GOVERNMENT COLLEGE

RAJAHMUNDRY, ANDHRA PRADESH | AUTONOMOUS

ISO - 21001 : 2018, ACCREDITED BY - NAAC - A+

AFFILIATED TO ADIKAVI NANNAYA UNIVERSITY

DEPARTMENT OF MICROBIOLOGY

BOARD OF STUDIES

2025-2026

(Single Major & Minor-I, II, III, IV, V Semestesr as per BOS Regulations 2025-26)

INDEX

Coordinator
IQAC
Govt. College (A)
RAJAHMUNDRY

Proceedings of the Principal, Government College (Autonomous), Rajahmundry
Present: Dr. Ramachandra R.K, M.Sc., Ph.D.
Rc. No. 33/GCRJY /UG-BoS/ 2025-26 dt. 04.09.2025

Sub: Government College (A), Rajamahendravaram- UG Boards of Studies (BoS)- Nomination of Members – Orders issued.

Ref: 1. UGC Guidelines of for Autonomous Colleges-2023.
2. Proc.No.ANUR/DAA/2025, dated 30-08-2025 of the Vice-Chancellor, ANUR

Order

The Principal, Government College (Autonomous) Rajahmundry is pleased to nominate the following members to UG Board of Studies to frame the syllabus of **Microbiology subject** in all the semesters duly following the norms of the UGC regulations for the Autonomous colleges 2023.

S. No	Name	Designation
1	Smt. T. Sony	Chairman
2	All Faculty members in the department	Member
3	Dr.K.Aruna, Krishna University	Subject Expert
4	Dr.B.S.Anuradha, Dean, Academic Affairs, Department of Microbiology, Chaitanya Deemed to be University, Warangal	Subject Expert
5	Dr. A.Padmavathi, St.Theresa's College, Eluru	University Nominee
6	Mr.Y.Bobby Quality control Pharma labs pvt Ltd VL Puram Junction Rajmundry	Expert from Industry/Corporate Sector
7	Kum.P.Mahima Saroja	Alumnus

The above members are requested to attend the BoS meeting in September 2025 and share their valuable views, and suggestions on the following functionaries.

a) Prepare syllabi for the subject keeping in view the objectives of the college, interest of the stake holders and National requirement for consideration and approval of the IQAC and Academic Council
b) Suggest methodologies for innovative teaching and evaluation techniques
c) Suggest the panel of names to the Academic Council for appointment of Examiners
d) Coordinate research, teaching, extension and other activities in the department of the College.
e) Suggest CLO, PLO, PI and subject experts to develop question bank in compliance with Bloom's Taxonomy.

The above said members are requested to bestow their services for the successful organization of the event.

PRINCIPAL

GOVERNMENT COLLEGE
(AUTONOMOUS), RAJAHMUNDRY

GOVERNMENT COLLEGE (A), RAJAMAHENDRAVARAM
DEPARTMENT OF MICROBIOLOGY
BOARD OF STUDIES

Composition of BOS

The Board of Studies meeting of I, II, and III B.Sc Microbiology for all semesters for the academic year 2025-26, held in the Department of Microbiology on 15-09-2025 at 10:00 AM with Smt. T. Sony, Lecturer in-Charge, in the chair along with the following members.

1. **Chairman** : Smt. T. Sony, Head of the Department of Microbiology, GC (A), Rajamahendravaram.
2. **Faculty Member** : Dr. T. Sujatha, Lecturer in Microbiology, GC (A), RJY
3. **Subject expert** : Dr. K. Aruna, Krishna University , 9490040657, kopuriarunadl@gmail.com
4. **Subject expert :** Prof Dr. B.S. Anuradha, Dean Academic Affairs , Dept of Microbiology, Chaitanya Deemed to be University, 9849569224, anuradharavikumar1970@gmail.com
5. **University Nominee:** Dr. A. Padmavathi, H. O. D of Microbiology and Biochemistry, C. H. S. D. St. Theresa's College for Women (A), Eluru, 9440581035, dr.padmavathi@stcelr.ac.
6. **Expert from Industry:** Mr. Y. Bobby HOD Quality control Pharma Labs Pvt
7. **Student Nominee**: Kum. P. Mahima Saroja

Co-ordinator
IQAC
Govt. College (A)
RAJAHMUNDRY

GOVERNMENT COLLEGE (A), RAJAMAHENDRAVARAM
DEPARTMENT OF MICROBIOLOGY
Minutes of Board of Studies 2025-2026

The Board of Studies meeting for I, II, and III B.Sc. Microbiology of all semesters for the academic year 2025-2026, was held at 10 AM on 15/09/2025. The Chairperson Smt. T .Sony & other members of the Board of Studies met in the department of Microbiology, Government College Rajahmundry and discussed the following agenda points:

AGENDA

1. Introduction of B.Sc. Microbiology Honours- Major and Minors B.Sc. Microbiology w.e.f the academic year 2025-2026. For B.Sc. II,III year regulations will be as per BOS conducted in year 2024-2025.
2. Approval of course framework, syllabus and work load for first year Microbiology Major and Microbiology Minor. Assigning and discussion on Program Outcomes and Course Out comes for the above programs.
3. Mode of instruction –Blended with offline & online teaching & learning.
4. Model question papers, Assignments question for each course as part of continuous internal assessment & blue prints for each course.
5. Panel of Question Paper Setters & Examiners.
6. SEE: CIA evaluation
7. Proposal for Extension Activities like Community Service / Field Trips/ Study tours/Student Study projects/Industrial Visits/ Lab to school/ Extension Lectures / Green Initiatives for the students
8. Enrolling students in SWAYAM / MOOC courses of Microbiology & IPRs
9. Certificate course on " Food technology".
10. Any other proposal with the permission of the chairman

BOARD OF STUDIES MEETING 2025-26,
15 September -2025

Resolutions:
Agenda point-1:

Introduction of B.Sc. Microbiology- Major and B.Sc. Microbiology Minors for first & second year students w.e.f the academic year 2025-2026 as per the directions given by APSCHE and Department of Higher education, A.P.

Discussion:

The members of BOS discussed the curriculum under NEP & APSCHE & University Guidelines for UG B.Sc. Microbiology for implementation of courses designed by department of Microbiology, Government College Autonomous, Rajahmundry, in tune with decision of introducing UG Minor and Major Government of AP.

Resolution: I.A

It is resolved to approve the introducing Microbiology major and Minor course for B.Sc. students by the Department of Microbiology according to our Teaching, Learning and Evaluation pattern which are in force at present.

Resolution: I.B.

It is also resolved to continue the same course structure for II & III B.Sc. Microbiology Honours as per BOS 2024-2025.

Agenda point-2:

Approval of course framework, syllabus and work load for Microbiology Major and Microbiology Minor. Assigning and discussion on Programme Outcomes and Course Out comes for the above programmes.

Discussion:

The members of the BOS discussed the Course framework, workload / Hours per week for microbiology major and Minor. The subject experts gave necessary suggestions wherever necessary for the setting up of syllabus for Both Major and Minor. Members of BOS also discussed Programme Outcomes and Course Outcomes for the above programmes.

Resolution: II.A

It is resolved to approve the course framework and work load of each course for microbiology major and minor.

Resolution-II.B.

It is also resolved to approve the syllabus for I semester to IV semester Microbiology major and Microbiology Minor with effect from the academic year 2025-2026. (The approved syllabus copy attached with this resolutions).

Resolution-II.C.

It is resolved to approve the Programmes codes and course codes assigned to the new B.Sc Microbiology Major and Microbiology Minor programmes

Agenda point III: - Mode of instruction –Blended with offline & online teaching & learning.

Discussion: The members of BOS discussed about the mode of instruction in both offline & online mode in 80:20. Eighty percent of teaching will be offline. Twenty percent of online instruction includes online test, online quizzes, LMS , YouTube lessons, free links for subject content.

Resolution III: The members resolved to follow the blended mode of teaching & learning in 80:20 ratios as discussed above.

Agenda point IV - Model question papers, Assignments question for each course as part of continuous internal assessment & blue prints for each course.

Discussion: The members of BOS discussed about changes in Model question papers& blue prints, Assignments question for each course as part of continuous internal assessment. Members suggested giving Course Outcomes & level of learning for `each course.

Resolution IV A

For ALL Semesters -The question paper is divided into two parts. The first part comprises of sections A having essay questions. Each essay question allocated 08 marks.

- The part 2 is of very short answer type questions/ Objective with 1 mark for each one. There will be 10 questions in part 2.
- The detailed split up of questions and marks allocated in the two sections is shown in detail in the following table.

- This blue print will be applicable for Semester two onwards of the single major course =in Microbiology for the new regulation taken up from 2025-26 academic years.
- The members of BOS unanimously approved the Blue Print, Model Question Papers & Assignment Questions for each course.

Resolution IVA. It is resolved to approve the given course outcomes for each course & levels of learning.

Life Sciences - Major Programmes B.Sc Microbiology honours & Minor Programmes B.Sc Botany Honours

Blue Print for Question Papers

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B (Short Answers) (With choice –any 5)	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-2	8 Marks / 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-3	8 Marks / 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-4	8 Marks / 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-5	8 Marks / 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M

SECTION - A **5X8=40Marks**

Draw labelled diagrams wherever necessary.

1. (a) – (i) and (ii) Or (b) - (i) and (ii) – if split essay
2. (a) or (b) – If an essay
3. (a) or (b) – If an essay
4. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
5. (a) or (b) – If an essay

SECTION – B **5X2=10 Marks**

Answer any 5 of the following questions.

6. From Unit-1
7. From Unit-1
8. From Unit-2
9. From Unit-2
10. From Unit-3
11. From Unit-3
12. From Unit-4
13. From Unit-5

Agenda point V: Panel of Question Paper Setters & Examiners

Discussion: The members of BOS discussed Panel of Paper Setters & Examiners and updated the same.

Resolution V: It is resolved to approve the list of Examiners & Paper Setters enclosed for the next academic years.

Agenda point VI: SEE (Semester End Examination): CIA evaluation

Discussion: The members present discussed the SEE: CIA evaluation and ratified the same. CIA would consist of two internal exams of 20 marks.

One online test for 10 marks. 5 marks for attendance, 5 marks for seminar,5 marks for SASA, 5 marks for assignment 1& 2. SEE for 50 marks.

Resolution VI: Resolved to approve 50:50 CIA & SEE evaluation pattern for I, II & III year B.Sc. students.

Agenda point VII: Proposal for Extension Activities like Community Service / Field Trips/ Study tours/Student Study projects/Industrial Visits/ Extension Lectures / Green Initiatives for the students.

Discussion: The members present discussed the need for Co-Curricular activities to enhance learning process & holistic approach to Microbiology subject.

Resolution VII: It is resolved to approve to conduct the above Co-Curricular activities during the course time. It is also approved that the co-curricular activities & additional inputs does not carry any Marks /Credits.

Agenda point VIII: Enrolling students in SWAYAM / MOOCs courses of Microbiology & IPRs.

Resolution VIII: It is resolved to enroll all B.Sc. students in Microbiology & related online courses through SWAYAM / MOOCs platforms.

Agenda point VIII: Any other proposal with the permission of the chairman

Resolution VIII : It is resolved to approve the above course structure for admitted batch **2025 – 2026**

Agenda point IX: Certificate course for the academic year 2025-26. Course title, framing syllabus, model papers and scheme of valuation and blue print etc.

Discussion: The members of BOS discussed about the title of the course as FOOD TECHNOLOG and syllabus includes Fundamentals of Food Science, Microbiology of food, food processing, preservation, processing, nutritional aspects of food. Members suggested to follows the same question paper model as discussed above.

Resolution IX: The members resolved to conduct FOOD TECHNOLOGY certificate course for this academic year. It is also resolved to follow the prescribed syllabus and same question paper model.

Signatures of Members:

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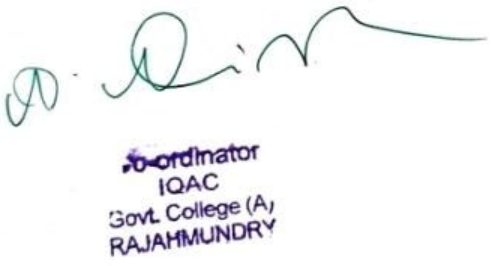
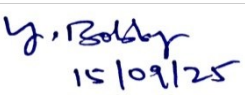
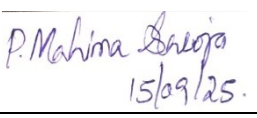


Government college Autonomous Rajahmundry NAAC A +

BOS Members 2025-2026

Department of Microbiology

S.no	Name	Signature
1.	**Chairman :** Smt. T. Sony Head of the Department of Microbiology, Govt. College (A) – Rajamahendravaram.	
2.	**Faculty member** : Dr. T. Sujatha Lecturer in Microbiology Govt. College (A) – Rajamahendravaram	
	Faculty Member : Kum. R. Jyothi Prasanna Lecturer in Microbiology Govt College (A) - rajamahendravaram	
3.	**Subject expert :** Dr. K. Aruna, Krishna University, 9490040657, kopuriarunadl@gmail.com	
4.	**Subject expert :** Prof Dr. B S Anuradha, Dean Academic Affairs , Dept of Microbiology, Chaitanya Deemed to be University,9849569224, anuradharavikumar1970@gmail.com	
5	**University Nominee :** Dr. A. Padmavathi, H. O. D of Microbiology and Biochemistry, C. H. S. D. St. Theresa's College for Women (A), Eluru, 9440581035, dr.padmavathi@stcelr.ac.	
5.	**Industrial nominee**: Mr. Y. Bobby HOD Quality control Pharma Labs Pvt Ltd VL Puram Junction, Rajahmundry	
6.	**Alumni member :** Kum. P. Mahima Saroja (MZC)	

Rajahmundry
Date: 15-09-2025

Chairman

Government college Autonomous Rajahmundry NAAC A +

BOS Meeting 2025-2026

Microbiology

List of paper setters & Examiners

S.No	Name of the lecturer	Papers	College
1	Dr. A.Padmavathi Lecturer in Microbiology	All	Head Department of Microbiology, Ch.S.D.St. Theresa's College For Women(A), Eluru, West Godavari (Dist.), 9440581035, Padmaanduri20@gmail.com
2	Sr. Sunila Rani, Lecturer in Microbiology	All	CH. S. D. St. Theresa's College for Women (A), Eluru, M. No -7675926861, mail id - sunilarani10@gmail.com
3	Smt.T.Sasikala Lecturer in Microbiology	All	ABN College, Kovvuru, 9885861088
4	Dr.K. Aruna Lecturer in Microbiology	All	SRR & CVR Government college, Vijayawada 9490040657, kopuriarunadl@gmail.com
5	Dr. Lalitha Lecturer in Microbiology	All	GDC Dr V S Krishna College (A) VISHAKAPATNAM 9491331865
6	Dr. Pallavi Lecturer in Microbiology	All	GDC ANANTAPUR, 9491233355, pallavi.pavan2003@gmail.com
7	Dr. Vimala Rhode Lecturer in Microbiology	All	Silver Jubilee college, GDC KURNOOL, 9030856521, microbiology@sjgckurnool.edu.in
8	Dr.CH. Madhavi Lecturer in Microbiology	All	GDC ANATAPUR, 9908658952, chavalimadhulatha@gmail.com
9	DR.CH. Shanti Devi	All	GDC Men Srikakulum, 9052177822, Ch.shanthi123@gmail.com
10	Dr. Maqsood	All	SKR Government degree college, Tilak Naga Gudur, Nellore 9849530338, mdmaqsood.micro@gmail.com
11	P. Aruna Lecturer in Microbiology	All	GDC Guntur WOMEN, patchalaaruna@gmail.com
12	Dr. K.Sucharita Lecturer in Microbiology	All	GDC (W) GUNTUR, 9963180561 sucharitak@gmail.com
13	Dr.Praveena Lecturer in Microbiology	All	GDC Guntur WOMEN

