO-2	3	2	–	–	–	2	3	1	–	–	–	–	2.2	3	2	3	2.6
CO-3	3	2	–	–	–	2	2	–	–	–	–	1	2.0	3	2	3	2.6
CO-4	3	3	–	1	–	2	3	–	–	–	2	–	2.3	3	2	3	2.6
Avg	3	3	0	1	1	2	2.75	1	0	0	2	1		3.0	2.0	3.0	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Ochei, J., & Kolhatkar, A. (2000). *Medical laboratory science: Theory and practice* (1st ed.). Tata McGraw-Hill Publishing. ISBN 9780074632239
2. Cheesbrough, M. (2006). *District laboratory practice in tropical countries* (Parts 1 & 2, 2nd ed.). Cambridge University Press. ISBN 9780521665469
3. Singh, A., & Kaur, S. (2012). *Biomedical waste disposal* (1st ed.). Jaypee Publication. ISBN 9789350255544
4. World Health Organization. (2004). *Laboratory biosafety manual* (3rd ed.). World Health Organization. ISBN 9789241546508

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 5		
Course Code **255510238016**	**Name of Course** **Blood Banking**	**Major**
Credit: 02	**Teaching Scheme: Theory (30)**	**Teaching Hours: 30**

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

Detailed Syllabus

Unit-1. Blood Cells (8h)

1.1 Blood cells – general characters of RBC, WBC and platelets; production and maturation; haemoglobin **(3h)**

1.2 Haemostatis – role of blood vessels, role of platelets **(3h)**

1.3 Blood coagulation – factors, intrinsic and extrinsic pathway **(2h)**

Unit-2. Blood Groups (7h)

2.1. Human blood group systems, principles of immuno hematology **(2h)**

2.2. Blood collection – preparation for blood collection **(3h)**

2.3. criteria for the selection of donor, registration of donor and blood collection procedure **(2h)**

Unit-3. Preservation of Blood (7h)

3.1. Transport and storage of blood **(2h)**

3.2. Organization in storage **(1h)**

3.3. Changes in stored blood **(2h)**

3.4. Preparation and use of blood components **(2h)**

Unit-4. Hematological tests (8h)

4.1. Significance of quality control in blood bank **(1h)**

4.2. Specimen collection for blood bank, laboratory preparations in blood bank **(2h)**

4.3. Hemagglutination reactions – ABO grouping (slide and tube test), Rh blood typing (slide and tube test) **(2h)**

4.4. Antihuman globulin (AHG) or Coombs test **(1h)**

4.5. Compatibility testing (cross matching) – major and minor, emergency cross matching **(1h)**

4.6. Transfusion reactions and hemolytic disease of the new born **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**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
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Baker, F. J., Silverton, R. E., & Pallister, C. J. (2001). *Introduction to medical laboratory technology* (7th ed.). Bounty Press.
2. Mukherjee, K. L. (2010). *Medical laboratory technology* (Vol. 1). Tata McGraw-Hill.
3. Godkar, P. B., & Godkar, D. P. (2003). *Textbook of medical laboratory technology*. Bhalani Publishing House.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 6		
Course Code **255510338017**	**Name of Course** **Genetic Engineering and Biotechnology**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**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

Detailed Syllabus

Unit-1. Fundamentals of Genetic Engineering (11h)

1.1 Introduction **(1h)**

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 **(6h)**

1.3 Site directed mutagenesis **(2h)**

1.4 Polymerase chain reaction **(2h)**

Unit-2. Construction of rDNA and its Transfer to Host Cell (11h)

2.1. Obtaining desired DNA fragment- Isolation from host, cDNA preparation and DNA synthesis **(2h)**

2.2. Protocol for joining isolated DNA with vector **(1h)**

2.3. Transfer of rDNA in to suitable host cell- transfection, gene gun, microinjection, protoplast fusion and electroporation **(4h)**

2.4. Selection of recombinant population: Use of marker genes and X- gal dye, colony hybridization, Gene probe: Southern blot & Western blot technique **(4h)**

Unit-3. Biotechnology and Techniques Employed (11h)

3.1. Introduction to biotechnology **(1h)**

3.2. Tissue culture: Plant and animal tissue culture **(3h)**

3.3. Analytical methods: Chromatography, electrophoresis, spectroscopy, molecular hybridization, DNA microarrays, ELISA, RIA, RAST **(7h)**

Unit-4. Areas of Application of Biotechnology (12h)

4.1. Agricultural biotechnology: Biofertilizers, bioinsecticides, genetically modified/transgenic plants **(3h)**

4.2. Enzyme biotechnology: Analytical, industrial and therapeutic applications **(2h)**

4.3. Environmental biotechnology: Bioremediation, biofuels and bioleaching, MEOR **(3h)**

4.4. Intellectual property rights and biotechnology **(2h)**

4.5. Ethical issues of biotechnology **(1h)**

4.6. Recent development in tools and techniques- CRISPR, gene editing **(1h)**

Mapping Matrix of POs, PSOs, and COs																
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	2	-	2	-	-	-	2	-	-	2	2.1	3	2	3	2.6
CO-2	3	3	2	-	-	2	3	-	2	-	-	2	2.4	3	3	3	3.0
CO-3	3	3	3	-	-	2	3	-	2	-	-	2	2.5	3	3	3	3.0
CO-4	3	3	-	2	2	3	2	-	3	-	-	3	2.6	3	2	3	2.6
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
	COs	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
Continuous Comprehensive Evaluation 40 Marks	**CO-1**	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Trevan, M. D., Boffey, S., Goulding, K. H., & Stanbury, P. F. (Eds.). (1987). *Biotechnology: The biological principles*. Tata McGraw-Hill.
2. Prescott, L., Harley, J. P., & Klein, D. A. (2008). *Microbiology* (7th ed.). Wm. C. Brown–McGraw Hill.
3. Atlas, R. M. (1997). *Principles of microbiology* (2nd ed.). Wm. C. Brown Publishers.

Online Resources & Tools:

- SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Microbiology) Semester- 6		
Course Code **255510238018**	**Name of Course** **Genetic Engineering and Biotechnology Practical**	**Major**
Credit: 02	**Teaching Scheme: Practical (60)**	**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

Detailed Syllabus

1) Separation of amino acids by paper chromatography **(3h)**
2) Separation of amino acids by thin layer chromatography **(3h)**
3) Demonstration of separation of components of India ink by paper electrophoresis **(3h)**
4) Immobilization of cells by calcium-alginate entrapment method and demonstration of activity by methylene blue reduction test **(9h)**
5) Isolation of DNA from *Escherichia coli* **(3h)**
6) Estimation of DNA by Diphenylamine method **(3h)**
7) Demonstration of Conjugation in *E.coli* **(18h)**
8) Demonstration of transformation **(18h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	3	-	-	-	3	-	2	-	-	1	2.5	3	3	2	2.6
CO-2	3	3	2	-	-	-	2	-	2	-	-	1	2.2	3	3	2	2.6
Avg	3.0	3.0	2.5	-	-	-	2.5	-	2.0	-	-	1.0		3.0	3.0	2.0	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Microbiology) Semester- 6		
Course Code **255510338019**	**Name of Course** **Virology and Mycology**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**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

Detailed Syllabus

Unit-1. Viruses (11h)

1.1 General characteristics and structural organization of virus **(1h)**

1.2 Cultivation of viruses: **(4h)**

a) Animal cultivation
b) Cultivation in embryonated eggs
c) In vitro culture: Cell Lines, primary and secondary cell lines, continuous cell lines, cytophathic effects
d) Cultivation of bacteriophage

1.3 Enumeration (assay) of viruses: Methods of enumeration of virus **(1h)**

1.4 Classification of viruses: PCNV, ICNV and Cryptogram system of viral classification **(2h)**

1.5 Sub-viral entities: Viroids, virusoids, prions, introduction to persistent, latent and slow viruses, oncogenic viruses **(3h)**

Unit-2. Bacterial / Plant / Animal Viruses (11h)