14	Dr. P.Suneetha, Lecturer in Microbiology	All	GDC Tanuku
15.	Dr. Sudhakar cheedi S Department of microbiology	All	Pr govt college kakinada 9703390776 Sudhakar.cheedi@gmail.com

MEMBERS **CHAIRMAN**

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Coordinator
IQAC
Govt. College (A)
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AFFILIATED TO ADIKAVI NANNAYA UNIVERSITY

DEPARTMENT OF MICROBIOLOGY
BOARD OF STUDIES
Programme: B.Sc., Honours in MICROBIOLOGY

COURSE STRUCTURE

Year	Sem	Course	Title	Hr/ week	credits
I	I	1	Introduction to Microbiology and Microbial Diversity	5	4
			Introduction to Microbiology and Microbial Diversity - **practical**	5	4
		2	Principles of Bacteriology & Microbial Techniques	3	3
			Principles of Bacteriology & Microbial Techniques **Practical**	2	1
	II	3	Fundamentals of Biochemistry and Analytical techniques	3	3
			Fundamentals of Biochemistry and Analytical techniques - **Practical**	2	1
		4	Microbial Physiology	3	3
			Microbial Physiology-**Practical**	2	1
II	III	5	Eukaryotic microorganisms	3	3
			Eukaryotic microorganisms - **Practical**	2	1
		6	Biomolecules & Enzymology	3	3
			Biomolecules & Enzymology - **Practical**	2	1
		7	Microbial and Analytical Techniques	3	3
			Microbial and Analytical Techniques **- Practical**	2	1
		8	Cell Biology and Genetics	3	3
			Cell Biology and Genetics - **Practical**	2	1
	IV	9	Molecular Biology and Microbial Genetics	3	3
			Molecular Biology and Microbial Genetics- **Practical**	2	1
		10	Microbial Physiology and Metabolism	3	3
			Microbial Physiology and Metabolism-**Practical**	2	1
			r DNA technology, Biostatistics& Bioinformatics	3	3

		11	r DNA technology, Biostatistics &Bioinformatics - **Practical**	2	1
III	**V**	**12 A**	Immunology & Medical Microbiology	3	3
			Immunology & Medical Microbiology -**Practical**	2	1
			OR		
		12 B	Pharmaceutical Microbiology	3	3
			Pharmaceutical Microbiology -**Practical**	2	1
		13 A	Applied Microbiology	3	3
			Applied Microbiology -**Practical**	2	1
			OR		
		13 B	Diagnostic Microbiology	3	3
			Diagnostic Microbiology -**Practical**	2	1
		14 A	Industrial Microbiology	3	3
			Industrial Microbiology -**Practical**	2	1
			OR		
		14 B	Agricultural Microbiology	3	3
			Agricultural Microbiology -**Practical**	2	1
		15 A	Food and Dairy Microbiology	3	3
			Food and Dairy Microbiology -**Practical**	2	1
			OR		
		15 B	Environmental Biotechnology	3	3
			Environmental Biotechnology -**Practical**	2	1
	VI		Internship		
IV	**VII**	**16**	VII & VIII semester syllabus will be available in due course of time		
		17			
		18			
	SEC	**19**			
		20			
	VIII	**21**	VII & VIII semester syllabus will be available in due course of time		
		22			
		23			
	SEC	**24**			
		25			

DEPARTMENT OF MICROBIOLOGY

MINOR, w.e.f 2025-26 AY

COURSE STRUCTURE

Year	Sem	Course	Title	Hr/ week	credi ts
II	III	6	Biomolecules & Enzymology	3	3
			Biomolecules & Enzymology - **Practical**	2	1
		7	Microbial and Analytical Techniques	3	3
			Microbial and Analytical Techniques **- Practical**	2	1
	IV	9	Molecular Biology and Microbial Genetics	3	3
			Molecular Biology and Microbial Genetics-**Practical**	2	1
		10	Microbial Physiology and Metabolism	3	3
			Microbial Physiology and Metabolism-**Practical**	2	1
III	V	12 A	Immunology & Medical Microbiology	3	3
			Immunology & Medical Microbiology - **Practical**	2	1
			OR		
		12 B	Pharmaceutical Microbiology	3	3
			Pharmaceutical Microbiology **-Practical**	2	1
		13 A	Applied Microbiology	3	3
			Applied Microbiology **-Practical**	2	1
			OR		
		13 B	Diagnostic Microbiology	3	3
			Diagnostic Microbiology **-Practical**	2	1

Course / Learning Objectives:

The student will be able to learn the diversity and classification of living organisms and understand their chemical, cytological, evolutionary and genetic principles.

COURSE OBJECTIVES (CO)	
CO1	Learn the principles of classification and preservation of biodiversity
CO2	Understand the plant anatomical, physiological and reproductive processes
CO3	Knowledge on animal classification, physiology, embryonic development and their economic importance
CO4	Outline the cell components, cell processes like cell division, heredity and molecular processes.
CO5	Comprehend the chemical principles in shaping and driving the macromolecules and life processes

PROGRAMME LEVEL OUTCOMES (PLO)

Program Level Outcomes (PLOs)

PLO-1: Domain Expertise

- Acquire comprehensive knowledge and skills
- Apply knowledge innovatively
- Address domain-specific issues effectively

PLO-2: Analytical Skills

- Identify problems
- Analyze problems
- Draw logical conclusions

PLO-3: Critical Thinking and Complex Problem Solving

- Predict and analyze problems
- Frame hypotheses
- Investigate and interpret empirical data
- Plan and execute actions

PLO-4: Modern Tools Usage and Industry Readiness

- Use technology intelligently
- Identify goals, objectives, and competencies
- Access and use authenticated information

PLO-5: Individual and Team Work

- Work efficiently as an individual
- Collaborate effectively in diverse teams
- Prioritize collective goals

PLO-6: Project Management

- Plan and organize projects
- Lead teams effectively
- Develop contingency strategies

PLO-7: Communication and Life Skills

- Listen, understand, and express ideas effectively
- Select appropriate communication media
- Present information clearly and concisely

PLO-8: Ethics

- Apply ethical principles
- Exhibit professional ethics
- Ensure ethical practices for societal wellbeing

PLO-9: Lifelong Learning

- Engage in self-directed learning
- Adapt to emerging professional demands
- Demonstrate inquisitiveness

PLO-10: Social and Environmental Awareness

- Participate in social development
- Uphold national values
- Address environmental sustainability challenges

Competency Mapping with PLOs

Competency No.	Competency	Mapped PLOs
1	Domain Knowledge	PLO 1
2	Analytical Skills	PLO 2
3	Critical Thinking	PLO 3
4	Employability Skills	PLO 4–7
5	Ethics	PLO 8
6	Lifelong Learning	PLO 9
7	Social & Environmental Awareness	PLO 10

NOTE: **Additional Inputs in the course are highlighted with Bold letters and yellow color**

SEMESTER-I

COURSE 1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

Theory : Credits: 3 **SYLLABUS** **3 hrs/week**

Course Outcomes: On completion of this course students will be able to
(Theory)

CO1: Explain the historical development of microbiology, contributions of key scientists, and evolution of microbial classification systems. (BT2)
CO2: Distinguish between prokaryotic and eukaryotic microorganisms using structural and functional criteria. (BT2)
CO3: Describe the general characteristics, morphology, reproduction, and significance of bacteria, archaea, and viruses. (BT2)
CO4: Explain the structure and replication mechanisms of bacteriophage T2 and HIV. (BT3)
CO5: Describe the morphology, reproduction, ecological role, and applications of microalgae, fungi, and protozoa. (BT2)
CO6: Relate the medical, industrial, environmental, and economic importance of microorganisms to real-world applications. (BT3)

Syllabus of Theory:

Unit 1: History and classification of Microbiology **10hrs**

1.1 Development of microbiology as a discipline, Spontaneous generation vs. biogenesis, Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming, Ivanowsky.
1.2 Systems of classification: Binomial Nomenclature; Whittaker's five kingdom Classification; **Carl Woese's three kingdom classification systems**, Concept of Species, Taxa, and Strain;
1.3 **Brief note on Bergey's Manual of Systematic Bacteriology**; Difference between prokaryotic and eukaryotic microorganisms; Definition and scope of Microbiology: Applications of Microbiology.

Unit 2: Prokaryotic microorganisms and Viruses **10hrs**

2.1 General characteristics of bacteria and archaea: distribution, occurrence, morphology, reproduction and economic importance.
2.2 General characteristics of Viruses with emphasis on discovery of viruses, Nature and definition of viruses, morphology, reproduction and a brief note on Cultivation of Viruses
2.3. General features of Viral Replication; Structure and multiplication of Bacteriophage T2 and HIV

Unit 3: Microalgae **8hrs**

3.1 General characteristics of algae: occurrence, morphology, habitat, ecological distribution, photosynthetic pigments, food reserves, reproduction and role in aquatic ecosystems

3.2 Morphology, reproduction, ecological significance and applications of a) Chlorella (Chlorophyceae) and b) Spirulina (Cyanophyceae).

3.3Economic Importance of Microalgae: Biofertilizers, Biofuels, Pharmaceuticals, Food supplements, Wastewater treatment, Carbon dioxide sequestration, algal polysaccharides.

Unit 4: Fungi 9hrs

4.1 Habitat, distribution, nutritional requirements, fungal cell ultra- structure, fungal wall, Outline classification of Fungi

4.2 Important Microfungi: Morphology and structure, reproduction and applications of a) Saccharomyces (Ascomycota – Yeast) and b) Aspergillus (Ascomycota)

4.3 Economic importance of fungi: in agriculture, food, industry, medicine.

Unit 5: Protozoa 8 hrs

5.1 General Characteristics of Protozoa: Morphology, Nutrition, reproduction, Habitat and ecological role

5.2 Important Protozoa: Morphology, locomotion, nutrition, reproduction, Ecological role of a)Amoeba and b) Slime Molds

5.3 Economic Importance of Protozoa (in ecosystems, waste management, soil fertility, research and Protozoa as pathogens).

Reference Books:

1. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). *Introductory Mycology*. John Wiley, New York.
2. Ali-Shtayeh, M. S., Jamous, R. M., & Yaghmour, R. M.-R. (1998). *Mycology manual*. An-Najah National University.
3. Becker, E. W. (2007). *Microalgae in Biotechnology*. Cambridge University Press.
4. Bessey, E. A. *Morphology and Taxonomy of Fungi*. Vikas Publishing House Pvt. Ltd., New Delhi.
5. Bold, H. C., & Wynne, M. J. (1985). *Introduction to the Algae: Structure and Reproduction* (2nd ed.). Prentice-Hall.
6. Deacon, J. W. (2006). *Fungal Biology* (4th ed.). Blackwell Publishing.
7. Funder, H. F. (1968). *Practical mycology: Manual for identification of fungi*. McGraw- Hill.
8. Garrity, G. M. (Ed.). (2011). *Bergey's Manual of Systematic Bacteriology* (2nd ed.). Springer.
9. Hausmann, K., & Bradbury, P. C. (2002). *Protistology* (2nd ed.). E. Schweizerbart'sche Verlagsbuchhandlung
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11. Kumar, H. D., & Singh, H. N. *A Textbook on Algae* (Macmillan International College Edition).
12. Lee, R. E. (2008). *Phycology* (4th ed.). Cambridge University Press.
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20. Webster, J., & Weber, R. (2007). *Introduction to Fungi* (3rd ed.). Cambridge University Press.

Co- Curricular Activities

1. Arrange guest lectures, to provide insights into the latest advancements and emerging trends in bacteriology and virology.

2. Conduct hands-on microscopy workshops using to observe eukaryotic microorganisms

3. Organize field trips to natural habitats, such as forests, ponds, or marine environments, where eukaryotic microorganisms thrive.

4. Arrange culturing workshops where students can learn how to isolate and culture eukaryotic microorganisms in the laboratory.

SEMESTER-I

COURSE 1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

Practical **Credits: 1** **2 hrs/week**

I. Course learning outcomes (Practical)

CO1: Identify viruses, algae, fungi, and protozoa using micrographs and prepared slides. (BT2)
CO2: Prepare microbiological culture media following standard laboratory protocols. (BT3)
CO3: Isolate, purify, and preserve fungi and algae using aseptic techniques. (BT3)
CO4: Observe and document vegetative and reproductive structures of fungi using microscopy. (BT3)
CO5: Demonstrate host–pathogen interaction concepts through laboratory observations. (BT4)
CO6: Practice laboratory biosafety, ethical handling of cultures, and proper documentation. (BT3)

II. Laboratory/Field exercises:

1. Study of viruses (Bacteriophage, TMV and HIV) using micrographs
2. Preparation of Potato Dextrose Medium.
3. Isolation and identification of pathogenic and non-pathogenic fungi.
4. Study of host-pathogen interaction.
5. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus* and *Alternaria*
6. Purification and preservation of pure cultures of common algae and fungi.
7. Observe prepared slides of slime mold structures.

SEMESTER-I QUESTION BANK

COURSE 1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

Unit	Q.No	Question	Marks	BL	CLO	PO
Unit 1	1	Essay on contributions of Louis Pasteur & Alexander Fleming	8	BL2	CLO1	PO1, PO2
	2	Describe Whittaker's five kingdom classification	8	BL2	CLO1	PO1, PO2
	3	Differentiate between prokaryotic and eukaryotic microorganisms	8	BL3	CLO1	PO1, PO2
	4	Write applications of microbiology	8	BL2	CLO1	PO1, PO2
Unit 2	1	General characteristics of bacteria – occurrence, morphology, reproduction and economic importance	8	BL2	CLO2	PO1, PO2
	2	General characteristics of Archaea – occurrence, morphology, reproduction and economic importance	8	BL2	CLO2	PO1, PO2
	3	General characteristics of viruses – morphology and reproduction	8	BL2	CLO2	PO1, PO2
	4	General features of bacteriophage T2 – structure and multiplication	8	BL3	CLO2	PO1, PO2
Unit 3	1	General characteristics of algae – morphology, pigments, reproduction and ecological role	8	BL2	CLO3	PO1, PO2, PO5
	2	Morphology, reproduction and applications of *Chlorella*	8	BL3	CLO3	PO1, PO2, PO5
	3	Morphology, reproduction and applications of *Spirulina*	8	BL3	CLO3	PO1, PO2, PO5
	4	Economic importance of microalgae	8	BL3	CLO3	PO1, PO2, PO5
Unit 4	1	Habitat, distribution, nutrition and fungal cell ultrastructure	8	BL2	CLO4	PO1, PO2, PO5
	2	Outline classification of fungi	8	BL2	CLO4	PO1, PO2, PO5
	3	Morphology, reproduction and applications of *Saccharomyces*	8	BL3	CLO4	PO1, PO2, PO5

Unit	Q.No	Question	Marks	BL	CLO	PO
	4	Economic importance of fungi in agriculture, food, industry and medicine	8	BL3	CLO4	PO1, PO2, PO5
Unit 5	1	General characteristics of protozoa – morphology, nutrition and reproduction	8	BL2	CLO5	PO1, PO2, PO5
	2	Morphology, locomotion and ecological role of *Amoeba*	8	BL3	CLO5	PO1, PO2, PO5
	3	Morphology and ecological role of slime molds	8	BL3	CLO5	PO1, PO2, PO5
	4	Economic importance of protozoa	8	BL3	CLO5	PO1, PO2, PO5

SHORT QUESTION & ANSWERS – 2M EACH

UNIT-1

1. Spontaneous Generation vs Biogenesis
2. Antonie van Leeuwenhoek
3. Robert koch
4. Carlwoes 3 kingdom classification

UNIT- 2

1. HIV
2. Cultivation of Viruses
3. Discovery of viruses
4. Differences b/w Bacteria and Archae

UNIT-3

1. Algae as Biofertilizer
2. Algae as Biofuel
3. Algae in Food industry
4. Algae in Pharma industry

UNIT-4

1. Aspergillus in Industry
2. Importance of fungi in food
3. Importance of fungi in medicine
4. Importance of fungi in industry

UNIT-5

1. Protozoa as pathogens
2. Amoeba
3. Slime molds
4. Importance of Protozoa in waste management.

SEMESTER-I BLUE PRINT

COURSE 1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

Unit Number	Section-A (Essay/ Split Essay)	Section-B Short Answers (with Choice)	Weightage of marks
Unit-1	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-2	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-3	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-4	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-5	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M

SECTION-A **5 × 8 = 40 Marks**

Essay questions.questions. Draw labelled diagrams wherever necessary.

1. (a) or (b)
2. (a) or (b)
3. (a) or (b)
4. (a) or (b)
5. (a) or (b)

SECTION-B **5 × 2 = 10 Marks**

Answer Any 5 of the following questions.

6. From Unit-1
7. From Unit-1
8. From Unit-2
9. From Unit-2
10. From Unit-3
11. From Unit-3
12. From Unit-4
13. From Unit-5

SEMESTER-I

MODEL QUESTION PAPER

COURSE 1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

SECTION-A **5 × 8 = 40 Marks**

Answer all the following questions . Draw labelled diagrams wherever necessary.

Unit	Q.No	Question	Marks	BL	CLO	PO
Unit 1	1a	Essay on contributions of Louis Pasteur and Alexander Fleming	8	BL2	CLO1	PO1, PO2
	1b	Write applications of microbiology	8	BL2	CLO1	PO1, PO2
Unit 2	2a	General characteristics of bacteria – occurrence, morphology, reproduction and economic importance	8	BL2	CLO2	PO1, PO2
	2b	Explain general characteristics of viruses – morphology and reproduction	8	BL2	CLO2	PO1, PO2
Unit 3	3a	General characteristics of algae – occurrence, morphology, pigments, reproduction and ecological role	8	BL2	CLO3	PO1, PO2, PO5
	3b	Illustrate the economic importance of microalgae	8	BL3	CLO3	PO1, PO2, PO5
Unit 4	4a	Explain habitat, distribution, nutritional requirements and fungal cell ultrastructure	8	BL2	CLO4	PO1, PO2, PO5
	4b	Summarize morphology, reproduction and applications of *Saccharomyces*	8	BL3	CLO4	PO1, PO2, PO5
Unit 5	5a	Explain general characteristics of protozoa – morphology, nutrition, reproduction and ecological role	8	BL2	CLO5	PO1, PO2, PO5
	5b	Discuss morphology, locomotion, nutrition and ecological role of *Amoeba*	8	BL3	CLO5	PO1, PO2, PO5

SECTION-B **5 × 2 = 10 Marks**

Answer any 5 the following questions.

1. Antonie van Leeuwenhoek
2. Robert Koch
3. Discovery of viruses
4. Differences b/w Bacteria and Archae
5. Algae as Biofertilizer
6. Algae as Biofuel
7. Importance of fungi in food
8. Amoeba

SEMESTER-I

COURSE 2: PRINCIPLES OF BACTERIOLOGY & MICROBIAL TECHNIQUES
Theory Credits: 3 **SYLLABUS** **3 hrs/week**

I. Course Outcomes: On completion of this course students will be able to:

1. Describe bacterial cell structure and explain effects of antibiotics on the cell wall.
2. Identify and describe the important features of Photosynthetic bacteria, Myxobacteria, Mycoplasma, Fermentative bacteria, Methanogens, and Halobacteria.
3. Gain insights into various microscopy techniques and apply simple and differential staining in bacterial observation.
4. Comprehend the principles, methods, and applications of sterilization and disinfection.
5. Comprehend methods for isolating and preserving pure cultures, and techniques for cultivating anaerobic and viable non-culturable bacteria.

II.Syllabus of Theory:

Unit 1 Cell organization 9 hrs

1.1 Cell size, shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili. Cell wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls.

1.2 Cell Membrane: Structure, function and chemical composition of bacterial cell membranes; Differences between eubacteria and archaebacteria;

1.3 Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids, Endospore; Effect of antibiotics and enzymes on the cell wall: sphaeroplasts, **protoplasts**, and **L-forms.**

Unit 2 Type studies of Bacteria and Archaea 9 hrs

2.1.Salient features of: a) Photosynthetic bacteria - Purple bacteria, Green bacteria and Anabaena b) Gliding bacteria - Myxobacteria

2.2.Salient features of a) Miscellaneous bacteria: Mycoplasma; b) Salient features of Fermentative bacteria

2.3.Salient features of Extremophiles- a) Methanogens and Halobacteria.

Unit 3 Basics of Microscopy
hrs

3.1 Light Microscopy: Bright-Field Microscope- Principle, Components, Operation, resolution and Applications; Principle of Dark-field, Phase contrast and fluorescent microscopes.

3.2 Electron microscope: Principle, Components, resolution and Applications of Scanning and Transmission Electron Microscopes.

3.3 Staining Techniques – Types and properties of dyes; Simple and negative staining; Differential staining techniques- Gram staining, spore staining.

Unit 4 Sterilization and disinfection techniques- 9 hrs

4.1 Definitions of Sterilization, Disinfection, Antiseptic, Germicide, Sanitizer, Fungicide, Virucide, Bacteriostatic and Bactericidal agent.

4.2 Physical methods of microbial control: Dry heat-Incineration, Hot air oven; Moist heat-Pressure cooker, autoclave; Filter sterilization- laminar air flow, Membrane filter; Radiation methods – UV rays, Gamma rays.

4.3 Chemical methods of microbial control: disinfectants, types and mode of action-alcohols, aldehydes, fumigants, phenols, halogens and heavy metals.

Unit 5 Microbiological techniques 9hrs

5.1 Pure culture isolation: Serial dilution, enrichment culturing technique, plating methods, micromanipulator;

5.2 Maintenance and preservation/stocking of pure cultures: sub culturing, overlaying cultures with mineral oils, lyophilization, sand cultures, storage at low temperature, Culture collection Centers (MTCC, ATCC, DSMZ).

5.3 Cultivation of anaerobic bacteria; Accessing Viable non-culturable bacteria (VNBC).

Reference Books:

1. Alcomo, I. E. (2001). *Fundamentals of Microbiology* (6th ed.). Jones and Bartlett Publishers.
2. Beckner, W. M., Kleinsmith, L. J., & Hardin, J. (2000). *The World of Cell* (4th ed.). Benjamin/Cummings.
3. Besty, T., & Koegh, D. C. *Microbiology Demystified*. McGraw-Hill.
4. Black, J. G. (2002). *Microbiology – Principles and Explorations*. John Wiley & Sons Inc., New York.
5. Ghatak, K. L. (2011). *Techniques and Methods in Biology*. PHI Publication.
6. Murphy, D. B. (2001). *Fundamentals of Light Microscopy & Electron Imaging* (1st ed.). Wiley-Liss.
7. Pelczar, M., Chan, E. C. S., & Krieg, N. R. *Microbiology*. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
8. Pranav Kumar. (2016). *Fundamentals and Techniques of Biophysics and Molecular Biology*.
9. Prescott, L. M., Harley, J. P., & Klein, D. A. (2002). *Microbiology* (5th ed.). WCB McGraw-Hill, New York.
10. Stainier, R. V., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. *The Microbial World*. Prentice-Hall of India Pvt. Ltd., New Delhi.

11. Tortora, G. J., Funke, B. R., & Case, C. L. (2004). *Microbiology: An Introduction*. Pearson Education, Singapore.

VI. Co-Curricular Activities:

1. Conduct laboratory workshops that allow students to gain hands- on experience in bacterial culture techniques
2. Competition in performing laboratory techniques like staining
3. Artwork with bacteria or fungi in petridish
4. Quiz in identifying microscopic technique in various micrographs

SEMESTER-I

COURSE 2: PRINCIPLES OF BACTERIOLOGY & MICROBIAL TECHNIQUES

Practical Credits: 1 2 hrs/week

I. Course objectives:

1. To gain practical skills in bacterial isolation, pure culture techniques, and visualization using different microscopy methods.
2. To comprehend and perform basic staining techniques, including Gram, simple, and negative staining, and observe bacterial structures such as motility and capsules.
3. To learn sterilization methods for media and glassware and apply aseptic techniques in microbiological experiments.

Laboratory/Field exercises:

1. Isolation of bacteria using Winogradsky column and observation
2. Study of bright field, dark field and phase contrast, Electron microscope micrographs to visualize microbial cells.
3. Simple staining & Negative staining.
4. Gram's staining.
5. Observation of motility and capsule in bacteria
6. Determination of bacterial cell size by the technique Micrometry.
7. Sterilization of medium using Autoclave, Sterilization of glassware using Hot Air Oven.
8. Isolation of pure cultures of bacteria by streaking method.
9. Isolation of bacteria from natural habitat by spread and pour plate method (using serial dilution method)

SEMESTER-I
QUESTION BANK
COURSE 2: PRINCIPLES OF BACTERIOLOGY & MICROBIAL TECHNIQUES

Unit	S.No	Question	Marks	BL	CO	PO
I	1	Describe cell size, shape, arrangement, glycocalyx, capsule, flagella, fimbriae and pili	8	BL2	CO1	PO1, PO2
	2	Differentiate between eubacteria and archaebacteria	8	BL3	CO1	PO1, PO2
	3	Explain cytoplasmic components – ribosomes, mesosomes, inclusion bodies, nucleoid, plasmids, endospore	8	BL2	CO1	PO1, PO2
	4	Essay on effect of antibiotics and enzymes on cell wall	8	BL4	CO1	PO1, PO2
II	1	Summarize *Anabaena*	8	BL2	CO2	PO1, PO2
	2	Describe Mycoplasma and gliding bacteria (Myxobacteria)	8	BL2	CO2	PO1, PO2
	3	Identify and explain salient features of fermentative bacteria	8	BL3	CO2	PO1, PO2
	4	Describe and differentiate extremophiles – methanogens and halobacteria	8	BL3	CO2	PO1, PO2
III	1	Explain principle, components, operation, resolution and uses of bright-field microscope	8	BL2	CO3	PO2, PO3
	2	Compare bright-field and dark-field microscopy	8	BL4	CO3	PO2, PO3
	3	Perform simple and negative staining techniques	8	BL3	CO3	PO2, PO3
	4	Demonstrate and interpret Gram staining	8	BL3	CO3	PO2, PO3
IV	1	Define sterilization, disinfection, antiseptic, germicide and sanitizer	8	BL1	CO4	PO1
	2	Define and classify antimicrobial agents	8	BL1	CO4	PO1
	3	Compare physical methods of microbial control	8	BL4	CO4	PO2, PO3, PO4
	4	Analyze chemical methods and mode of action of disinfectants	8	BL4	CO4	PO2, PO3, PO4
V	1	Perform pure culture isolation	8	BL3	CO5	PO2, PO3
	2	Explain methods for maintenance and preservation of	8	BL2	CO5	PO2,

Unit	S.No	Question	Marks	BL	CO	PO
		cultures				PO3, PO4
	3	List and identify culture collection centers (MTCC, ATCC, DSMZ)	8	BL1	CO5	PO2
	4	Explain and evaluate cultivation of anaerobic bacteria	8	BL4	CO5	PO2, PO3, PO4

SHORT QUESTION & ANSWER – EACH 2M

UNIT-1

1. Differences b/w Gram positive and Gram Negative cell wall
2. Endospore
3. Protoplasts
4. Sphaeroplasts

UNIT-2

1. Purple Bacteria
2. Green Bacteria
3. Applications of Fermentative bacteria
4. Mycoplasms

UNIT-3

1. Transmission Electron Microscope (TEM)
2. Scanning Electron Microscope (SEM)
3. Spore Staining
4. Flourescent Microscope

UNIT-4

1. Phenols
2. Alcohols
3. Fumigants
4. Halogens

UNIT-5

1. Serial dilution
2. Micro manipulator technique
3. Viable but not culturable bacteria
4. Enrichment Culture technique.

SEMESTER-I

BLUE PRINT

COURSE 2: PRINCIPLES OF BACTERIOLOGY & MICROBIAL TECHNIQUES

Unit Number	Section-A (Essay/ Split Essay)	Section-B Short Answers (with Choice)	Weightage of marks
Unit-1	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-2	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-3	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-4	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M
Unit-5	8 Marks or 2×4 Marks	2 mark each (1 Questions) 1x2=2M	10 M

SECTION-A **5 × 8 = 40 Marks**

Answer all the following questions. Draw labelled diagrams wherever necessary.

1. (a) or (b)
2. (a) or (b)
3. (a) or (b)
4. (a) or (b)
5. (a) or (b)

SECTION-B **5 × 2= 10 Marks**

Answer any 5 of the following questions.

6. From Unit-1
7. From Unit-1
8. From Unit-2
9. From Unit-2
10. From Unit-3
11. From Unit-3
12. From Unit-4
13. From Unit-5

SEMESTER-I MODEL QUESTION PAPER

COURSE 2: PRINCIPLES OF BACTERIOLOGY & MICROBIAL TECHNIQUES

SECTION-A 5 × 8 = 40 Marks

Answer all the questions. Draw labelled diagrams wherever necessary.

Unit	Q.No	Question	Marks	BL	CLO	PO
Unit 1	1a	Describe cell size, shape, arrangement, glycocalyx, capsule, flagella, fimbriae and pili	8	BL2	CLO1	PO1, PO2
	1b	Differentiate between eubacteria and archaebacteria	8	BL3	CLO1	PO1, PO2
Unit 2	2a	Essay on *Anabaena*	8	BL2	CLO2	PO1, PO2
	2b	Identify and explain salient features of fermentative bacteria	8	BL3	CLO2	PO1, PO2
Unit 3	3a	Explain principle, components, operation, resolution and uses of bright-field microscope	8	BL2	CLO3	PO2, PO3
	3b	Perform Gram staining	8	BL3	CLO3	PO2, PO3
Unit 4	4a	Define sterilization, disinfection, antiseptic, germicide and sanitizer	8	BL1	CLO4	PO2, PO3, PO4
	4b	Explain and compare physical methods of microbial control	8	BL3	CLO4	PO2, PO3, PO4
Unit 5	5a	Perform pure culture isolation	8	BL3	CLO5	PO2, PO3, PO4
	5b	Explain and evaluate cultivation of anaerobic bacteria	8	BL4	CLO5	PO2, PO3, PO4

SECTION-B 5× 2 = 10 Marks

<u>Answer any 5 of the</u> following questions.