2.1. Bacteriophage lytic cycle (T4 Phage) **(5h)**

a) One step growth curve experiment, burst size
b) Phage adsorption and penetration, intracellular development, early and late events,replication of phage chromosome, phage morphogenesis and release
c) Host induced modifications
d) Introduction to single stranded DNA and RNA phages ØX174 and MS2

2.2. Bacteriophage lysogenic cycle (lambda phage): Mechanism of establishment of lysogeny, induction of lysogeny, phage-conversion, replication of lambda phage **(4h)**

2.3. Plant Viruses: Introduction and replication of plant viruses (TMV) **(2h)**

Unit-3. Fungi: General (11h)

3.1. General characters: Somatic structure, ultra-structure of fungal cell, hyphal modification **(3h)**

3.2. Cultivation of fungi **(3h)**

a) Principles of fungal nutrition
b) Cultivation media and methods, slide culture technique, prevention of bacterial contamination
c) Preservation of fungi

3.3. Importance of fungi **(5h)**

a) Primary and secondary metabolites of fungi and its importance
b) Diseases caused by fungi in plant

Unit-4. Fungi: Reproduction and Classification (12h)

4.1. Reproduction in fungi: Asexual and sexual methods of reproduction, parasexuality among fungi, fruiting bodies in fungi **(3h)**

4.2. Fungal classification: Criteria used for classification, recent classification system **(2h)**

4.3. Brief outline of different classes of fungi: (Structure, habitat, reproduction/life cycle and economic importance in general) **(7h)**

a) Phycomycetes (Phycomycotina)
b) Ascomycetes (Ascomycotina)
c) Basidiomycetes (Basiomycotina)
d) Deutromycetes (Duteromycotina)
e) Slime molds

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	-	-	2	3	-	2	-	-	2	2.4	3	2	3	2.6
CO-2	3	3	-	-	-	2	2	-	2	-	2	1	2.1	3	2	2	2.3
CO-3	3	2	2	2	-	2	2	-	2	-	2	2	2.1	3	2	3	2.6
CO-4	3	2	-	2	-	2	-	-	2	-	2	2	2.1	3	2	3	2.6
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method					
			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	COs	Marks	Written Test	Assignment/Seminar	Quiz/Discussion
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	COs	Marks	Exam Component		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

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.
3. Dube, H. C. (1990). *An introduction to fungi* (2nd ed.). Vikas Publishing House.
4. Biswas, S. B., & Biswas, A. (1984). *An introduction to viruses* (3rd ed.). Vani Educational Books.
5. Atlas, R. M. (1997). *Principles of microbiology* (2nd ed.). Wm. C. Brown Publishers.
6. Prescott, L., Harley, J. P., & Klein, D. A. (2008). *Microbiology* (7th ed.). Wm. C. Brown–McGraw Hill.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 6		
Course Code **255510238020**	**Name of Course** **Virology and Mycology Practical**	**Major**
Credit: 02	**Teaching Scheme: Practical (60)**	**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

Detailed Syllabus

1) Isolation of bacteriophage from sewage **(9h)**
2) Isolation and cultivation of yeasts **(9h)**
3) Cultivation of and microscopic examination of molds by slide culture technique **(9h)**
4) Cultivation and microscopic examination of molds—N*eurospora, Fusarium, Alternaria, Curvularia and Helminthosporium* **(24h)**
5) Study of plant diseases caused by Virus and Fungi—Mosaic, redrot, rust, smut, wilt, leaf curl, powdery mildew, downy mildew **(9h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	3	2	-	2	3	-	2	-	-	1	**2.4**	3	3	2	2.6
CO-2	3	3	2	2	-	3	2	-	2	-	-	2	**2.4**	3	3	3	3.0
Avg	3.0	3.0	2.5	2.0	-	2.5	2.5	-	2.0	-	-	1.5		3.0	3.0	2.5	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Microbiology) Semester- 6		
Course Code **255510338021**	**Name of Course** **Medical Microbiology**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**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

Detailed Syllabus

Unit-1. Host-Parasite Relationship (11h)

1.1 Concept of host- parasite Relation **(2h)**

1.2 Microbial pathogenicity: **(5h)**

a) Overview of bacterial and viral pathogenicity
b) Factors affecting the process of infection
c) Pathogenicity
   i. Invasiveness: Role of structures and secretions of bacteria
   ii. Toxigenicity: Protein and LPS toxins; their properties and mode of Action

1.3 Non-specific host defences **(4h)**

a) First line of (primary) defense: Physical and mechanical defense; role of skin and mucus membrane
b) Second line of (secondary) defense: cellular and chemical

Unit-2. Microbiota of Human Body and Epidemiology (11h)

2.1. Normal microbiota of human body **(5h)**

a) Importance, origin and establishment
b) Microbiota of various body parts
c) Gnotobiotic life and gnotobiosis

2.2. Epidemiology of infectious disease **(6h)**

a) Concept of Epidemiology
b) Epidemiological types of infections and emerging diseases
c) Techniques used to study epidemiology
d) Epidemiological markers
e) Disease cycle
f) Nosocomial infections: sources, transmission and their control

Unit-3. Microbial Diseases of Human Being (11h)

3.1. Airborne infections: Tuberculosis, influenza **(2h)**

3.2. Food and waterborne infections: Typhoid fever, food poisoning, hepatitis **(2h)**

3.3. Contagious diseases: Syphilis, AIDS **(2h)**

3.4. Arthropod borne diseases: Plague, yellow fever, malaria **(2h)**

3.5. Zoonoses: Rabies, anthrax **(3h)**

Unit-4. Clinical Microbiology (12h)

4.1. Specimen: Types of specimen, method of collection, storage and transport **(6h)**

4.2. Methods used for diagnosis and identification of pathogen **(6h)**

a) Microscopy
b) Growth and biochemical characteristics
c) Clinical immunology
d) Pathological changes in blood, body fluids and tissues
e) Significance of computer and possible use of biosensors

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	-	-	2	2	-	2	-	2	2	2.25	3	2	3	2.6
CO-2	3	2	-	2	-	2	2	-	2	-	2	2	2.1	3	1	3	2.3
CO-3	3	3	2	-	-	2	2	-	2	-	2	2	2.25	3	1	3	2.3
CO-4	3	2	2	-	-	2	2	2	2	-	-	2	2.1	3	2	2	2.3
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Prescott, L., Harley, J. P., & Klein, D. A. (2008). *Microbiology* (7th ed.). Wm. C. Brown–McGraw Hill.
2. Baker, F. J., Silverton, R. E., & Pallister, C. J. (1998). *Baker and Silverton's introduction to medical laboratory technology* (7th ed.). Butterworth-Heinemann.
3. Tortora, G. J., Funke, B. R., & Case, C. L. (2008). *Microbiology: An introduction* (8th ed.). Benjamin Cummings.
4. Ananthanarayan, R., & Paniker, C. K. J. (2005). *Textbook of microbiology* (7th ed.). University Press.
5. Roitt, I. (2001). *Essential immunology* (10th ed.). Blackwell Science.
6. Kuby, J. (2000). *Immunology* (4th ed.). W. H. Freeman & Company.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 6		
Course Code **255510238022**	**Name of Course** **Medical Microbiology Practical**	**Major**
Credit: 02	**Teaching Scheme: Practical (60)**	**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

Detailed Syllabus

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* **(30h)**
2) Demonstration of characterization of Gram-negative bacteria based on biochemical reactions using rapid identification kit **(9h)**
3) Study of antibiogram (using multidisc) **(9h)**
4) Physical and chemical analysis of urine **(3h)**
5) Estimation of blood urea by diacetyl monoxime method (DAM) **(3h)**
6) Study of permanent slides **(6h)**
   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*

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	3	2	1	2	3	2	2	2	2	1	2.2	3	3	2	2.6
CO-2	3	3	2	2	1	3	2	2	2	2	2	2	2.3	3	3	3	3.0
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Microbiology) Semester- 6		
Course Code **255510338023**	**Name of Course** **Fermentation Technology**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**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