1. Protoplasts
2. Sphaeroplasts
3. Green Bacteria
4. Applications of Fermentative bacteria
5. Spore Staining
6. Flourescent Microscope
7. Alcohols
8. Serial dilution

SEMESTER-II

COURSE 3: FUNDAMENTALS OF BIOCHEMISTRY AND ANALYTICAL TECHNIQUES

Theory : Credits: 3 **SYLLABUS** **3 hrs/week**

I. Course Outcomes: On completion of this course students will be able to:

(Theory)

1. CO1: Describe the structure, classification, and functional significance of carbohydrates in biological systems. (BT2)
2. CO2: Explain the structure, properties, and biological roles of lipids, fatty acids, phospholipids, steroids, and waxes. (BT2)
3. CO3: Explain the classification, structure, and functional roles of amino acids and proteins, including protein denaturation. (BT2)
4. CO4: Describe the structure and functions of nucleic acids and explain the metabolic significance of vitamins. (BT2)
5. CO5: Apply principles of spectroscopy, chromatography, centrifugation, and electrophoresis for biomolecular analysis. (BT3)
6. CO6: Relate biochemical principles and analytical techniques to applications in microbiology, health sciences, and biotechnology. (BT3)

II. Syllabus of Theory:

UNIT-1: Carbohydrates **Hrs: 9**

1. General characters and outline classification of Carbohydrates.
2. Monosaccharides- Glucose, fructose, ribose; Stereo- isomerism of monosaccharides, epimers, mutarotation and anomers of glucose;
3. Disaccharides- concept of reducing and non-reducing sugars; Sucrose, Lactose, Maltose
4. Polysaccharides: Storage- Starch, glycogen; Structural- Cellulose, peptidoglycan and chitin

UNIT-2: Lipids and fatty acids **hrs: 9**

1. Definition and classification of lipids. Structure and properties of lipids. Importance of Lipids in biological systems.
2. Introduction to fatty acids: definition, structure, and nomenclature. Saturated and unsaturated fatty acids.
3. Triglycerides: structure and function
4. Phospholipids: structure, function, and role in cell membranes. Steroids: structure and physiological roles. Waxes: structure, functions, and applications

UNIT-3: Amino acids and Proteins. **Hrs 9**

1. Aminoacids –classification, structure and function.
2. General characteristics of amino acids and proteins. **Denaturation of proteins.**
3. Primary, secondary, tertiary and quaternary structures of Protein

UNIT-4: Nucleic acids and Vitamins **Hrs 9**

1. Structure and functions of DNA and RNA. Types of DNA and RNA.

2. Base composition. A+T and G+C rich genomes. Basic concept of nucleic acids protein interactions. Chargaff's rule. Forces stabilizing nucleic acid structures, (hydrogen bonds and hydrophobic associations, base stacking).
3. Concept and types of vitamins and their role in metabolism.

Unit 5 Analytical Techniques **Hrs 9**

1. Spectroscopy – Principle, Beer-Lambert law, Instrumentation and applications of UV- visible spectrophotometer. Colorimetry and turbidometry.
2. Chromatography: Principles and applications of paper and Column chromatography
3. Centrifugation- Principle of centrifugation; Types of centrifuges: Low-speed, High- speed, and Ultracentrifuge – and their applications.
4. Electrophoretic technique: Agarose gel electrophoresis-Components, working principle and applications.

III. Reference Books:

1. Aurora Blair. *Laboratory Techniques & Experiments in Biology*. Intelliz Press.
2. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2011). *Biochemistry*. W. H. Freeman and Company.
3. Caldwell, D. R. (1995). *Microbial Physiology and Metabolism*. W. C. Brown Publications, Iowa, USA.
4. Ghatak, K. L. (2011). *Techniques and Methods in Biology*. PHI Publication.
5. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (1993). *Principles of Biochemistry* (2nd ed.). CBS Publishers and Distributors, New Delhi.
6. Plummer, D. T. (1987). *An Introduction to Practical Biochemistry*. McGraw Hill Publication.
7. Pranav Kumar. (2016). *Fundamentals and Techniques of Biophysics and Molecular Biology*.
8. Rao, B. S., & Deshpande, V. (2007). *Experimental Biochemistry: A Student Companion*. I.K. International Pvt. Ltd.
9. Tymoczko, J. L., Berg, J. M., & Stryer, L. (2012). *Biochemistry: A Short Course* (2nd ed.). W. H. Freeman.
10. Voet, D., & Voet, J. G. (2004). *Biochemistry* (3rd ed.). John Wiley and Sons.
11. White, D. (1995). *The Physiology and Biochemistry of Prokaryotes*. Oxford University Press, New York.
12. Wilson, K., & Walker, J. (2000). *Principles and Techniques in Practical Biochemistry* (5th ed.). Cambridge University Press.

VI. Co-Curricular Activities:

1. Test various food samples for the presence of mono-, di-, and polysaccharides using simple chemical tests. Results can be presented as a poster or infographic explaining the type and significance of carbohydrates in different foods.
2. Organize Biomolecule Modeling Workshops where students can learn to build physical models or use computer simulations to visualize biomolecules such as proteins, nucleic acids, carbohydrates, and lipids.
3. Test knowledge of principles, applications, and troubleshooting of analytical methods by conducting a quiz.

SEMESTER-II

COURSE 3: FUNDAMENTALS OF BIOCHEMISTRY AND ANALYTICAL TECHNIQUES

Practical **Credits: 1** **2 hrs/week**

I. Course learning outcomes **(Practical)**

1. CO1: Perform qualitative tests to identify carbohydrates, amino acids, and proteins in biological samples. (BT3)
2. CO2: Estimate biomolecules such as DNA and proteins using colorimetric techniques. (BT3)
3. CO3: Separate biomolecules using paper chromatography techniques. (BT3)
4. CO4: Apply centrifugation techniques to separate cellular components. (BT3)
5. CO5: Perform agarose gel electrophoresis to separate and analyze DNA fragments. (BT3)
6. CO6: Follow laboratory biosafety, ethical practices, and accurate documentation during biochemical experiments. (BT3)

Laboratory/Field exercises:

1. Qualitative tests for sugars
2. Qualitative Analysis of Aminoacids.
3. Colorimetric estimation DNA by diphenylamine method.
4. Colorimetric estimation of proteins by Biuret/Lowry method
5. Separation of monosaccharides/amino acids by paper chromatography.
6. Separation of bacterial cells (cell pellet) from broth culture by using a laboratory scale centrifuge.
7. Separation of DNA fragments by Agarose gel electrophoresis.

IV SEMESTER

COURSE -3: : FUNDAMENTALS OF BIOCHEMISTRY AND ANALYTICAL TECHNIQUES

Blue Print for Question Papers

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B Short Answers (with Choice)	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	2 mark (1 Questions)	10 M
Unit-2	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-3	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-4	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-5	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M

SECTION-A $5 \times 8 = 40$ Marks

Answer all the following questions. Draw labelled diagrams wherever necessary.

1. (a) or (b)
2. (a) or (b)
3. (a) or (b)
4. (a) or (b)
5. (a) or (b)

SECTION-B $5 \times 2 = 10$ Marks

Answer any 5 of the following questions.

1. From Unit-1
2. From Unit-1
3. From Unit-2
4. From Unit-2
5. From Unit-3
6. From Unit-3
7. From Unit-4
8. From Unit-5

Department of Microbiology
I B.Sc Microbiology Honours- II SEMESTER
COURSE -3: : FUNDAMENTALS OF BIOCHEMISTRY AND ANALYTICAL TECHNIQUES
Model Question Paper

Time: 2.30 Hrs **Max. marks:50**

Section-A **5X8=40**

(Answer all the questions. Draw the labelled diagrams when necessary.)

Unit	Q.N	Questions	Marks	BL	CO	PO
I	1	a. Generalize the outline classification of Carbohydrates	8	1	1	PO1, PO2
		(OR)				
		b. Detailed structure and functions of Starch and cellulose		2	1	PO1, PO2
II	2	a. Write about structure and nomenclature of Fatty acids.	8	2	2	PO1, PO2
		(OR)				
		b. What are phospholipids? Explain structure and functions and their role in cell membrane		1 & 2	2	PO1, PO2
III	3	a. Explain General characters and functions of amino acids	8	2	3	PO1, PO2
		(OR)				
		b. Discuss about Classification of amino acids		2	3	PO1, PO2
IV	4	a. Analyze the structure of DNA according to Watson and Crick.	8	3	4	PO1, PO2, PO5
		(OR)				
		b. Give outlines on types and Functions of RNA		2	4	PO1, PO2, PO5
V	5	a. Explain principle, Instrumentation and applications of UV- visible spectrophotometer.	8	2& 3	5	PO2, PO3, PO4
		(OR)				
		b. Explain about components, working principle and applications of Gel electrophoresis.		2& 3	5	PO2, PO3, PO4

Section -B

Answer any FIVE of the following questions 5x2=10

6. What is a monosaccharide? Give one example.
7. What bond forms between two monosaccharides?
8. What is the difference between saturated and unsaturated fatty acids?
9. What is the main function of triglycerides in the body?
10. What is an amino acid?
11. What is a polypeptide?
12. What is a nucleotide?
13. What is the difference between DNA and RNA?
14. What is chromatography?
15. What is isoelectric focusing?

Department of Microbiology
I B.Sc Microbiology Honours- II SEMESTER
COURSE -3: FUNDAMENTALS OF BIOCHEMISTRY AND ANALYTICAL TECHNIQUES
Question Bank

Time:2.30 Hrs **Max. marks:50**

Section-A

UNIT	Q.NO	QUESTION	MARKS	BL	CO	PO
I	1.	General characters and biological significance of Carbohydrates.	8	1	1	PO1, PO2
	2	Write about outline classification of carbohydrates	8	1&2	1	PO1, PO2
	3	Detailed structure and functions of Starch and cellulose	8	2	1	PO1, PO2
	4	Define reducing and Non reducing sugars. Explain structure and functions of Sucrose and Lactose	8	2&3	1	PO1, PO2
II	1.	Interpret the classification of lipids according to the complexity of the structure	8	2	2	PO1, PO2
	2	Write about structure and nomenclature of Fatty acids.	8	2	2	PO1, PO2
	3	Define triglycerides? illustrate the structure and functions of Triglycerides.	8	1&2	2	PO1, PO2
	4	What are phospholipids? Explain structure and functions and their role in cell membrane	8	1&2	2	PO1, PO2
III	1	Explain General characters and functions of amino acids	8	1&3	3	PO1, PO2
	2	Discuss about the structure and functions of amino acids	8	1&3	3	PO1, PO2
	3	Write a note on Classification of amino acids	8	1	3	PO1, PO2
	4	Elucidate the structure of proteins.	8	2	3	PO1, PO2
IV	1	Analyse the structure and types of DNA according to Watson and Crick.	8	4	4	PO1, PO2, PO5
	2	State Chargaff's rule. Explain about forces that stabilize nucleic acid structures	8	1&2	4	PO1, PO2, PO5
	3	Give outlines on types and Functions of RNA	8	1	4	PO1, PO2

						, PO5
	4	Generalise concept and types of vitamins and their role in metabolism.	8	3	4	PO1, PO2 , PO5
V	1	Explain principle, Instrumentation and applications of UV- visible spectrophotometer	8	1&3	5	PO2, PO3, PO4
	2	Principles and applications of paper chromatography	8	1&3	5	PO2, PO3 , PO4
	3	State principle of centrifugation. Differentiate types of centrifuge	8	1&3	5	PO2, PO3 , PO4
	4	Explain about components, working principle and applications of Gel electrophoresis.	8	1&3	5	PO2, PO3 , PO4

SECTION-B (TWO marks Questions) 5x2=10

Two marks questions

Unit-I

1. What is a monosaccharide? Give one example.
2. What bond forms between two monosaccharides?
3. Why can humans digest starch but not cellulose?
4. What is glycogen, and where is it stored in the body?

Unit: II

1. What is the difference between saturated and unsaturated fatty acids?
2. Why are unsaturated fats usually liquid at room temperature?
3. What is the main function of triglycerides in the body?
4. What is the role of phospholipids in cell membranes?

Unit-III:

1. What is an amino acid?
2. What is a polypeptide?
3. What is the secondary structure of a protein?
4. What determines the shape and function of a protein?

UNIT-IV:

1. What is a nucleotide?
2. What is the difference between DNA and RNA?
3. What is complementary base pairing?
4. What is a gene?

UNIT-V

1. What is chromatography?
2. What is ultracentrifugation?
3. What is isoelectric focusing?
4. What is agarose gel electrophoresis used for?

SEMESTER-II

COURSE 4: MICROBIAL PHYSIOLOGY

Theory : Credits: 3 **SYLLABUS** **3 hrs/week**

I. Course Outcomes: On completion of this course students will be able to:

1. CO1: Describe microbial nutritional requirements, nutrient uptake mechanisms, and types of growth media. (BT2)
2. CO2: Explain microbial growth patterns, factors affecting growth, and methods for measuring microbial growth. (BT3)
3. CO3: Explain enzyme structure, classification, kinetics, and factors influencing enzyme activity and inhibition. (BT3)
4. CO4: Describe the biochemical pathways of microbial respiration and fermentation under aerobic and anaerobic conditions. (BT3)
5. CO5: Explain the mechanisms of energy generation through electron transport and oxidative phosphorylation. (BT3)
6. CO6: Describe bacterial photosynthetic pigments and distinguish between oxygenic and anoxygenic photosynthesis. (BT2)

II. Syllabus of Theory:

UNIT I: Microbial Nutrition No. of hrs: 9

1.1. Nutritional requirements of Microorganisms

1.2. Methods of uptake of nutrients by microbial cells- Primary and secondary active transport, concept of uniport, symport and antiport **Group translocation; Iron uptake**

1.3Nutritional groups of microorganisms-based on C, energy and electron sources: autotrophs, heterotrophs, lithotrophs, organotrophs, Phototrophs, Chemotrophs;

1.4Growth media - synthetic, nonsynthetic, selective, enrichment and differential media.

UNIT II: Microbial Growth **Hrs: 9**

2.1. Microbial Growth- Definitions of growth, generation time and specific growth rate; different phases of growth in batch cultures;

2.2. Synchronous, continuous, biphasic growth.

2.3. Factors influencing microbial growth: Temperature, oxygen concentration, pH, Salt

2.4. Methods for measuring microbial growth - Direct microscopy, viable count estimates, turbidometry and biomass.

Unit III Enzymes **Hrs: 9**

3.1 Structure of enzyme, Apoenzyme and cofactors, **prosthetic group- TPP, coenzyme -NAD**, metal cofactors; Definitions of terms: enzyme unit, specific activity and turnover number. Properties of enzymes.

3.2 Outline Classification and nomenclature of enzymes, Mechanism of action of enzymes: Lock and key hypothesis, and Induced Fit hypothesis. Michaelis-Menten equation,

3.3 Factors affecting enzyme activity

3.4 Inhibition of enzyme activity- competitive, noncompetitive, uncompetitive and allosteric inhibition.

UNIT IV: Microbial Respiration and Fermentation **Hrs: 9**

4.1 Glycolytic Pathways: Glycolysis/EMP pathway and ED; TCA cycle.

4.2. Aerobic respiration - ETS and oxidative phosphorylation

4.3. Anaerobic respiration, chemoautotrophy - oxidation of inorganic compounds - N and S.
4.4. Fermentative modes in microorganisms with special reference to alcoholic, Lactic acid fermentations

UNIT V: Bacterial Photosynthesis **Hrs: 9**

5.1. Photosynthetic pigments, Photosynthetic apparatus in prokaryotes
5.2. Outlines of oxygenic photosynthesis in bacteria
5.3. Outlines of anoxygenic photosynthesis in bacteria

III. Reference Books:

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
2. Caldwell, D.R. (1995). Microbial Physiology and Metabolism, W.C. Brown Publications,Iowa, USA.
3. Lehninger, A.L., Nelson, D.L. and Cox, M.M. (1993). Principles of Biochemistry, 2 nd Edition, CBS Publishers and Distributors, New Delhi.
4. Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.
5. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
6. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
7. White, D. (1995). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York.

VI. Co-Curricular Activities:

1. Assignments in nutrient utilization, energy production, metabolic pathways,
2. Students can study microbial growth curves, metabolic pathways, or physiological responses to environmental factors.
3. Organize seminars where students can deliver presentations on specific topics in microbial physiology and metabolism.
4. Create visual representations of microbial metabolic pathways.
5. Extract and analyse bacterial photosynthetic pigments using paper chromatography to visualize pigment composition and understand functional roles.

SEMESTER-II

COURSE 4: MICROBIAL PHYSIOLOGY

Practical **Credits: 1** **2 hrs/week**

I. Learning outcomes

1. CO1: Cultivate phototrophic bacteria using enrichment techniques and observe pigmentation and morphology. (BT3)
2. CO2: Study the effect of temperature, pH, and salinity on bacterial growth and interpret growth patterns. (BT4)
3. CO3: Plot and interpret bacterial growth curves using turbidometric and viable count methods. (BT4)
4. CO4: Identify cyanobacteria from prepared slides and relate their ecological significance. (BT2)
5. CO5: Apply aseptic techniques and biosafety practices during microbial physiology experiments. (BT3)
6. CO6: Record, analyze, and interpret experimental data using appropriate scientific formats. (BT4)

Laboratory/Field exercises:

1. Cultivation of phototrophic bacteria by enrichment method.
2. Effect of Temperature on *E. Coli* growth
3. Effect of pH on bacterial *E. Coli* growth
4. Effect of salt on growth of *E. coli* growth
5. Study and plot the growth curve of E. coli by turbidometric and standard plate count methods
6. Observation and identification of permanent slides of cyanobacteria

IV SEMESTER

COURSE 4: MICROBIAL PHYSIOLOGY

Blue Print for Question Papers

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B Short Answers (with Choice)	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	2 mark (1 Questions)	10 M
Unit-2	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-3	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-4	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-5	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M

SECTION-A $5 \times 8 = 40$ Marks

Answer all the following questions. Draw labelled diagrams wherever necessary.

1. (a) or (b)
2. (a) or (b)
3. (a) or (b)
4. (a) or (b)
5. (a) or (b)

SECTION-B $5 \times 2 = 10$ Marks

Answer any 5 of the following questions.

1. From Unit-1
2. From Unit-1
3. From Unit-2
4. From Unit-2
5. From Unit-3
6. From Unit-3
7. From Unit-4
8. From Unit-5

COURSE 4: MICROBIAL PHYSIOLOGY

MODEL QUESTION PAPER

Section-A

Answer all the following

Q.NO	QUESTION	MARKS	BL	CLO	PO
1. a	General characters and biological significance of carbohydrates	8	BL1	CLO1	PO1, PO2
	(OR)				
b	Write about outline classification of carbohydrates	8	BL1, BL2	CLO1	PO1, PO2
2.a	Interpret the classification of lipids according to complexity of structure	8	BL2	CLO2	PO1, PO2
	(OR)				
b	Explain structure, functions and role of phospholipids in cell membrane	8	BL1, BL2	CLO2	PO1, PO2
3.a	Explain general characters and functions of amino acids	8	BL1, BL3	CLO3	PO1, PO2
	(OR)				
b	Discuss the structure and functions of amino acids	8	BL1, BL3	CLO3	PO1, PO2
4.a	Analyse the structure and types of DNA according to Watson and Crick	8	BL4	CLO4	PO1, PO2, PO5
	(OR)				
b	Outline the types and functions of RNA	8	BL1	CLO4	PO1, PO2, PO5
5.a	Explain principle, instrumentation and applications of UV-visible spectrophotometer	8	BL1, BL3	CLO5	PO2, PO3, PO4
	(OR)				
b	Principles and applications of paper chromatography	8	BL1, BL3	CLO5	PO2, PO3, PO4

Section -B

Answer Any FIVE of the following

(5x2=10)

1. Active transport
2. Synthetic media
3. Microbial count
4. Viable count method
5. Coenzyme
6. Competitive inhibitor
7. Glycolysis
8. Photosynthetic apparatus

COURSE 4: MICROBIAL PHYSIOLOGY

QUESTION BANK-ESSAY QUESTIONS FOR 8 MARKS

UNIT	Q.No	Questions	Marks	BL	CLO	PO
I	1	Explain nutritional requirements of microorganisms	8	BL2	CLO1	PO1, PO2
	2	Describe nutritional groups of microorganisms based on C, energy and electron sources	8	BL2	CLO1	PO1, PO2
	3	Explain primary and secondary active transport, uniport, symport and antiport	8	BL2	CLO1	PO1, PO2
	4	Explain growth media – synthetic, nonsynthetic, selective, enrichment and differential media	8	BL2	CLO1	PO1, PO2
II	1	Explain different phases of growth in batch cultures	8	BL2	CLO2	PO1, PO2
	2	Describe synchronous, continuous and biphasic growth	8	BL2	CLO2	PO1, PO2
	3	Write notes on factors influencing microbial growth	8	BL2	CLO2	PO1, PO2
	4	Describe methods for measuring microbial growth – microscopy, viable count, turbidometry, biomass	8	BL3	CLO2	PO1, PO2
III	1	Essay on properties of enzymes	8	BL2	CLO3	PO1, PO2
	2	Outline classification and nomenclature of enzymes	8	BL2	CLO3	PO1, PO2
	3	Mechanism of enzyme action – Lock and Key and Induced Fit hypothesis	8	BL3	CLO3	PO1, PO2
	4	Factors affecting enzyme activity	8	BL3	CLO3	PO1, PO2
IV	1	Explain glycolytic pathway and its significance	8	BL3	CLO4	PO1, PO2, PO5
	2	Anaerobic respiration with reference to oxidation of sulphur	8	BL3	CLO4	PO1, PO2, PO5
	3	Fermentative modes in microorganisms – alcoholic fermentation	8	BL3	CLO4	PO1, PO2, PO5
	4	Fermentative modes in microorganisms – lactic acid fermentation	8	BL3	CLO4	PO1, PO2, PO5
V	1	Explain photosynthetic pigments in prokaryotes	8	BL2	CLO5	PO1, PO2, PO5
	2	Explain photosynthetic apparatus in prokaryotes	8	BL2	CLO5	PO1, PO2,

UNIT	Q.No	Questions	Marks	BL	CLO	PO
						PO5
	3	Outline oxygenic photosynthesis in bacteria	8	BL3	CLO5	PO1, PO2, PO5
	4	Outline anoxygenic photosynthesis in bacteria	8	BL3	CLO5	PO1, PO2, PO5

SHORT ANSWERS FOR 2 MARKS

UNIT-1

1. Autotrophs.
2 Active Transport
3. Synthetic Media
4. Heterotrophs

UNIT-2

1. Microbial Growth
2. Phases Of Microbial Growth
3. Direct Microscopy Method
4. Viable Count Method

UNIT-3

1 Enzyme
2. Coenzyme
3. Lock & Key Hypothesis
4 Competitive Inhibition

UNIT-4

1. Glycolysis
2. Aerobic Respiration
3. Anaerobic Respiration
4. Fermentation

UNIT-5

1. Photosynthetic Pigments
2. Photosynthetic Apparatus In Prokaryotes
3 Oxygenic Photosynthesis
4. Anoxygenic Photosynthesis

III SEMESTER

COURSE 5: - EUKARYOTIC MICROORGANISMS credits -_3

SYLLABUS

I. Course Outcomes:

On successful completion of the course, the students will be able to

Theory – CLOs

1. CLO1: Explain the characteristics, classification, and reproduction of fungi, algae, and protozoa. (BT2 – Understand)
2. CLO2: Describe the role of fungi in biotechnology, agriculture, and medicine. (BT2 – Understand)
3. CLO3: Explain the importance of algae in food, industry, and environmental sustainability. (BT2 – Understand)
4. CLO4: Identify pathogenic protozoa and explain their impact on human health. (BT2 – Understand)
5. CLO5: Explain life cycles and cultivation methods of selected eukaryotic microorganisms. (BT2 – Understand)
6. CLO6: Analyze the ecological and industrial significance of eukaryotic microorganisms. (BT4 – Analyze)

Unit 1: Fungi No. of Hours:9

1. Habitat, distribution, nutritional requirements, fungal cell ultra- structure, fungal wall, Outline classification of Fungi
2. Reproduction in different fungal groups- Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes
3. Heterokaryosi s, heterothallism and parasexual mechanism.
4. Fungal dimorphism (Candida albicans)

Unit 2: Importance of Fungi No. of Hours:9

1. Role of fungi in biotechnology: food, medicine and pharmaceutical industry (baking, brewing, antibiotics, alcohols, enzymes, organic acids, and pharmaceuticals)
2. Beneficial Role of fungi in Agriculture: Biofertilizers, Myco toxins; Biological control (Myco fungicides, Myco herbicides, Myco insecticides).
3. Mushrooms and its cultivation. (White button, Milky and Oyster)
4. Fungi as plant and animal pathogens (Cercospora, Puccinia, Candida, Aspergillus)

Unit 3: Algae No. of Hours:9

1. Algae- occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves, outline classification
2. Vegetative, asexual and sexual reproduction in Algae
3. Photosynthetic apparatus, and outline of Photosynthesis in Algae.

Unit 4: Importance and cultivation of Algae No. of Hours:9

1. Importance of algae in agriculture, industry, environment and food with examples.

2. Algal culture techniques- Indoor, Outdoor, Closed, Open, Batch, continuous, Fed batch Culture media and growth parameters for algal cultivation (Spirulina)

Unit 5: Protozoa No. of Hours:9

1. General characteristics with special reference to Amoeba, Paramecium
2. Pathogenic Protozoa- Plasmodium, Leishmania and Giardia
3. Importance of protozoa (in waste management, soil fertility, industry and scientific study)
4. Culturing protozoans from natural sources-Hay water, pond water, Chalkley's solution
5. Haplobiontic (Nemalion), Haplontic (Chlamydomonas), Diplontic (Cladophora), Diplobiontic (Polysiphonia) and Diplohaplontic (Cladophora) life cycles. deleted.

II. Skill Outcomes:

1. On successful completion of the course, the students will be able to
2. Develop practical skills in the isolation, identification, and cultivation of fungi and algae.
3. Acquire knowledge about the preparation of growth media and study hostpathogen interactions.
4. Gain the ability to examine the vegetative and reproductive structures of selected genera through microscopy.
5. Demonstrate proficiency in purifying and preserving pure cultures of common algae and fungi.

III SEMESTER

COURSE 5: - EUKARYOTIC MICROORGANISMS credits -_1

Practical – CLOs

1. CLO1: Prepare growth media for cultivation of fungi and algae. (BT3 – Apply)
2. CLO2: Isolate and identify pathogenic and non-pathogenic fungi and algae. (BT3 – Apply)
3. CLO3: Examine vegetative and reproductive structures using microscopy. (BT3 – Apply)
4. CLO4: Demonstrate host–pathogen interaction studies. (BT3 – Apply)
5. CLO5: Purify and preserve pure cultures of common fungi and algae. (BT3 – Apply)
6. CLO6: Record, analyze, and interpret experimental observations. (BT4 – Analyze)

Learning outcomes

1. Preparation of Potato Dextrose Medium.
2. Isolation and identification of pathogenic and non-pathogenic fungi.
3. Study of host-pathogen interaction.

4. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor,*
5. *Saccharomyces, Penicillium, Agaricus* and *Alternaria*
6. Purification and preservation of pure cultures of common algae and fungi.

References

1. Alexopoulus, C.J., Mims,C.W. and Blackwel, M, Introductory Mycology.
2. John Wiley,New York.
3. Mehrotra, R.S. and K.R.Aneja An Introduction to Mycology. New Age International press, New Delhi
4. Webster, J. Introduction to fungi. Cambridge University Press. Cambridge, U.K. (1985).
5. Bessey E.A. Morphology and Taxonomy of fungi. Vikas Publishing House Pvt. Ltd.,New Delhi.
6. Jhon Webster and R W S Weber. Introduction to Fungi. Cambridge University Press2007.
    A. V. S. S. .Sambamurty. A Textbook of Algae. I.K. International Publishing House Pvt.Limited, 2010
7. H.D. Kumar and H.N. Singh.A Textbook on Algae (Macmillan international collegeedition)

III. Co- Curricular Activities

1. Conduct hands-on microscopy workshops using to observe eukaryotic microorganisms
2. Organize field trips to natural habitats, such as forests, ponds, or marine environments, where eukaryotic microorganisms thrive.
3. Arrange culturing workshops where students can learn how to isolate and culture eukaryotic microorganisms in the laboratory.
4. Eukaryotic Microorganism Photography Contest

COURSE 5: - EUKARYOTIC MICROORGNISMS

Blue Print for Question Papers from II Semester onwards

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B (MCQ/ True or False/ Fill in the blank) – No choice	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M
Unit-2	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M
Unit-3	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M
Unit-4	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M
Unit-5	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M

SECTION-A **5 × 8 = 40 Marks**

Answer all the following questions. Draw labelled diagrams wherever necessary.

1. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
2. (a) or (b) – If an essay
3. (a) or (b) – If an essay
4. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
5. (a) or (b) – If an essay

SECTION-B **10 × 1 = 10 Marks**

Answer all the following questions.