Detailed Syllabus

Unit-1. Introduction toBioprocess & Fermentation media (12h)

1.1 Concept of fermentation and changing phases in industrial microbiology **(1h)**
1.2 Range of fermentation processes **(2h)**
1.3 Screening of industrially important organisms: **(2h)**
  a) Characteristics of an industrially ideal organism
  b) Primary screening of amylase, organic acid, antibiotics and aminoacid producers
  c) Primary screening of amylase, organic acid, antibiotics and aminoacid producers
1.4 Introduction to Fermentation media **(2h)**
  a) Principles of media formulation
  b) Media ingredients: Water, carbon sources, nitrogen sources, minerals, growth factors, buffers, precursors, inducers, inhibitors, antifoam agents
1.5 Sterilization of media **(2h)**
  a) Use of high-pressure steam: Principle, batch and continuous sterilization process
  b) Use of filtration: Principle, types of filters
1.6 Inoculum development: General principles for development of seed culture **(2h)**
1.7 Introduction to strain improvement **(1h)**

Unit-2. Bioreactor Design, Fermentation Economics, Modes of Operations and Control parameters (12h)

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 **(3h)**
2.2. Design of batch fermenter and continuous fermenter **(3h)**
2.3. Introduction tofermentation economics **(2h)**
2.4. Modes of Operations: Open and closed fermentation, surface culture fermentation, submerged culture (batch, fed-batch & continuous) fermentation, solidsubstrate fermentation **(2h)**
2.5. Operating parameters and their control: Aseptic operation, mass transferof oxygen, foam, pH & temperature **(2h)**

Unit-3. Downstream Processing and Quality Assurance and Safety Measurement (12h)

3.1. Introduction to downstream processes: Problems and designing **(1h)**
3.2. Removal of microbial cells and suspended solids **(2h)**
  a) Foam separation
  b) Precipitation
  c) Filtration

d) Centrifugation

3.3. Cell disruption methods **(2h)**
- a) Introduction
- b) Physico-mechanical methods
- c) Chemical methods

3.4. Product concentration and purification **(2h)**
- a) Liquid-liquid extraction
- b) Chromatography
- c) Membrane processes

3.5. Finishing stages **(2h)**
- a) Drying
- b) Crystallization

3.6. Quality assurance of products **(1.5h)**
- a) Bioassay
- b) Sterility testing
- c) Pyrogen testing

3.7. Manufacturing and environment safety **(1h)**
- a) Containment
- b) Clean room environment
- c) Effluent treatment

3.8. Introduction to scale-up **(0.5h)**

Unit-4. Typical Fermentation Processes (9h)

4.1. Penicillin fermentation **(2h)**
4.2. Citric acid fermentation **(2h)**
4.3. Ethanol fermentation **(1h)**
4.4. Vitamin B12 fermentation **(2h)**
4.5. Lysine fermentation **(1h)**
4.6. Amylase fermentation **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	2	1	2	2	2	2	2	2	2	2.1	3	2	3	2.6
CO-2	3	3	2	1	1	2	3	2	2	2	3	2	2.2	3	2	3	2.6
CO-3	3	3	2	1	1	2	3	2	2	2	3	2	2.2	3	2	3	2.6
CO-4	3	3	2	2	1	2	2	2	2	2	3	3	2.2	3	2	3	2.6
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

Continuous Comprehensive Evaluation 40 Marks			**Exam Component**		
	COs	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (1995). *Principles of fermentation technology* (2nd ed.). Pergamon Press.
2. Waites, M. J., & Morgan, N. L. (2002). *Industrial microbiology: An introduction*. Blackwell Science.
3. Crueger, W., & Crueger, A. (2000). *Biotechnology: A textbook of industrial microbiology* (2nd ed.). Panima Publishing Corporation.
4. Trevan, M. D., Boffey, S., Goulding, K. H., & Stanbury, P. F. (Eds.). (1987). *Biotechnology: The biological principles*. Tata McGraw-Hill.
5. Casida, L. E., Jr. (1968). *Industrial microbiology*. Wiley Eastern Ltd.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 6		
Course Code **255510238024**	**Name of Course** **Fermentation Technology Practical**	**Major**
Credit: 02	**Teaching Scheme: Practical (60)**	**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

Detailed Syllabus

1) Primary screening of amylase producers **(15h)**
2) Primary screening of organic acid producers **(5h)**
3) Primary screening of antibiotic producers by crowded plate method **(9h)**
4) Determination of OTR under static, sparging and shake flask condition by sulfite oxidation method **(6h)**
5) Fermentative production of amylase and its activity check **(9h)**
6) Bioassay of antibiotics using *Bacillus subtilis* **(6h)**
7) Sterility testing of pharmaceutical product **(10h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	3	2	1	2	3	2	2	2	2	1	2.2	3	3	2	2.6
CO-2	3	3	2	2	1	3	2	2	2	2	2	2	2.3	3	3	3	3.0
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	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

MINOR COURSE (Chemistry)

Program – B.Sc. (Microbiology) Semester- 1		
Course Code **254510337001**	**Name of Course** **Physical Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

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

CO-1: Interpret ionic equilibrium in terms of acid-base reactions, pH scale, Hydrolysis of salt, and buffer systems.

CO-2: Describe the relationship between physical properties and molecular structure

CO-3: Recognize the catalytic processes and adsorption phenomena

Detailed Syllabus

Unit-1 Ionic equilibrium (15h)

1.1 Degree of ionization **(1h)**

1.2 Ostwald dilution law and its limitations **(1h)**

1.3 pH scale **(2h)**

- Definition of pH and importance of pH scale
- Relation between pH and concentration of H^+ in solution
- pH range of acidic, basic solution
- Introduction about pOH, relation between pH and pOH, ionic product of water (K_w)

1.4 Hydrolysis of salts (from weak acid [HA] and strong base [BOH]) including derivation of

- $K_h = \frac{[HA][OH^-]}{[A^-]}$ **(2h)**
- $K_h = \frac{K_w}{K_a}$
- $h = \sqrt{\frac{K_h}{C}}$
- $pH = \frac{1}{2}[pK_w + pK_a + \log C]$

1.5Hydrolysis of salts (from weak base [BOH] and strong acid [HA]) including derivation of

- $K_h = \frac{[BOH][H^+]}{[B^+]}$ **(2h)**
- $K_h = \frac{K_w}{K_b}$
- $h = \sqrt{\frac{K_h}{C}}$
- $pH = \frac{1}{2}[pK_w - pK_b - \log C]$

1.6 Hydrolysis of salts (from weak acid [HA] and weak base [BOH]) including derivation of

- $K_h = \frac{[HA][BOH]}{[A^-][B^+]}$ **(2h)**
- $K_h = \frac{K_w}{K_a \times K_b}$
- $h = \sqrt{K_h}$
- $pH = \frac{1}{2}[pK_w + pK_a - pK_b]$

1.7 Buffer solutions **(2h)**

- Properties of buffer solutions

- Buffer capacity and buffer limit of buffer solution
- pH of buffer formed from weak acid and its salt including derivation of Henderson-Hasselbach equation
- pOH of buffer formed from weak base and its salt including derivation of Henderson-Hasselbach equation
- Action of buffer solutions in adjustment of pH during addition of acid or Base
- Buffer standards
- Importance of buffer solutions

1.8 Numericals based on topics 1.3 to 1.7 **(3h)**

Unit-2. Physical properties and molecular structure (15h)

2.1 Additive and constitutive properties **(1h)**

2.2 Molar volume: **(2h)**

- Additivity of molar volume
- Calculation of approximate molar volumes of given compound

2.3 Surface tension: **(2h)**

- Definition, unit
- Derivation of formula of relative surface tension of liquid
- Use of stalagmometer in determination of relative surface tension of liquid
- Numericals

2.4 Parachor:**(2h)**

- Relation between parachor, surface tension and molarvolume
- Calculation of approximate parachor of given compound
- Application of parachor
- Numericals