6. From Unit-1
7. From Unit-1
8. From Unit-2
9. From Unit-2
10. From Unit-3
11. From Unit-3
12. From Unit-4
13. From Unit-4
14. From Unit-5
15. From Unit-5

COURSE 5: - EUKARYOTIC MICROORGANISMS

MODEL QUESTION PAPER

SECTION

Answer all the questions. 5x8= 40

Q.No	Question	Marks	BL	CLO	PO
1a	Describe habitat, distribution, nutritional requirements, fungal cell ultrastructure, fungal wall and classification of fungi	8	BL2	CLO1	PO1, PO2
1b	Analyse fungal dimorphism (*Candida albicans*)	8	BL4	CLO1	PO1, PO2
2a	Describe the role of fungi in biotechnology	8	BL2	CLO2	PO1, PO2, PO5
2b	Examine beneficial role of fungi in agriculture	8	BL4	CLO2	PO1, PO2, PO5
3a	Discuss algae – occurrence, thallus organization, pigments, flagella, eyespot, food reserves and classification	8	BL2	CLO3	PO1, PO2
3b	Explain vegetative, asexual and sexual reproduction in algae	8	BL2	CLO3	PO1, PO2
4a	Analyse importance of algae in agriculture, industry, environment and food	8	BL4	CLO4	PO1, PO2, PO4, PO5
4b	Develop culture media and growth parameters for algal cultivation with reference to *Spirulina*	8	BL4	CLO4	PO1, PO2, PO4, PO5
5a	Explain general characteristics of protozoa with reference to *Amoeba* and *Paramecium*	8	BL2	CLO5	PO1, PO2, PO5
5b	Develop culture media and growth parameters for algal cultivation with reference to *Spirulina*	8	BL4	CLO4	PO1, PO2, PO4, PO5

SECTION B

OBJECTIVE 10X1=10

1. The fungal cell wall is primarily composed of _____, a polysaccharide that provides structural support.
2. Mycoherbicides are fungal-based agents used to control fungal diseases in humans. → **False**
3. Algae store food in the form of _____ in green algae and **laminarin** in brown algae.
4. Classification of algae is based on pigment composition, thallus structure, and mode of reproduction. → **True**
5. Leishmania is transmitted to humans by the bite of a sandfly. → **True**

COURSE 5: - EUKARYOTIC MICROORGANISMS

QUESTION BANK

Unit	S.No	Question	Marks	BT	CO	PO
Unit 1	1	Describe habitat, distribution, nutritional requirements, cell wall and ultrastructure of fungi	8	BL2	CO1	PO1, PO2
	2	Outline classification of fungi	8	BL1	CO1	PO1
	3a	Explain heterokaryosis	4	BL2	CO1	PO1, PO2
	3b	Discuss heterothallism	4	BL4	CO1	PO1, PO2
	4	Differentiate fungal dimorphism	8	BL4	CO1	PO1, PO2
Unit 2	1	Examine beneficial role of fungi in food, medicine and pharma industry	8	BL4	CO2	PO2, PO3, PO5
	2	Evaluate beneficial role of fungi in agriculture	8	BL5	CO2	PO2, PO3, PO5
	3	Demonstrate cultivation of milky mushrooms	8	BL3	CO2	PO2, PO3
	4a	Analyze *Puccinia*	4	BL4	CO1	PO1, PO2
	4b	Assess Aspergillosis	4	BL5	CO4	PO1, PO2, PO4
Unit 3	1	Describe habitat, distribution, nutritional requirements, cell wall and ultrastructure of algae	8	BL2	CO1	PO1, PO2
	2	Summarize classification of algae	8	BL1	CO1	PO1
	3	Explain reproduction in algae	8	BL2	CO1	PO1, PO2
	4	Illustrate photosynthetic apparatus in algae	8	BL3	CO3	PO1, PO2, PO3
Unit 4	1	Justify importance of algae in food and environment	8	BL5	CO3	PO1, PO2, PO5
	2	Assess importance of algae in industry and agriculture	8	BL5	CO3	PO2, PO3, PO5
	3	Compare indoor and outdoor cultivation of algae	8	BL4	CO3	PO2, PO3
	4	Design a method for cultivation of *Spirulina* and physical parameters	8	BL6	CO3	PO2, PO3, PO5
Unit 5	1	Explain general characteristics of protozoa with *Amoeba*	8	BL2	CO1	PO1, PO2
	2	Differentiate protozoa with reference to *Paramecium*	8	BL4	CO1	PO1, PO2
	3	Demonstrate cultivation of protozoa by hay infusion method	8	BL3	CO1	PO2, PO3
	4	Evaluate importance of protozoa in waste management, soil fertility, industry and research	8	BL5	CO4	PO1, PO2, PO4, PO5

OBJECTIVE

1. The fungal cell wall is primarily composed of _____, a polysaccharide that provides structural support.
2. _____ fungi are called "Fungi Imperfecti" due to the absence of a known sexual reproductive stage
3. Heterothallism refers to the condition where sexual reproduction requires two genetically different but compatible mycelia. → **True**
4. The parasexual cycle includes plasmogamy, karyogamy, and meiosis, just like in the sexual cycle. → **False** (It lacks a regular meiotic phase)
5. Fungi are autotrophic organisms and can perform photosynthesis. → **False**
6. In agriculture, fungi like **Trichoderma** are used as _____ to control plant diseases.
7. The fungus **Puccinia** causes _____ disease in wheat.
8. Fungi play an important role in baking and brewing industries through the process of fermentation. → **True**
9. Mycoherbicides are fungal-based agents used to control fungal diseases in humans. → **False**
10. The white button mushroom is scientifically known as **Agaricus bisporus**. → **True**
11. _____ is a specialized light-sensitive organelle found in motile algal cells, helping them to detect light.
12. Algae store food in the form of _____ in green algae and **laminarin** in brown algae.
13. Algae perform photosynthesis using chloroplasts that contain thylakoid membranes. → **True**
14. In all algae, sexual reproduction is absent. → **False**
15. Classification of algae is based on pigment composition, thallus structure, and mode of reproduction. → **True**
16. The _____ culture system allows better control of contamination and environmental parameters in algal cultivation.
17. _____ medium is commonly used for cultivating *Spirulina* due to its high bicarbonate and nitrate content.
18. Algae play a significant role in carbon dioxide fixation and oxygen production. → **True**
19. Outdoor algal cultures are easier to control and maintain than indoor cultures. → **False**
20. Algae are used in the food industry for producing products like agar, carrageenan, and alginate. → **True**
21. . _____ is a unicellular protozoan that moves and feeds using pseudopodia.
22. _____ is the protozoan responsible for causing malaria in humans.
23. Protozoa help in _____ management by feeding on bacteria and organic debris in aquatic systems.
24. Leishmania is transmitted to humans by the bite of a sandfly. → **True**
25. Hay infusion is a simple method used to culture protozoa from natural sources. → **True**

III SEMESTER

COURSE 6: - BIOMOLECULES AND ENZYMOLOGY credits -_3

SYLLABUS

I. Course Outcomes:

On successful completion of the course, the students will be able to

Theory – CLOs

1. CLO1: Explain classification, structure, and properties of carbohydrates and their biological roles. (BT2 – Understand)
2. CLO2: Describe structure, functions, and metabolic roles of lipids and fatty acids. (BT2 – Understand)
3. CLO3: Explain structure and functional organization of amino acids and proteins. (BT2 – Understand)
4. CLO4: Describe structure and functions of nucleic acids and the role of vitamins in metabolism. (BT2 – Understand)
5. CLO5: Explain enzyme structure, classification, and mechanisms of action. (BT2 – Understand)
6. CLO6: Analyze factors affecting enzyme activity and inhibition. (BT4 – Analyze)

UNIT-I: Carbohydrates **No. of hours: 9**

1. General characters and outline classification of Carbohydrates
2. Monosaccharides- Glucose, fructose, ribose**; Stereo isomerism of monosaccharides, epimers, mutarotation and anomers of glucose 3**. Disaccharides- concept of reducing and non-reducing sugars;
3. Sucrose, Lactose
4. Polysaccharides- Storage -Starch, glycogen, StructuralCellulose peptidoglycan and chitin Sugar derivatives- glucosamine.

UNIT-II: Lipids and fatty acids **No. of hours: 9**

1. .Definition and classification of lipids. Structure and properties of lipids. Importance of lipids in biological systems.
2. Introduction to fatty acids: definition, structure, and nomenclature. Saturated and unsaturated fatty acids.
3. Triglycerides: structure, function, and metabolism. Phospholipids: structure, function, and role in cell membranes. Steroids: structure, biosynthesis, and physiological roles.Waxes: structure, functions, and applications.

UNIT-III: Amino acids and Proteins. **No. of hours: 9**

1. Biochemical structure and notation of standard protein amino acids
2. General characteristics of amino acids and proteins.
3. Primary, secondary, tertiary and quaternary structures of Protein

4. Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid.

UNIT-IV: Nucleic acids and Vitamins **No. of hours:9**

1. Structure and functions of DNA and RNA.
2. Base composition. A+T and G+C rich genomes. Basic concept of nucleic acids protein interactions.
3. Concept and types of vitamins and their role in metabolism.

UNIT-V: Enzymes **No. of hours: 9**

1. Structure of enzyme, Apoenzyme and cofactors, prosthetic groupTPP, coenzyme -NAD, metal cofactors; Definitions of terms – enzyme unit, specific activity and turnover number
2. Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis.
3. Effect of pH and temperature on enzyme activity.
4. Inhibition of enzyme activity- competitive, noncompetitive, uncompetitive and allosteric.

III. Skill Outcomes:

1. On successful completion of the course, the students will be able to
2. Qualitatively Identify mono and disaccharides
3. Qualitatively Identify specific aminoacids
4. Quantitatively estimate DNA
5. Quantitatively estimate protein

III SEMESTER

COURSE 6: - BIOMOLECULES AND ENZYMOLOGY credits -1

Practical – CLOs

1. CLO1: Perform qualitative tests to identify carbohydrates. (BT3 – Apply)
2. CLO2: Identify amino acids using standard biochemical tests. (BT3 – Apply)
3. CLO3: Quantitatively estimate DNA using colorimetric methods. (BT3 – Apply)
4. CLO4: Quantitatively estimate proteins using standard biochemical assays. (BT3 – Apply)
5. CLO5: Handle biochemical reagents and instruments following safety protocols. (BT3 – Apply)
6. CLO6: Analyze and interpret biochemical experimental results. (BT4 – Analyze)

Learning outcomes

1. Qualitative tests for sugars
2. Qualitative Analysis of Aminoacids.
3. Colorimetric estimation DNA by diphenylamine method.
4. Colorimetric estimation of proteins by Biuret/Lowry method

References:

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company Caldwell, D.R. (1995). Microbial Physiology and Metabolism, W.C. Brown Publications,Iowa, USA.
2. Lehninger, A.L., Nelson, D.L. and Cox, M.M. (1993). Principles of Biochemistry, 2 nd Edition, CBS Publishers and Distributors, New Delhi.
3. Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.
4. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
5. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
6. White, D. (1995). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York.

Co-Curricular Activities:

1. Organize Biomolecule Modeling Workshops where students can learn to build physical models or use computer simulations to visualize biomolecules such as proteins, nucleic acids, carbohydrates, and lipids. These workshops can help students understand the three-dimensional structures and interactions of biomolecules, enhancing their comprehension of molecular biology concepts.

Assign Biomolecule and Enzyme Case Studies case studies that require students to analyze real-world scenarios related to biomolecules and enzymes in medicine, biotechnology, or environmental science.

COURSE 6: - BIOMOLECULES AND ENZYMOLOGY

Blue Print for question papers from II Semester onwards

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B (MCQ/ True or False/ Fill in the blank) – No choice	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M
Unit-2	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M
Unit-3	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M
Unit-4	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M
Unit-5	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 M

SECTION-A **5 × 8 = 40 Marks**

Answer all the following questions. Draw labelled diagrams wherever necessary.

16. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
17. (a) or (b) – If an essay
18. (a) or (b) – If an essay
19. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
20. (a) or (b) – If an essay

SECTION-B **10 × 1 = 10 Marks**

Answer all the following questions.

21. From Unit-1
22. From Unit-1
23. From Unit-2
24. From Unit-2
25. From Unit-3
26. From Unit-3
27. From Unit-4
28. From Unit-4
29. From Unit-5
30. From Unit-5

COURSE 6: - BIOMOLECULES AND ENZYMOLOGY

MODEL QUESTION PAPER

SECTION-A **5 × 8 = 40 Marks**

Answer all the following questions. Draw labelled diagrams wherever necessary.5X8=40

Q.No	Question	Marks	BT	CO	PO
1 i	Explain polysaccharides – storage (starch, glycogen) and structural (cellulose, peptidoglycan, chitin)	8	BL2	CO1	PO1, PO2
1 ii	a. Write a note on glucosamine b. Write a note on sucrose	4	BL1	CO1	PO1
2 i	Discuss definition and functions of lipids	8	BL2	CO2	PO1, PO2
2 ii	Write notes on triglycerides	8	BL2	CO2	PO1, PO2
3 i	Discuss the role of proteins	8	BL2	CO3	PO1, PO2
3 ii	Explain primary, secondary, tertiary and quaternary structure of proteins	8	BL2	CO3	PO1, PO2
4 i	Explain structure and functions of DNA and RNA	8	BL2	CO4	PO1, PO2
4 ii	Discuss concept and types of vitamins	8	BL2	CO4	PO1, PO2
5 i	Explain enzyme classification	4	BL1	CO5	PO1
5 ii	Write an essay on mechanism of action of enzymes	8	BL3	CO5	PO1, PO2, PO3

SECTION-B **10 × 1 = 10 Marks**

1. 1. The sugar present in RNA is _____, whereas DNA contains _____. **(Answer: ribose, deoxyribose)**
2. The regions of DNA that have a high number of guanine and cytosine bases are known as _____ rich genomes. **(G+C)**
3. Vitamins act only as structural components and have no role in enzyme function. **(False)**
4. Ribosomal RNA (rRNA) plays a key role in the synthesis of proteins. **(True)**
5. The number of substrate molecules converted into product per unit time by a single enzyme molecule is known as the ____. **(turnover number)**

COURSE 6: - BIOMOLECULES AND ENZYMOLOGY

QUESTION BANK

Unit	Q.No	Question	Marks	BL	CO	PO
I	1	Describe the general characters and outline classification of carbohydrates	8	BL2	CO1	PO1, PO2
	2	Explain the structure and properties of monosaccharides with examples	8	BL2	CO1	PO1, PO2
	3	Compare the properties and biological roles of disaccharides	8	BL4	CO1	PO1, PO2
	4	Classify polysaccharides and analyze their structural diversity	8	BL4	CO1	PO1, PO2
II	1	Discuss the structure, properties and importance of lipids in biological systems	8	BL2	CO2	PO1, PO2
	2	Define and differentiate saturated and unsaturated fatty acids	8	BL1/BL4	CO2	PO1, PO2
	3	Explain the structure and functions of triglycerides and phospholipids in cell membranes	8	BL2	CO2	PO1, PO2, PO3
	4	Illustrate structure and evaluate functions of waxes with applications	8	BL3/BL5	CO2	PO1, PO2, PO3
III	1	Describe biochemical structure and notation of standard amino acids	8	BL2	CO3	PO1, PO2
	2	List the general characteristics of amino acids	8	BL1	CO3	PO1
	3	Explain primary, secondary, tertiary and quaternary structures of proteins	8	BL2	CO3	PO1, PO2
	4	Explain non-protein amino acids with examples	8	BL2	CO3	PO1, PO2
IV	1	Structure and functions of DNA	8	BL2	CO4	PO1, PO2
	2	Structure and functions of RNA	8	BL4	CO4	PO1, PO2
	3	Base composition and nucleic acid–protein interactions	8	BL2	CO4	PO1, PO2
	4	Role of vitamins in metabolism	8	BL4/BL5	CO4	PO1, PO2, PO4
V	1	Describe structure of enzymes, apoenzymes and cofactors	8	BL2	CO5	PO1, PO2
	2	Classify enzymes with suitable examples	8	BL1	CO5	PO1
	3	Compare lock-and-key and induced fit hypothesis	8	BL4	CO5	PO1, PO2
	4	Analyze effect of pH and temperature on	8	BL4	CO5	PO1,

Unit	Q.No	Question	Marks	BL	CO	PO
		enzyme activity				PO2, PO3

OBJECTIVE

6. The two monosaccharides that form **sucrose** are _____ and _____. **(glucose, fructose)**
7. The structural polysaccharide found in the exoskeleton of arthropods is _____. **(chitin)**
8. Lactose is a non-reducing sugar. **(False)**
9. Glycogen serves as a storage polysaccharide in plants. **(False)**
10. Peptidoglycan is a polysaccharide found in the cell walls of bacteria. **(True)**
11. The basic structure of a triglyceride consists of one molecule of glycerol and _____ molecules of fatty acids. **(three)**
12. Fatty acids with no double bonds in their hydrocarbon chain are called _____ fatty acids. **(Answer: saturated)**
13. Phospholipids are a major component of _____ membranes. **(cell)**
14. Unsaturated fatty acids contain one or more double bonds in their structure. **(True)**
15. Waxes are esters formed from fatty acids and long-chain alcohols. **(True)**
16. The folding of a polypeptide chain into alpha-helices and beta-sheets refers to the _____ structure. **(secondary)**
17. Gramicidin is a type of _____ amino acid with antibiotic properties. **(non-protein)**
18. Proteins with more than one polypeptide chain exhibit a _____ structure. **(quaternary)**
19. . All naturally occurring amino acids in proteins are L-isomers. **(True)**
20. Beta-alanine is a standard amino acid found in protein synthesis. **(False)** – *It is a non-protein amino acid.*
21. In DNA, adenine pairs with _____ and guanine pairs with _____. **(thymine, cytosine)**
22. The sugar present in RNA is _____, whereas DNA contains _____. **(Answer: ribose, deoxyribose)**
23. The regions of DNA that have a high number of guanine and cytosine bases are known as _____ rich genomes. **(G+C)**
24. Vitamins act only as structural components and have no role in enzyme function. **(False)**
25. Ribosomal RNA (rRNA) plays a key role in the synthesis of proteins. **(True)**
26. The number of substrate molecules converted into product per unit time by a single enzyme molecule is known as the ____. **(turnover number)**
27. A competitive inhibitor binds to the _____ site of an enzyme, preventing the substrate from binding. **(active)**
28. TPP (thiamine pyrophosphate) is a prosthetic group that is permanently attached to enzymes. **(True)**
29. Enzyme activity generally increases continuously with increasing temperature. **(False)**
30. Noncompetitive inhibitors bind to the active site of enzymes. **(False)**

III SEMESTER

COURSE 7: MICROBIAL AND ANALYTICAL TECHNIQUES

credits -_3 SYLLABUS

I . Course Outcomes:

On completion of the course, the students will be able to

Theory – CLOs

1. CLO1: Explain principles and applications of microscopy and staining techniques. (BT2 – Understand)
2. CLO2: Describe physical and chemical methods of sterilization and disinfection. (BT2 – Understand)
3. CLO3: Explain methods for isolation, cultivation, and preservation of microorganisms. (BT2 – Understand)
4. CLO4: Explain principles and applications of spectrophotometry and chromatography. (BT2 – Understand)
5. CLO5: Describe principles and applications of centrifugation and electrophoresis. (BT2 – Understand)
6. CLO6: Analyze the use of analytical techniques in microbiological investigations. (BT4 – Analyze)

Unit -1: Microscopy No. of Hours: 9hrs

1. Microscopy: Principle, mechanism and applications of Bright field microscope.
2. Principle, mechanism and applications of electron microscope **(SEM and TEM).** Micrometry.
3. Staining Techniques – Simple, negative and Differential staining techniques (Gram staining, spore staining, Acid fast staining).

Unit-2: Sterilization and disinfection techniques No. of Hours: 9hrs

1. Sterilization, Disinfection, Antiseptic, Germicide, Sanitizer, Fungicide, Virucide, Bacteriostatic and Bactericidal agent.
2. Physical methods of microbial control: Dry heat-Incineration, Hot air oven; Moist heat-Pressure cooker, autoclave; Filter sterilization- laminar air flow, Membrane filter; Radiation methods – UV rays, Gamma rays.
3. Chemical methods of microbial control: disinfectants, types and mode of action-alcohols, aldehydes, fumigants, phenols, halogens and heavy metals.

Unit -3: Microbiological techniques No. of Hours: 9hrs

1. Pure culture isolation: Streaking, serial dilution and plating methods, micromanipulator; cultivation.
2. Maintenance and preservation/stocking of pure cultures: sub culturing, overlaying cultures with mineral oils, lyophilization, sand cultures, storage at low temperature, Culture collection centers(MTCC, ATCC, DSMZ);

3. Cultivation of anaerobic bacteria; Accessing Viable non-culturable bacteria (VNBC). Buffers in culture medium. Cultivation of fungi, Actinomycetes, yeasts.

Unit-4: Spectrophotometry & Chromatography No. of Hours: 9

1. Spectroscopy – Principles, laws of light absorption, Instrumentation and applications of UV- visible spectrophotometer. Colorimetry and turbidometry.
2. **Chromatography:** Principles and applications of paper chromatography (Ascending, Descending and 2-D), Thin layer chromatography.
3. Principle and applications of column chromatography (Partition, adsorption, ion exchange, exclusion and affinity chromatography). Column packing and fraction collection.

Unit - 5: Centrifugation, Electrophoresis & Radio isotopes No.of Hrs:9

1. Centrifugation-Principles, types and applications.
2. Electrophoretic technique (agarose and SDS polyacrylamide gel) its Components, working principle and applications
3. Radioisotopes– characters and applications of radioisotopes, principle of autoradiography.

II. Skill Outcomes:

On successful completion of the course, the students will be able to

1. Recognize different microscopy techniques, identify microbial cell structures, interpret micrograph images, and understanding the principles of image contrast.
2. Prepare stained slides, differentiate stained and unstained structures, recognizing staining techniques, and describing the staining characteristics of microbial cells.
3. Perform the staining procedure, distinguishing between Gram-positive and Gramnegative bacteria, recognizing the importance of Gram's staining in bacterial classification, and interpreting Gram-stained slides.
4. Understand sterilization principles, operate autoclave and hot air oven, implement proper sterilization protocols, ensure sterility of media and glassware, and recognize the importance of sterile techniques in microbiology.
5. Understand streaking techniques, perform streak plate method, obtain isolated colonies, recognize contamination, and demonstrate proficiency in maintaining pure cultures for further study.

III SEMESTER

COURSE 7: MICROBIAL AND ANALYTICAL TECHNIQUES

credits -_1

Practical – CLOs

1. CLO1: Operate microscopes and perform staining techniques effectively. (BT3 – Apply)
2. CLO2: Sterilize media and glassware using appropriate methods. (BT3 – Apply)
3. CLO3: Isolate and maintain pure microbial cultures. (BT3 – Apply)
4. CLO4: Perform chromatographic separation of biomolecules. (BT3 – Apply)

5. CLO5: Separate biomolecules using centrifugation and electrophoresis techniques. (BT3 – Apply)
6. CLO6: Analyze and document experimental data obtained from analytical techniques. (BT4 – Analyze)

LEARNING OUTCOMES

1. Study of bright field, dark field and phase contrast, Electron microscope micrographs to visualize microbial cells.
2. Simple staining & Negative staining.
3. Gram's staining.
4. Sterilization of medium using Autoclave, Sterilization of glassware using Hot Air Oven.
5. Isolation of pure cultures of bacteria by streaking method.
6. Isolation of bacteria from natural habitat by spread and pour plate method (using serial dilution method)
7. Separation of monosaccharides/amino acids by paper/thin layer chromatography.
8. Demonstration of column packing in gel filtration chromatography.
9. Determination of absorption max for an aromatic amino acid.
10. Separation of bacterial cells (cell pellet) from broth culture by using a laboratory scale centrifuge.
11. Separation of DNA fragments by Agarose gel electrophoresis.

V References:

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2. Stainier R.V., Ingraham, J.L., Wheelis, M.L. and Painter P.R. The Microbial World. Printice-Hall of India (Pvt.) Ltd., New Delhi
3. Wilson& Walker. Principles and Techniques in Practical Biochemistry. 5th EditionCambridge University Press (2000).
4. Murphy D.B. Fundamental of Light Microscopy & Electron Imaging.1st Edition. Wiley Liss. (2001).
5. K L Ghatak. Techniques and Methods In Biology PHI Publication (2011)
6. Pranav Kumar. Fundamentals and Techniques of Biophysics and Molecular Biology (2016)
7. Aurora Blair. Laboratory Techniques & Experiments in Biology.Intelliz Press
8. D.T Plummer. An Introduction to Practical Biochemistry. McGraw Hill Publication 1987
9. Beckner, W.M., Kleinsmith L.J and Hardin J. The world of cell. IV edition Benjamin /Cummings (2000)

VI. Co-Curricular Activities:

- Competition in performing laboratory techniques like staining
- Artwork with bacteria or fungi in petridish
- Quiz in identifying microscopic technique in various micrographs

COURSE 7: MICROBIAL AND ANALYTICAL TECHNIQUES

Blue Print for Question Papers from III Semester

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B (MCQ/ True or False/ Fill in the blank) – No choice	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-2	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-3	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-4	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-5	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks

SECTION-A **10 M 5 × 8 = 40 Marks**

Answer all the following questions.

Draw labelled diagrams wherever necessary.

1. (a) – (i) and (ii) Or (b) - (i) and (ii)
2. (a) or (b) – If an essay
3. (a) or (b) – If an essay
4. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
5. (a) or (b) – If an essay

SECTION-B **10X1=10 Marks**

Answer all the following questions.

6. From Unit-1
7. From Unit-1
8. From Unit-2
9. From Unit-2
10. From Unit-3
11. From Unit-3
12. From Unit-4
13. From Unit-4
14. From Unit-5
15. From Unit-5

II SEMESTER

C-7 (MICROBIAL AND ANALYTICAL TECHNIQUES)

Model Question Paper

Time:2.30 Hrs **max. marks:60**

Section-A 5X8=40

(Answer all the questions. Draw the labelled diagrams when necessary.)

Unit	Q.No	Questions	Marks	BL	CO	PO
I	1	Explain principle and construction of light microscope	8	BL2	CO1	PO1, PO2
		OR				
		Generalise principle and applications of Scanning Electron Microscope	8	BL3	CO1	PO1, PO2
II	2A	State definitions and examples of fungicide, viricide, bacteriostatic and bactericidal agents	4	BL1	CO2	PO1
	2B	Write a short note on sterilization by UV and Gamma rays	4	BL3	CO2	PO2, PO3
		OR				
		Describe working principle and applications of autoclave	8	BL2	CO2	PO1, PO2, PO3
III	3	Define MTCC and ATCC. Evaluate subculture, lyophilization and low temperature methods for preservation of cultures	2+6	BL1 & BL4	CO3	PO2, PO3, PO4
		OR				
		Explain different methods of cultivating anaerobic bacteria	8	BL3	CO3	PO2, PO3
IV	4	Describe instrumentation and applications of spectroscopy	8	BL3	CO4	PO1, PO2, PO3
		OR				
		Explain principle and applications of paper chromatography	8	BL2 & BL3	CO4	PO1, PO2, PO3
V	5	Differentiate types of centrifuges and their applications	8	BL2	CO5	PO1, PO2
		OR				
		Analyse characters and applications of radioisotopes	8	BL4	CO5	PO1, PO2, PO4

SECTION -B **10x1=10**

1. Acid-fast staining is primarily used to identify organisms like _____
2. Negative staining is particularly useful for observing _____,
3. Moist heat sterilization, like autoclaving, is more effective than dry heat sterilization because water conducts heat more effectively than air. (TRUE/FALS)
3. Differentiate Bacteriostatic and Bactericidal agents.
4. What is meant by Viricide?

Department of Microbiology
II B.Sc Microbiology Honours -III Semester
Course-7 (MICROBIAL AND ANALYTICAL TECHNIQUES)
Question Bank
Essay type questions (Select any Two from each Unit for Internal Choice)

Unit	Q.No	Questions	Marks	BL	CO	PO
I	1	Explain the principle and construction of light microscopy	8	BL2	CO1	PO1, PO2
I	2	Generalise principle and applications of Transmission Electron Microscope	8	BL3	CO1	PO1, PO2
I	3	Generalise principle and applications of Scanning Electron Microscope	8	BL3	CO1	PO1, PO2
I	4	Explain principle and importance of Gram staining and Ziehl–Neelsen staining	4+4	BL2	CO1	PO1, PO2
II	1a	State definitions and examples of fungicide, viricide, bacteriostatic and bactericidal agents	4	BL1	CO2	PO1
II	1b	Write a short note on sterilization by UV and Gamma rays	4	BL3	CO2	PO2, PO3
II	2	Describe working principle and applications of autoclave	8	BL2	CO2	PO1, PO2, PO3
II	3	Evaluate different chemical methods of sterilization	8	BL4	CO2	PO2, PO3
II	4	Compare and conclude filtration techniques as a tool of sterilization	8	BL4	CO2	PO2, PO3
III	1	Justify streak plate and spread plate methods for pure culture isolation	8	BL5	CO3	PO2, PO3
III	2	Define MTCC and ATCC. Evaluate preservation methods (subculture, lyophilization, low temperature)	2+6	BL1 & BL4	CO3	PO2, PO3, PO4
III	3	Explain methods of cultivating anaerobic bacteria	8	BL3	CO3	PO2, PO3
III	4	Write an essay on cultivation of actinomycetes and fungi	4+4	BL2	CO3	PO2, PO3
IV	1	Describe instrumentation and applications of spectroscopy	8	BL3	CO4	PO1, PO2, PO3
IV	2	Explain principle and applications of paper chromatography	8	BL2 & BL3	CO4	PO1, PO2, PO3
IV	3a	Explain principle of ion exchange chromatography	4	BL3	CO4	PO1, PO2
IV	3b	Explain principle of affinity chromatography	4	BL3	CO4	PO1, PO2

Unit	Q.No	Questions	Marks	BL	CO	PO
IV	4	Compare colorimetry and turbidometry	4+4	BL2	CO4	PO1, PO2
V	1	Differentiate types of centrifuges and their applications	8	BL2	CO5	PO1, PO2
V	2	Explain principles and applications of gel electrophoresis	8	BL3	CO5	PO1, PO2, PO3
V	3	Analyse applications of radioisotopes	8	BL4	CO5	PO1, PO2, PO4
V	4	Explain working principle and construction of analytical centrifuge	8	BL2	CO5	PO1, PO2, PO3

One mark Questions:-

Unit-I:

1. Electron microscopes use a beam of _____ instead of visible light to achieve higher resolution.

2. Acid-fast staining is primarily used to identify organisms like _____

3. Negative staining is particularly useful for observing _____,

4. Scanning Electron Microscopy (SEM) is ideal for observing the surface details of a specimen. (TRUE/FALS)

5. In Spore staining, what color do the spores appear after staining with malachite green?

Unit-II

1. Fungicides are chemical agents specifically designed to kill _____.

2. Moist heat sterilization, like autoclaving, is more effective than dry heat sterilization because water conducts heat more effectively than air. (TRUE/FALS)