2.5 Viscosity: **(2h)**

- Definition, unit
- Derivation of formula of relative viscosity of liquid
- Use of Ostwal's viscometer in determination of relative viscosity of given liquid
- Numericals

2.6 Molar refraction: **(2h)**

- Definition and applications
- Molar refraction of mixture
- Measurement of refraction index by Abbe refractometer
- Numerical

2.7 Optical activity: **(2h)**

- Definition, measurement by polarimeter
- d / (+) / dextro, l /(-) / levo concept
- Numericals

2.8 Dipole moment, its measurement and its application **(2h)**

Unit- 3(A) Catalysis (8h)

3(A).1 Definition of catalyst and catalysis **(1h)**

3(A).2 Types of catalyst: Positive catalyst, negative catalyst and auto catalyst **(1h)**

3(A).3 Catalytic reaction:Homogeneous catalytic reaction and Heterogeneous catalytic reaction **(1h)**

3(A).4 Characteristics of catalyst **(1h)**

3(A).5 Action of finely divided catalyst **(1h)**

3(A).6 Catalytic promoters or activators **(1h)**

3(A).7 Catalytic poisons or anticatalysts **(1h)**

3(A).8 Enzyme catalyst: definition and characteristics **(1h)**

Unit- 3(B) Adsorption (7h)

3(B).1 Definition of adsorption, absorption, Positive adsorption, negative adsorption, absorbate, desorption **(1h)**

3(B).2 Types of adsorption (physical adsorption, chemical adsorption) **(2h)**
3(B).3 Adsorption of gases by solids **(1h)**
3(B).4 Freudlich and langmuir adsoption isotherm(derivation) **(2h)**
3(B).5 Application of adsorption **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	–	–	2	2	–	–	–	–	–	2.40	3	2	2	2.33
CO-2	3	2	–	–	–	2	1	–	–	–	–	–	2.00	3	1	3	2.33
CO-3	2	3	3	1	–	–	2	–	–	–	–	–	2.17	2	2	3	2.33
Avg	2.67	2.67	2.5	1.0	–	2.0	1.67	–	–	–	–	–		2.67	1.67	2.67	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
	COs	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
Continuous Comprehensive Evaluation 40 Marks	**CO-1**	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Puri, B. R., Sharma, L. R., & Pathania, M. S. (2022). Principles of Physical Chemistry (48th ed.). Vishal Publishing Co.
- Mahan, B.**h)**., & Meyers, R. J. (2020). University Chemistry (5th ed.). Pearson Education.
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- Raj, G. (2024). Advanced physical chemistry . Goel Publishing House.
- Viswanathan, B., Sivasanker, S., & Ramaswamy, A. V. (2011). Catalysis: Principles and applications (Reprint ed.). Narosa Publishing House.
- **Online Resources & Tools**:
  SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 1		
Course Code **254510237002**	**Name of Course** **Physical Chemistry Practical**	**Minor**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

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

CO-1: prepare chemical solutions accurately

CO-2: analyze physical properties of liquids and ability to determine catalytic and adsorption activity

Detailed Syllabus

1 Solution preparation (24h)

(1) General introduction ,Percentage solution: %v/v, %w/v **(4h)**

(2) Preparation and standardization of sodium hydroxide solution (approximately 0.1 N) **(4h)**

(3) To determine normality of given HCl/HNO_3 solution using standard sodium hydroxide Solution **(4h)**

(4) Preparation and standardization of hydrochloric acid solution (approximately 0.1 N) **(4h)**

(5) To determine normality of given NaOH/KOH solution using standard hydrochloric acid solution**(4h)**

(6) Preparation of molar and normal solution of H_2SO_4 and Na_2CO_3 **(4h)**

(B) Experiments of Physical chemistry (28h)

(1) To measure the density of a given liquid by R.D. bottle **(4h)**

(2) To determine the relative surface tension of a liquid with respect to water at room temperature by Stalagmometer **(4h)**

(3) To determine the surface tension of methyl alcohol, ethylalcohol and n-hexane at room temperature and calculate the atomic parachors of carbon,hydrogen and oxygen **(8h)**

(4) To determine the relative viscosity of a liquid with respect to water at room temperature by Ostwald's Viscometer **(4h)**

(5) To determine the composition of a given mixture consisting of two miscible liquids, A and B by viscosity Measurement **(4h)**

(6) To determine the refractive index of a given liquid and find its specific and molar refractivities **(4h)**

(C) Catalysis and Adsorption (8h)

(1) To determine the relative strength between HCl and H_2SO_4 by studying hydrolysis of methyl acetate **(4h)**

(2) To study the adsorption of an organic acid by Animal Charcoal. (Acetic acid /Oxalic acid) **(4h)**

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	3	–	–	2	2	–	–	–	–	–	2.40	2	3	2	2.33
CO-2	3	3	3	1	–	–	2	–	–	–	–	–	2.00	3	2	2	2.33
Avg	3.0	2.5	3.0	1.0	–	2.0	2.0	–	–	–	–	–		2.50	2.50	2.00	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method			
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	15	Continuous Evaluation
	CO-2	15	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

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- Patil, R. S., & Sawant, R. M. (2023). ***Laboratory manual of analytical chemistry*** (2nd ed.).Himalaya Publishing House.
- Furniss, B. S.,Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (2021). ***Vogel's textbook of practical organic chemistry*** (5th ed., Reprint). Pearson Education.

Program – B.Sc. (Microbiology) Semester- 2		
Course Code **254510337003**	**Name of Course** **Inorganic Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

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

CO-1: relate the elements and their periodic relationships

CO-2: express occurrence, chemical and physical properties of s, p, d and f-block elements

CO-3: recognize the importance of chemical elements and their diverse applications

Detailed Syllabus

Unit- 1(A) s- Block Elements (Alkali and Alkaline earth metals) (10h)

Group-1: Alkali metals

1(A).1 General introduction, electronic configuration, occurrence **(1h)**

1(A).2 Anomalous properties of the Lithium **(0.5h)**

1(A).3 Diagonal Relationship between Lithium and Magnesium **(0.5h)**

1(A).4 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii) **(1h)**

1(A).5 Trends in chemical reactivity with oxygen, water, hydrogen and halogens **(1h)**

1(A).6 Biological importance of sodium and potassium **(0.5h)**

1(A).7 Uses of Alkali metals **(0.5h)**

Group-2: Alkaline earth metal

1(A).8 General introduction, electronic configuration, occurrence **(1h)**

1(A).9 Anomalous properties of the Beryllium **(0.5h)**

1(A).10 Diagonal Relationship between Beryllium and Aluminium **(0.5h)**

1(A).11 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii) **(1h)**

1(A).12 Trends in chemical reactivity with oxygen, water,**h)**ydrogen and**h)**alogens **(1h)**

1(A).13 Biological importance of Mg and Ca **(0.5h)**

1(A).14 Uses of Alkaline earth metals **(0.5h)**

Unit- 1 (B)d-Block Elements Transition Elements (First, second and third Transition Series (5h)

1(B).1 General introduction, electronic configuration **(1h)**

1(B).2 Physical properties of transition metals **(0.5h)**

1(B).3Variation in Atomic and Ionic Sizes of Transition Metals **(1h)**

1(B).4 Ionisation Enthalpies of Transition Metals **(0.5h)**

1(B).5 Oxidation states of Transition Metals **(0.5h)**

1(B).6 Magnetic Properties of Transition Metals **(0.5h)**

1(B).7 Formation of coloured ions **(0.5h)**

1(B).8 Catalytic properties of Transition Metals **(0.5h)**

Unit- 2 p-Block Elements (10h)

2.1 General Introduction to p-Block Elements **(0.5h)**

Group 13 elements: Boron Family

2.2 General introduction, electronic configuration, occurrence **(0.5h)**

2.3 Anomalous properties of the Boron **(0.5h)**

2.4 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.5 Physical properties and chemical reactivity (with air, acids, alkalies and**h)**alogens) **(0.5h)**

2.6 Uses of boron, aluminium and their compounds **(0.5h)**

Group 14 elements: Carbon Family

2.7 General introduction, electronic configuration, occurrence **(0.5h)**

2.8 Anomalous properties of the carbon **(0.5h)**

2.9 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.10 Physical properties and chemical reactivity (with oxygen, water and halogens) **(0.5h)**

2.11 Allotropes of carbon (Diamond, Graphite and Fullerenes) and Uses of carbon **(0.5h)**

Group 15 elements: Nitrogen Family

2.12 General introduction, electronic configuration, occurrence **(0.5h)**

2.13 Anomalous properties of the Nitrogen **(0.5h)**

2.14 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.15 Physical properties and chemical reactivity (with hydrogen, oxygen,**h)**alogens and metals) **(0.5h)**

2.16 Uses of nitrogen and allotropes of Phosphorus (White, Red and Black) **(0.5h)**

Group 16 elements: Oxygen Family

2.17 General introduction, electronic configuration, occurrence **(0.5h)**

2.18 Anomalous properties of the Oxygen **(0.5h)**

2.19 Trends in the variation of properties (such as ionization enthalpy, electron gain enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.20 Physical properties and chemical reactivity (with hydrogen, oxygen and**h)**alogens) **(0.5h)**

2.21 Allotropes of Sulphur (Rhombic, Monoclinic) **(0.5h)**

2.22 Uses of oxygen, ozone, sulphur dioxide and sulphuric acid **(0.5h)**

Group 17 elements: Halogen Family

2.23 General introduction, electronic configuration, occurrence **(0.5h)**

2.24 Anomalous properties of the Fluorine **(0.5h)**

2.25 Trends in the variation of properties (such as ionization enthalpy, electron gain enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.26 Physical properties and chemical reactivity (with**h)**ydrogen, oxygen, metals and other halogens) **(0.5h)**

Group 18 elements: Noble gas Family

2.27 General introduction, electronic configuration, occurrence **(0.5h)**

2.28 Trends in the variation of properties (such as ionization enthalpy, electron gain enthalpy, atomic and ionic radii) **(0.5h)**

2.29 Physical properties and chemical reactivity **(0.5h)**

2.30 Uses of noble gases **(0.5h)**

Unit- 3(A) The lanthanide series (6h)

3(A).1 Electronic configuration **(1h)**

3(A).2 Oxidation states **(1h)**

3(A).3 Magnetic properties **(1h)**

3(A).4 Colour and absorption spectra of lanthanide ions **(1h)**

3(A).5 Lanthanide contraction **(1h)**

3(A).6 Separation and purification of lanthanides :Ion exchange and solvent extraction methods **(1h)**

Unit -3(B) The Actinide series (9h)

3(B).1 Electronic configuration **(1h)**

3(B).2 Oxidation states **(1h)**

3(B).3 Magnetic properties **(1h)**

3(B).4 Colour and absorption spectra of actinide ions **(1h)**

3(B).5 Actinide contraction **(1h)**

3(B).6 Nuclear synthesis of trans uranic elements **(1h)**
3(B).7 Chain reaction **(1h)**
3(B).8 Importance of uranium **(1h)**
3(B).9 Comparison with lanthanides **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	2	–	–	2	1	–	–	–	–	–	2.00	3	1	2	2.00
CO-2	3	3	2	1	–	–	2	–	–	–	–	–	2.20	3	1	2	2.00
CO-3	3	2	2	2	1	–	2	1	–	–	–	2	2.00	3	1	3	2.33
Avg	3.0	2.33	2.0	1.5	1.0	2.0	1.67	1.0	–	–	–	2.0		3.0	1.0	2.33	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

References

- Shriver, D. F., & Atkins, P. W. (2024). Inorganic Chemistry (7th ed.). Oxford University Press.
- Tandon, O. P. (2023). Inorganic Chemistry (6th ed.). S. Chand Publishing.
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- Elias, A. (2024). Chemistry of the p-Block Elements: Syntheses, Reactions, and Applications (1st ed.). Universities Press.

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- Cotton, S. (2024). Lanthanide and Actinide Chemistry (2nd ed.). John Wiley & Sons.
- Rai, B. K., Bretana, A., Morrison, G., Greer, R., Gofryk, K., & zur Loye,H.-C. (2024). Crystal Structure and Magnetism of Actinide Oxides: A Review. arXiv.https://arxiv.org/abs/2403.01634

Online Resources & Tools:

SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 2		
Course Code **254510237004**	**Name of Course** **Inorganic Chemistry Practical**	**Minor**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

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

CO-1: identify ions in inorganic mixtures by dry tests

CO-2: identify ions in inorganic mixtures by wet tests

Detailed Syllabus

Qualitative analysis of inorganic mixture (60h)

Semi-micro method of analysis of mixture of powders containing four radicals excluding soluble PO43-, arsenite, arsenate and borate.Mixture may be partly soluble in water and wholly soluble in an acid. Candidate should perform the analysis of following ions: Na^{+}, K^{+}, NH^{4+}, Mg^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Fe^{2+}, Fe^{3+} , Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Sn^{2+}, Ag^{+} and $S^{2-,}$ SO_3^{2-}, SO_4^{2-}, CO_3^{2-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-}, NO_2^{-}

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	3	–	–	1	2	–	–	–	–	–	2.2	2	3	1	2
CO-2	3	3	3	–	–	1	2	–	–	–	–	–	2.4	2	3	1	2
Avg	3.0	2.5	3.0	–	–	1.0	2.0	–	–	–	–	–		2	3	1	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	15	Continuous Evaluation
	CO-2	15	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Kesavan, M. P. (2025). Inorganic Semi-Micro Qualitative Analysis. LAP Lambert Academic Publishing.
- Mukherjee, G. N. (2008). Semi-Micro Qualitative Inorganic Analysis. University of Calcutta Press.
- Vogel, A. I., & Svehla, G. (1979). Text-book of Macro and Semi-Micro Qualitative Inorganic Analysis (5th ed.). Longman.

Program – B.Sc. (Microbiology) Semester- 3		
Course Code **255010337005**	**Name of Course** **Organic Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

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

CO-1: state the concepts of stereochemistry and the mechanism of electrophilic substitution reactions

CO-2: describe the chemistry underlying the synthesis and behavior of amino acids, peptides, and proteins.

CO-3: identify aromatic and antiaromatic systems using delocalization and resonance criteria.

Detailed Syllabus

Unit-1 (A): Stereochemistry (8h)

1(A).1 Definition of stereochemistry and stereoisomerism **(0.5h)**

1(A).2 Configurational isomers: cis-trans isomers (for acyclic and cyclic compounds) **(0.5h)**

1(A).3 E-Z nomenclature **(1h)**

1(A).4 Chirality **(1h)**

1(A).5 Configurational isomers: isomers with one & more than one chiral centre (Lactic acid, Tartaric acid, 2,3-dibromopentane, 3-chloro-2-butanol): enantiomers, diastereomers, mesocompounds **(2h)**

1(A).6 R-S nomenclature (one and more than one chiral centre) **(2h)**

1(A).7 Conformational analysis of ethane and n-butane only **(1h)**

Unit-1 (B): Aromatic substitution reaction (7h)

1(B).1 Introduction about electrophilic and nucleophilic substitution reactions **(1h)**

1(B).2 Electrophilic reagent / electrophilic substitution reaction **(0.5h)**

1(B).3 Mechanism of nitration, sulphonation, halogenation, friedal craft alkylation, friedal craft acylation **(2h)**

1(B).4 Classification of substituents groups **(0.5h)**

1(B).5 Theory of orientation of second group in monosubstituted benzene [first substituent is activating / deactivating group] **(1h)**

1(B).6 Orientation of third group in disubstituted benzenes **(0.5h)**

1(B).7 Conversion [reactions form] based on above topics **(1.5h)**

Unit-2 Aminoacids, Peptides and Protein (15h)

2.1 General structure of aminoacids **(1h)**

2.2 Classification and nomenclature of amino acids**(1h)**

2.3 Configuration of amino acids: D and L notation **(1h)**

2.4 Preparation of amino acids: Amination of α-haloacids, Gabriel phthalamide synthesis, strecker synthesis **(2h)**

2.5 Zwitter ion (dipolar ion) **(1h)**

2.6 Isoelectric point of amino acids **(1h)**

2.7 Reaction of amino acid with ninhydrine (not structural reaction) **(1h)**

2.8 Peptide linkage (dipeptides, tripeptides, polypeptides) **(1h)**

2.9 Geometry of peptide linkages **(1h)**

2.10 Determination of structure of peptides **(2h)**

- N-terminal residue analysis (DNFB method, Phenyl isothiocynate method)
- C-terminal residue analysis(by thiohydantoin and with carboxypeptidase enzyme)

2.11Work out the sequence of amino acid residues from given peptides **(1h)**

2.12 The strategy of peptide synthesis (Benzyloxycarbonyl method) **(1h)**

2.13Overview of primary, secondary,tertiary and quternary structure of proteins **(1h)**

Unit-3 Electron delocalization, Resonance and Aromaticity (15h)

3.1 Delocalization electron and resonance **(1h)**

3.2 How to draw resonance contributors: rules for drawing resonance contributors (3h)

3.3 The resonance hybrid **(2h)**

3.4 Resonance energy **(1h)**

3.5 Stability of allylic and benzylic cations **(2h)**

3.6 Stability of allylic and benzylic radicals **(2h)**

3.7 Criteria for aromaticity **(1h)**

3.8 Aromaticity **(2h)**

3.9 Antiaromaticity **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	–	–	2	2	–	–	–	–	–	2.40	3	2	2	2.33
CO-2	3	2	–	–	–	2	1	–	–	–	–	–	2.00	3	1	3	2.33
CO-3	2	3	3	1	–	–	2	–	–	–	–	–	2.17	2	2	3	2.33
Avg	2.67	2.67	2.5	1.0	–	2.0	1.67	–	–	–	–	–		2.67	1.67	2.67	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

References

- Clayden, J., Greeves, N., Warren, S., & Wothers, P. (2012). Organic chemistry (2nd ed.). Oxford University Press.
- Eliel, E. L., & Wilen, S.H. (1994). Stereochemistry of organic compounds (Rev. ed.). Wiley.
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Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 3		
Course Code **255010337006**	**Name of Course** **Organic Chemistry Practical**	**Minor**
Credit: 03	**Teaching Scheme: Practical (90)**	**Teaching Hours: 90**

Course Outcomes (COs)

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

CO-1: demonstrate proficiency in performing qualitative analysis of organic compounds using standard laboratory techniques.

CO-2: apply appropriate methods and safety protocols to synthesize organic compounds effectively in a laboratory setting.

Detailed Syllabus

(A) Preparation of organic compounds and its confirmation by function group test and M.P (with mole ratio calculation) (30h)

(1) Oxidation: Benzoic acid from benzaldehyde by $KMnO_4$

(2) Nitration: p-nitroacetanilide from acetanilide

(3) Nitration: 1,3-dinitrobenzene from nitrobenzene

(B) Qualitative analysis of organic compounds (60h)

Candidates are expected to perform the following tests for the organic compounds

(1) Nature of compound: acidic, basic, phenolic, neutral based on solubility tests

(2) Presence of elements: Lassaigne's test (C,H, N,S,X)

(3) Identification of functional groups:

-COOH, >C=O

-OH (alcoholic), $-NH_2$

-OH (phenolic), $-NO_2$

$-CONH_2$

-CH, -X

(4) B.P. / M.P.

(5) Identification of compound

List of organic compounds for qualitative analysis

Compounds	Acidic	Basic	Phenolic	Neutral
C, H, O elements	Tartaric acid Citric acid Phthalic acid Benzoic acid Oxalic acid Succinic acid	-	Phenol α-Naphthol β-Naphthol Resorcinol	Methanol Ethanol Benzaldehyde Acetone Acetophenone Benzene Toluene Naphthalene
C, H, O, N elements	Anthranilic acid p-Nitrobenzoic acid	Aniline o-Nitroaniline m-Nitroaniline p-Nitroaniline α-Naphthylamine	o-Nitrophenol p-Nitrophenol	Acetamide Benzamide Nitrobenzene Urea
C, H, O, N, S elements	-	-	-	Thiourea
C, H, O, X elements	-	-	-	Chloroform Carbontetrachloride Chlorobenzene Bromobenzene

Mapping Matrix of POs, PSOs, and COs																	
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	–	–	2	2	–	–	–	–	–	2.40	2	3	1	3
CO-2	3	3	3	1	–	–	2	–	–	–	–	–	2.00	2	3	2	2.33
Avg	3.0	2.5	3.0	1.0	–	2.0	2.0	–	–	–	–	–		2	3	1.5	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method			
Continuous Comprehensive Evaluation 40 Marks	COs	Marks	Exam Component
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	COs	Marks	Exam Component
	CO-1	30	Term End Examination
	CO-2	30	

References

- Vogel, A. I., Tatchell, A. R., Furniss, B. S.,Hannaford, A. J., & Smith, P. W. G. (1996). Vogel's Textbook of Practical Organic Chemistry (5th ed.). Prentice Hall PTR.
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- Liskin, D., Brunke, K., & Carney, J. (2023). Organic Chemistry Laboratory Manual (5th ed.). Kendall Hunt Higher Education.
- Singh, S. K. (2017). Lab manual of qualitative and quantitative analysis. Manakin Press.

Program – B.Sc. (Microbiology) Semester- 4		
Course Code **255010337007**	**Name of Course** **Organic Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

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

CO-1: interpret ionic equilibrium in terms of acid-base reactions, pH scale, hydrolysis of salt and buffer systems.

CO-2: describe the relationship between physical properties and molecular structure

CO-3: recognize the catalytic processes and adsorption phenomena

Detailed Syllabus

Unit-1 Heterocyclic compounds (15h)

1.1 Introduction **(1h)**

1.2 Nomenclature of heterocycles: **(3h)**

-systematic nomenclature system for naming three to ten membered monocyclic hetero cycles of various unsaturation containing one or more hetero atoms

-system of nomenclature is based on the trivial and semitrivial names of heterocycles [Pyrrole, Furan, Thiophene, Selenophene, Pyrazole, Imidazole, Isoxazole, Pyridine, Pyridazine, Pyrimidine, Pyrazine, Pyrene, Indole, Isoindole, Purine, Quinoline, Isoquinoline]

-nomenclature systems for fused heterocycles

Five membered heterocyclic compounds [Pyrrole, Furan, Thiophene]

1.3 Source of pyrrole, furan and thiophene **(1h)**

1.4 Aromaticity and orbital structure of pyrrole,furan and thiophene **(1h)**

1.5 Preparation of pyrrole,furan and thiophene **(1h)**

1.6 Orientation of electrophilic substitution in pyrrole,furan and thiophene **(1h)**

1.7 Relative reactivity toward electrophilic aromatic substitution in pyrrole, furan, thiophene and benzene **(1h)**

Six membered heterocyclic compounds [Pyridine]

1.8 Source of pyridine compound **(1h)**

1.9 Aromaticity and orbital structure of pyridine **(1h)**

1.10 Basicity of pyridine including comparison with basicity of pyrroleand aliphatic amine **(1h)**

1.11 Orientation of electrophilic and nucleophilic substitution in pyridine **(2h)**

1.12 Relative reactivity toward electrophilic aromatic substitution in benzene, pyridine **(1h)**

Unit-2 Carbohydrates (15h)

2.1 Definition and classification **(0.5h)**

2.2 Nomenclature **(0.5h)**

2.3 D and L notation **(0.5h)**

2.4 Configuration of aldose and ketose containing three through six carbon atoms **(2h)**

2.5 General properties of monosaccharide (Glucose and Fructose): colour, taste, physical state, solubility **(0.5h)**

2.6 Chemical properties of monosaccharide (Glucose and Fructose): acetylation, oxidation, reduction, cynohydrin formation, oxime formation, osazone formation **(2.5h)**

2.7 Epimers, epimers of D-glucose, conversion of an aldohexose into its C-2 epimer (mannose) **(1h)**

2.8 Methods of interconversion of sugars **(2h)**

- Lengthening the carbon chain of aldoses (The Kiliani Fischer synthesis: aldohexose from aldopentose)
- Shortening the carbon chain of aldoses (The Ruff degradation: aldopentose from aldohexose)

2.9 Configuration of (+) glucose: The Fischer proof **(2h)**

2.10 Cyclic structure of glucose **(2h)**

2.11Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and

cellulose) excluding their structure elucidation **(1.5h)**

Unit-3 Chemical Reactivity and Molecular Structure (Acid-Base Properties) (15h)

3.1 Theories of acids and bases **(1h)**

3.2 pK_a scale: relation between ionization constant Ka (pKa) , K_b (pK_b) with strength of organic acids and bases**(2h)**

3.3 Inductive effect and strength of organic acids/ bases**(2h)**

3.4 Effect of resonance on strength of acids and bases **(3h)**

3.5 Effect of hybridization on acidity and basicity of organic acids/ bases **(2h)**

3.6 Role of steric effect on strength of organic acids/bases **(2h)**

3.7 Effect of hydrogen bond on strength of organic acids **(2h)**

3.8 Keto-enol tautomerism **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	3	–	–	2	2	–	–	–	–	–	2.40	3	2	2	2.33
CO-2	3	2	2	–	–	2	1	–	–	–	–	–	2.00	3	1	3	2.33
CO-3	3	3	2	1	–	–	1	–	–	–	–	–	2.00	3	2	2	2.33
Avg	3.0	2.33	2.33	1.0	–	2.0	1.33	–	–	–	–	–		3	1.67	2.33	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Bruice, P. Y. (2024). Organic Chemistry (9th ed.). Pearson.
- Morrison, R. T., & Boyd, R. N. (2010). Organic Chemistry (7th ed.). Pearson Education IndiaClayden,
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- Pugh, A. (2021). Heterocyclic chemistry (1st ed.). University Press.
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- Sinnott, M. L. (2016). Carbohydrate chemistry and biochemistry: Structure and mechanism (2nd ed.). Royal Society of Chemistry.
- Smith, M. B. (2022). Organic chemistry: An acid–base approach (3rd ed.). CRC Press.
- Solomons, T. W. G., Fryhle, C. B., & Snyder, S. A. (2022). Organic chemistry (13th ed.). Wiley.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 4		
Course Code **255010337008**	**Name of Course** **Analytical Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

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

CO-1: demonstrate foundational knowledge of Analytical Chemistry and its significance in chemical analysis.

CO-2: explain the principles and procedures of acid-base and complexometric titrations.

CO-3: apply statistical tools for the evaluation and interpretation of analytical data.

Detailed Syllabus

Unit-1 (A)Introduction of analytical chemistry (7h)

1(A).1 Role of analytical chemistry **(1h)**

1(A).2 Classification of analytical methods: chemical and instrumental methods **(1h)**

1(A).3 Advantages and limitations of chemical and instrumental methods **(3h)**

1(A).4 Literatures of analytical chemistry **(1h)**

1(A).5 Safety in analytical / chemistry laboratory **(1h)**

Unit-1 (B)Complexometric titrations (8h)

1(B).1 Introduction **(0.5h)**

1(B).2Classification of ligands **(0.5h)**

1(B).3 Structure and acidic properties of EDTA **(0.5h)**

1(B).4 Complexes and formation constant:**h)**ow stable are complexes? **(1h)**

1(B).5 Effect of pH on EDTA equilibria**(1h)**

1(B).6 Types of EDTA titrations: direct titration, back titration, substitution titration **(1h)**

1(B).7 Indicators for EDTA titrations / metal ion indicators **(2h)**

- working mechanism
- Preliminary information of metal ion indicators- Murexide, Eriochrome black T, xylenol orange

1(B).8 Masking and demasking agents **(1.5h)**

Unit-2. Acid-base titrations (15h)

2.1 Introduction **(1h)**

2.2 Neutralization of strong acid with a strong base by pH metry **(2h)**

2.3 Neutralization of weak acid with a strong base by pH metry **(2h)**

2.4 Neutralization of weak base with a strong acid by pH metry **(2h)**

2.5 Titration of mixture of strong acid and weak acid / base by pH metry**(1h)**

2.6 Comparative study of different nature of curves for 2.2 to 2.5 **(1h)**

2.7 Acid-base indicators: definition, theory and Henderson-Hasselbach equation **(1h)**

2.8 Application of acid-base titrations **(2h)**

-Reagents for neutralization titrations: preparation and standardization of acids / bases

-The determination of inorganic substances (ammonium salts, nitrates and nitrites, carbonates and carbonate (mixtures)

-The determination of organic functional groups (carboxylic and sulphonic acid groups, amine groups, ester groups, hydroxyl groups (Phenolic), carbonyl groups)

2.9 Numerical based on 2.2 to 2.4, 2.7 **(3h)**

Unit-3. Statistics for analytical data (15h)

3.1 Limitation of analytical data **(0.5h)**

3.2 Accuracy and precision **(0.5h)**

3.3 Measurement of central tendency: mean, median and mode **(1h)**

3.4 Way of expressing accuracy: absolute error, relative error **(0.5h)**

3.5 Way of expressing precision: range, deviation, average deviation, relative average deviation, standard deviation, coefficient of variation, variance **(1h)**
3.6 Types of error in chemical analysis: systematic errors [instrumental error, errors of method, operative errors, personal errors] and random errors **(2h)**
3.7 The effect of systematic errors on analytical results: constant errors and proportional errors **(1h)**
3.8 Minimization of errors **(0.5h)**
3.9 Significant figure and computations **(1h)**
3.10 Confidence interval **(0.5h)**
3.11 Student's t-test: Are there difference in the methods? **(1h)**
-when accepted value is known
-comparison of the means of two samples
3.12 F-test: comparison of precision of two sets of data **(1h)**
3.13 Rejection of a result: the Q-test **(0.5h)**
3.14 Correlation coefficient: **(0.5h)**
- Pearson correlation coefficient
3.15 Linear regression **(0.5h)**
3.16 Numerical based on all topics **(3h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	3	–	1	2	2	–	–	–	–	–	2.17	3	2	2	2.33
CO-2	3	2	3	–	–	1	2	–	–	–	–	–	2.20	3	3	2	2.67
CO-3	3	3	2	–	–	2	3	–	2	–	–	–	2.50	2	2	3	2.33
Avg	3.0	2.33	2.67	–	1.0	1.67	2.33	–	2.0	–	–	–		2.67	2.33	2.33	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
	COs	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
Continuous Comprehensive Evaluation 40 Marks	**CO-1**	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References
• Christian, G. D., Dasgupta, P. K., & Schug, K. A. (2020). Analytical chemistry (7th ed.). Wiley. • Harris, D. C. (2015). Quantitative chemical analysis (9th ed.). W.H Freeman. • Skoog, D. A., West, D. M.,Holler, F. J., & Crouch, S. R. (2021). Fundamentals of analytical chemistry (10th ed.). Cengage Learning • Vogel, A. I. (1991). Vogel's textbook of quantitative chemical analysis (5th ed.). Longman Scientific & Technical Publishing Group. • Day, R. A., Jr., & Underwood, A. L. (2015). Quantitative analysis (6th ed.). Pearson Education India. **Online Resources & Tools**: • SWAYAM Courses: **https://swayam.gov.in**

Program – B.Sc. (Microbiology) Semester- 4		
Course Code **255010237009**	**Name of Course** **Organic and Analytical Chemistry Practical**	**Minor**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

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

CO-1: Perform systematic separation and qualitative analysis of components in organic mixtures using standard laboratory techniques..

CO-2: Execute EDTA titrations and pH-metric titrations with accuracy and adherence to analytical protocols.

Detailed Syllabus

(A) Qualitative analysis of organic mixture (28h)

Separation of two components from the mixture of organic compounds using semi-micro method, identification of compounds by lassaigne's test, functional group test, melting point / boiling point test

(1) Acids: Benzoic acid, Salicylicacid, Cinnamic acid, Phthalic acid , Anthranilic acid, Oxalic acid , Tartaric acid, p-nitrobenzoic acid

(2) Phenols: α-Naphthol, β-Naphthol, o-Nitrophenol, p-Nitrophenol, Resorcinol

(3) Amines: p-Toludine, o-Nitroaniline, m- Nitroaniline, p- Nitroaniline

(4) Neutral: Urea, Thiourea, Acetamide, Benzamide, Acetanilide, Glucose, Naphthalene

(B) EDTA titrations and pH metry titrations (32h)

(1) Determination of nickel: direct titration **(4h)**

(2) Determination of aluminium: back titration **(4h)**

(3) Determination of calcium: substitution titration **(4h)**

(4) Preparation of buffer solution from buffer tablets/various chemical mixtures **(4h)**

(5) Titration of HCl using standard solution of NaOH by pH metrically **(4h)**

(6) Titration of NaOH using standard solution of HCl by pH metrically **(4h)**

(7) Titration of CH_3COOH using standard solution of NaOH by pH metrically **(4h)**

(8) Titration of HCl + CH_3COOH using standard solution of NaOH by pH metrically **(4h)**

Mapping Matrix of POs, PSOs, and COs

COs	POs												PSOs				
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	2	2	3	-	-	-	2	-	-	2	-	1	2.00	2	3	1	2.00
CO-2	2	2	3	-	-	-	3	-	-	2	-	-	2.33	3	3	2	2.67
Avg	2	2	3	-	-	-	2.5	-	-	2	-	1		2.50	3.00	1.50	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

<table>
<tr><th colspan="4">Teaching Pedagogy</th></tr>
<tr><td>CO-1</td><td colspan="3">Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling</td></tr>
<tr><td>CO-2</td><td colspan="3">Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling</td></tr>
<tr><td>CO-3</td><td colspan="3">Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling</td></tr>
<tr><th colspan="4">Assessment Method</th></tr>
<tr><td rowspan="3">Continuous Comprehensive Evaluation 40 Marks</td><td>COs</td><td>Marks</td><td>Exam Component</td></tr>
<tr><td>CO-1</td><td>20</td><td rowspan="2">Continuous Evaluation</td></tr>
<tr><td>CO-2</td><td>20</td></tr>
<tr><td rowspan="3">Term-End Evaluation 60 Marks</td><td>COs</td><td>Marks</td><td>Exam Component</td></tr>
<tr><td>CO-1</td><td>30</td><td rowspan="2">Term End Examination</td></tr>
<tr><td>CO-2</td><td>30</td></tr>
<tr><th colspan="4">References</th></tr>
<tr><td colspan="4">• .Vogel, A. I., Tatchell, A. R., Furniss, B. S.,Hannaford, A. J., & Smith, P. W. G. (1996). Vogel's Textbook of Practical Organic Chemistry (5th ed.). Prentice Hall PTR.
• Flaschka,H A. (2013). EDTA Titrations: An Introduction to Theory and Practice (2nd ed.). Elsevier.</td></tr>
</table>

MDC

AEC

VAC

SEC

Annexure-1

Multidisciplinary Course (MDC) (3 Courses x 3 Credits = Total 9 Credits)

(For semester 1 to 3)

Multi-Disciplinary Courses (MDC) (3 Courses x 3 Credits = Total 9 Credits)			
No.	**Course**	**Department/Centre**	**Course Code**
1	Information, Communication and Media	Journalism	254510346801
2	Introduction to Commerce and Management	Commerce	254510358801
3	Social Science and Language	Gujarati	254510301801

Annexure-2

Ability Enhancement Course (AEC) (4 Courses x 2 Credits = Total 8 Credits)

(For semester 1 to 4)

Ability Enhancement Courses (AEC) (4 Courses x 2 Credits = Total 8 Credits)			
No.	**Course**	**Department/Centre**	**Course Code**
1	English for Communication	English	254510203601
2	Introduction to Gujarati Language	Gujarati	254510201601
3	Gujarati	Gujarati	254510201602
4	Hindi	Hindi	254510202601
5	Sanskrit	Bhartiya Bhasha Sanskriti Santhan	254510263601
6	Marathi	Bhartiya Bhasha Sanskriti Santhan	254510263602
7	Punjabi	Bhartiya Bhasha Sanskriti Santhan	254510263603
8	Malyalam	Bhartiya Bhasha Sanskriti Santhan	254510263604
9	Kannada	Bhartiya Bhasha Sanskriti Santhan	254510263605
10	Telugu	Bhartiya Bhasha Sanskriti Santhan	254510263606
11	Tamil	Bhartiya Bhasha Sanskriti Santhan	254510263607
12	Urdu	Bhartiya Bhasha Sanskriti Santhan	254510263608
13	Sindhi	Bhartiya Bhasha Sanskriti Santhan	254510263609
14	Bengali	Bhartiya Bhasha Sanskriti Santhan	254510263610
15	French	Bhartiya Bhasha Sanskriti Santhan	254510263611
16	Spanish	Bhartiya Bhasha Sanskriti Santhan	254510263612
17	German	Bhartiya Bhasha Sanskriti Santhan	254510263613
18	Chinese	Bhartiya Bhasha Sanskriti Santhan	254510263614
19	Japanese	Bhartiya Bhasha Sanskriti Santhan	254510263615
20	Russian	Bhartiya Bhasha Sanskriti Santhan	254510263616
21	Pali	Puratattva Mandir	254510264601
22	Prakrit	Puratattva Mandir	254510264602

Annexure-3

Value Added Course (VAC) (3 Courses x 2 Credits = Total 6 Credits) (For semester 1, 2 and 4)

Value Added Courses (VAC) (3 or 4 Courses x 2 Credits = Total 6 or 8 Credits)			
No.	**Course**	**Department/Centre**	**Course Code**
1	Understanding India: History, Constitution, and Cultural Heritage	Puratattva Mandir	254510264701
2	Environmental Education	Microbiology	254510238701
3	Health, Yoga and Sports	Physical Education (Sports)	254510232701

Annexure-4

Skill Enhancement Course (SEC) (3 Courses x 3 Credits = Total 9 Credits) (For semester 1 to 3)

Skill Enhancement Courses (SEC) (3 Courses x 3 Credits = Total 9 Credits)			
No.	**Course**	**Department/Centre**	**Course Code**
1	Appreciation of Indian Classical Instrument – Harmonium	Kala Mandir	254510362901
2	Appreciation of Indian Classical Music – Tabla	Kala Mandir	254510362902
3	Appreciation of Indian Classical Dance – Kathak	Kala Mandir	254510362903
4	Appreciation of Indian Classical Dance – Bharatnatyam	Kala Mandir	254510362904
5	Appreciation of Indian Art – Elementary Drawing	Kala Mandir	254510362905
6	Appreciation of Indian Classical Music – Vocal	Kala Mandir	254510362906
7	Drawing and Painting	Kala Mandir	254510362907
8	Sculpture	Kala Mandir	254510362908
9	Spinning and Handicraft	Gandhian Studies	254510314901
10	Dress Making (Khadi Clothes)	VIKAS	254510361901
11	Embroidery Skills	VIKAS	254510361902
12	Solar PV Technician	VIKAS	254510361903
13	Electric Vehicle Technology	VIKAS	254510361904
14	Electronics Technician	VIKAS	254510361905
15	Horticulture	Rural Planning & Development	254510316901
16	Principles of Seed Production	Rural Planning & Development	254510316902
17	Seed Certification and Quality Testing	Rural Planning & Development	254510316903
18	3D Printing and Design	Computer Science	254510345901

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