3. Differentiate Bacteriostatic and Bactericidal agents.

4. What is meant by Viricide?

5. What is the difference between disinfectant and antiseptic?

Unit-III

1. Subculturing is the process of transferring microorganisms from one _____ to another to maintain pure cultures. Answer: medium
2. Anaerobic bacteria require specialized conditions for cultivation because they cannot tolerate _____ in their environment. Answer: oxygen
3. True or False: Sand cultures are a method used to preserve bacteria in sterile, dry sand at room temperature. Answer: True
4. True or False: ATCC is an international culture collection center that provides cultures of bacteria, fungi, and other microorganisms. Answer: True
5. True or False: The cultivation of fungi typically requires an acidic medium, such as Sabouraud's agar, to inhibit bacterial growth. Answer: True

Unit-IV

1. Beer-Lambert law states that the absorbance of a solution is directly proportional to the _____ of the solution and the path length. Answer: concentration

2. In colorimetry, a solution's concentration is determined by measuring the intensity of the _____ produced by a specific color. Answer: light
3. In affinity chromatography, specific interactions between a target molecule and a ligand attached to the stationary phase are used to achieve _____. Answer: separation
4. True or False: In column chromatography, partition chromatography separates components based on their different solubilities in two immiscible liquids. Answer: True
5. True or False: In adsorption chromatography, the mobile phase is a solid, and the stationary phase is a liquid. Answer: False

Unit V

1. In ultracentrifugation, particles are separated based on their _____ and buoyant density, using extremely high rotational speeds. Answer: size
2. Agarose gel electrophoresis is commonly used to separate _____ based on size. Answer: nucleic acids (DNA/RNA)
3. SDS-PAGE electrophoresis uses polyacrylamide gels to separate proteins based on their _____. Answer: molecular weight
4. True or False: In density gradient centrifugation, the sample forms layers based on the density of the particles, with heavier particles moving to the top. Answer: False
5. Autoradiography allows visualization of radioactive molecules on a gel after electrophoresis. Answer: True

III SEMESTER

COURSE 8: - CELL BIOLOGY AND GENETICS **credits -_3**

SYLLABUS

I. Course Outcomes:

By the Completion of the course the learner should able to–

Theory – CLOs

1. CLO1: Explain cell theory, cell organelles, cytoskeleton, and cell cycle regulation. (BT2 – Understand)
2. CLO2: Describe structure and functions of cell membrane, nucleus, and nucleolus. (BT2 – Understand)
3. CLO3: Explain intracellular signaling, protein sorting, apoptosis, and stem cells. (BT2 – Understand)
4. CLO4: Explain principles of Mendelian genetics and patterns of inheritance. (BT2 – Understand)
5. CLO5: Describe linkage, recombination, and population genetics concepts. (BT2 – Understand)
6. CLO6: Analyze genetic mechanisms underlying inheritance, variation, and disease. (BT4 – Analyze)

Unit 1 Hours : 09

1. Cell theory and cell organelles (Mitochondria, Chloroplasts, Lysosomes, Glyoxysomes and Peroxisomes, Golgi apparatus and ER).
2. Cell cycle and its regulation.
3. Cytoskeleton: Structure and organization of actin, myosin and intermediate filaments, microtubules, and their role.

Unit 2 Hours : 09

1. Structure and functions Cell membrane, proton pumps associated (Na-K, Cacalmodulin etc. and their distribution), phagocytosis, pinocytosis, exocytosis.
2. Nuclear envelope, structure of nuclear pore complex, nuclear lamina, transport across nuclear membrane, Nucleolus.
3. Elementary knowledge of development and causes of cancer; Oncogenes and suppressor genes,

Unit 3 Hours : 09

1. Protein sorting and Transport Intracellular signal transduction pathways (GPCR , ERK Pathway, mTOR Signaling)
2. Programmed Cell Death; Stem cells.
3. **Specialized chromosomes (polytene, lampbrush)**

UNIT 4 Hours : 09

1. Mendalien Genetics , Mono hybrid and Dihybrid cross , Law of dominance segregation and Independent assortment.
2. Chromosome theory of inheritance, Pedigree analysis, Incomplete dominance and co-dominance,
3. Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Allele frequencies, Genotype frequencies.

Unit – 5 Hours : 09

1. Linkage and Crossing over, Molecular mechanism of crossing over. Recombination frequency as a measure of linkage intensity,
2. Hardy-Weinberg Law, role of natural selection, Genetic drift. Speciation
3. Sex determination – Sex linked inheritance, extra chromosomal Inheritance

Skill Outcomes:

On successful completion of the course, the students will be able to

1. Develop proficiency in cell counting and viability assessment techniques.
2. Observe and analyze mitosis and meiosis in onion root tips, understanding their stages and significance.
3. Identify and analyze the ultrastructure of cells through electron micrographs.
4. Recognize and interpret cancer cells through permanent slides or photographs.
5. Understand genetic concepts like linkage, recombination, gene mapping, DNA fingerprinting, and pedigree chart analysis

III SEMESTER

COURSE 8: - CELL BIOLOGY AND GENETICS credits -_1

Practical – CLOs

1. CLO1: Perform cell counting and viability assessment techniques. (BT3 – Apply)
2. CLO2: Observe and analyze mitosis and meiosis using permanent or temporary slides. (BT3 – Apply)
3. CLO3: Identify ultrastructural features of cells using micrographs. (BT3 – Apply)
4. CLO4: Analyze cancer cells using slides or photographic evidence. (BT4 – Analyze)
5. CLO5: Solve problems related to linkage, recombination, and pedigree analysis. (BT4 – Analyze)
6. CLO6: Interpret experimental and genetic data using scientific reasoning. (BT4 – Analyze)

Learning Outcomes

1. Cell counting and Viability

2. Mitosis from onion root tips
3. Meiosis of onion root tips
4. Study of ultrastructure of cell (Plasma membrane, Nucleus, Nuclear Pore Complex, Chloroplast, Mitochondrion, Golgi bodies, Lysosomes, SER and RER)
5. Identification and study of types of cancer, cancer cells by permanent slides/ photographs.
6. Study of Linkage, recombination, gene mapping using marker-based data from Drosophila.
7. Demonstration of DNA fingerprinting.
8. Pedigree chart analysis.

III. References:

1. A.J.F Griffiths, S. R Wessler, S. B Carroll & J. Doebley, An Introduction to Genetic Analysis,. 10th Ed., W.H. Freeman & Company (New York) 2010
2. Geoffrey M. Cooper and Robert E. Hausman - The cell a molecular approach.
3. Bruce Alberts , Rebecca Heald, et al. Molecular Biology Of The Cell
4. Arnold Berk (Author), Chris A. Kaiser (Author), Harvey Lodish (Author), Angelika Amon (Author), Molecular Cell Biology.
5. Benjamin Lewin Genes
6. Eldon John Gardner, Michael J. Simmons, D. Peter Snustad Principles of Genetics
7. Karp G, John Wiley Cell Biology
8. Jane B. Reece (Author), Martha R. Taylor (Author), Eric J. Simon (Author), Jean L. Dickey , Campbell Biology: Concepts and Connections
9. Veer Bala Rastogi, Genetics B D Singh, Genetics

IV. Co-Curricular Activities:

1. Laboratory demonstrations where students can observe and participate in various experiments related to cell biology and genetics.
2. Guest Lectures: Invite experts and professionals from the field of cell biology and genetics to deliver guest lectures. They can share their research, industry experiences, and advancements in the field, providing students with valuable insights and exposure to real-world applications.
3. Seminars and Workshops on emerging areas, such as gene editing technologies, stem cell research, or personalized medicine
4. Research Project on literature reviews, designing experiments, and analyzing data.
5. Science Outreach Programs: Giving presentations at local schools, or creating educational materials

Course – 8 Cell Biology and genetics

Blue Print for Question Papers from III Semester

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B (MCQ/ True or False/ Fill in the blank) – No choice	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-2	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-3	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-4	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-5	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks

SECTION-A **10 M 5 × 8 = 40 Marks**

Answer all the following questions.

Draw labelled diagrams wherever necessary.

1. (a) – (i) and (ii) Or (b) - (i) and (ii)
2. (a) or (b) – If an essay
3. (a) or (b) – If an essay
4. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
5. (a) or (b) – If an essay

SECTION-B **10X1=10 Marks**

Answer all the following questions.

6. From Unit-1
7. From Unit-1
8. From Unit-2
9. From Unit-2
10. From Unit-3
11. From Unit-3
12. From Unit-4
13. From Unit-4
14. From Unit-5
15. From Unit-5

Course-8 (CELL BIOLOGY AND GENETICS)

Model Question Paper

Time:2.30 Hrs **max.marks:50**

Section-A 5X8=40

(Answer all the questions. Draw the labelled diagrams when necessary.)

Unit	Q.No	Questions	Marks	BL	CO	PO
I	1a	State Cell Theory and explain detailed structure of chloroplast	2+6	BL1 & BL2	CO1	PO1
I	1b	Illustrate cell cycle and its regulation	8	BL3	CO1	PO1
II	2a	Review structure and functions of cell membrane	8	BL6	CO2	PO2
II	2b	Define and describe oncogenes and tumor suppressor genes	8	BL1	CO2	PO2
III	3a	Generalise different intracellular signal transduction pathways	8	BL3	CO3	PO3
III	3b	Explain programmed cell death	8	BL2	CO3	PO3
IV	4a	Define and distinguish between incomplete dominance and codominance	8	BL1 & BL5	CO4	PO4
IV	4b	Define multiple alleles, lethal alleles, epistasis and pleiotropy	4×2 = 8	BL1	CO4	PO4
V	5a	Evaluate the role of natural selection in genetic drift and genetic shift	8	BL4	CO5	PO5
V	5b	Write short notes on: (A) Sex-linked inheritance (B) Extrachromosomal inheritance	4+4	BL2	CO5	PO5

SECTION-B **10x1=10**

1. blood group system. Answer: alleles
2. Lethal alleles can cause death when present in the _____ state, often resulting in altered Mendelian ratios in offspring. Answer: homozygous
3. Pleiotropy occurs when a single gene affects _____ traits, as seen in conditions like Marfan syndrome. Answer: multiple
4. The nuclear lamina is a mesh-like structure that provides mechanical support to the nuclear envelope and regulates nuclear events such as DNA replication. (true/false)
5. In linkage, genes that are located far apart on the same chromosome assort independently. Answer: False

II B.Sc Microbiology Honours -III Semester
Course-8 (CELL BIOLOGY AND GENETICS)
Question Bank
Essay type questions (Select any Two from each Unit for Internal Choice)

Unit	Q.No	Questions	Marks	BL	CO	PO
I	1	State Cell theory and explain detailed structure of chloroplast	2+6	BL1 & BL2	CO1	PO1
I	2	Discuss detailed structure and functions of mitochondria	8	BL2	CO1	PO1
I	3	Illustrate cell cycle and its regulation	8	BL3	CO1	PO1
I	4	Outline structure and organization of cytoskeleton	8	BL2	CO1	PO1
II	1	Review structure and functions of cell membrane	8	BL6	CO2	PO2
II	2	Discuss structure and functions of nuclear membrane	8	BL3	CO2	PO2
II	3	Define and describe oncogenes and tumor suppressor genes	8	BL1	CO2	PO2
II	4	Explain causes and development of cancer	8	BL2	CO2	PO2
III	1	Generalise intracellular signal transduction pathways	8	BL3	CO3	PO3
III	2	Explain programmed cell death	8	BL2	CO3	PO3
III	3	Describe structure and importance of lampbrush and polytene chromosomes	8	BL2	CO3	PO3
III	4	Write note on types and applications of stem cells	8	BL3	CO3	PO3
IV	1	Compare and evaluate Mendel's laws of segregation and independent assortment	8	BL4 & BL5	CO4	PO4
IV	2	Define and distinguish incomplete dominance and codominance	8	BL1 & BL5	CO4	PO4
IV	3	Define multiple alleles, lethal alleles, epistasis and pleiotropy	4×2 = 8	BL1	CO4	PO4
IV	4	Explain monohybrid and dihybrid crosses and their significance	8	BL1	CO4	PO4
V	1	Define crossing over and explain its molecular mechanism	8	BL1 & BL3	CO5	PO5
V	2	Evaluate role of natural selection in genetic drift and genetic shift	8	BL4	CO5	PO5
V	3	Write short notes on sex-linked inheritance and extrachromosomal inheritance	4+4	BL2	CO5	PO5
V	4	Explain role of Hardy–Weinberg law in population genetics	8	BL2	CO5	PO5

One mark questions : (Choose any two from each unit. No choice)

Unit-I:

1. Which organelle is responsible for packaging and modifying proteins in eukaryotic cells?
2. What is the main function of peroxisomes?
3. The G1 checkpoint in the cell cycle ensures that the cell is ready to enter the S phase and begin _____ replication.
4. Lysosomes are involved in the breakdown of cellular waste and damaged organelles. (TRUE/FALSE)
5. Prokaryotic Ribosomes.

Unit _II

6. Define phagocytosis?
7. Exocytosis is a process where vesicles fuse with the plasma membrane to release their contents into the----------
8. The nuclear lamina is a mesh-like structure that provides mechanical support to the nuclear envelope and regulates nuclear events such as DNA replication. (true/false)
9. What is chromatin?
10. Give example of oncogene?

Unit-III

1. Programmed cell death is called—---------
2. Lampbrush chromosomes are large, extended chromosomes found in the oocytes of _____ and amphibians, with loops of chromatin active in transcription.
   Answer: birds
3. Stem cells have the ability to differentiate into specialized cell types and are also capable of _____ division, giving rise to identical stem cells. Answer: self-renewing True or False
4. True or False: In the GPCR signaling pathway, GTP-bound G proteins activate downstream effectors such as adenylyl cyclase or phospholipase C. Answer: True
5. True or False: Apoptosis is an uncontrolled cell death process that results in damage to neighboring cells and tissue. Answer: False

Unit-IV

6. Multiple alleles refer to a gene having more than two _____, such as the ABO blood group system. Answer: alleles
7. Lethal alleles can cause death when present in the _____ state, often resulting in altered Mendelian ratios in offspring. Answer: homozygous
8. Pleiotropy occurs when a single gene affects _____ traits, as seen in conditions like Marfan syndrome. Answer: multiple
9. True or False: In incomplete dominance, the heterozygote exhibits a phenotype that is an intermediate between the two homozygous phenotypes. Answer: True
10. True or False: Epistasis occurs when one gene masks or alters the expression of another gene at a different locus. Answer: True

Unit-V

1. Speciation occurs when populations of the same species become _____ and evolve into different species over time. Answer: reproductively isolated
2. Extra-chromosomal inheritance refers to the transmission of genetic material found outside the _____. Answer: nucleus
3. Crossing over results in new combinations of alleles, which contributes to genetic _____ in a population. Answer: variation True or False.
4. True or False: The process of natural selection acts only on phenotypes, not genotypes. Answer: True
5. True or False: In linkage, genes that are located far apart on the same chromosome assort independently. Answer: False

IV SEMESTER - Major & Minor

COURSE 9: - MOLECULAR BIOLOGY AND MICROBIAL GENETICS

credits -_3 **SYLLABUS**

I. Course Outcomes:

By the Completion of the course the learner should able to–

Theory – CLOs

1. CLO1: Explain experimental evidences establishing DNA and RNA as genetic material and genome organization. (BT2 – Understand)
2. CLO2: Describe the mechanism of DNA replication in prokaryotes and roles of associated enzymes. (BT2 – Understand)
3. CLO3: Explain concepts of genes, transcription, and RNA processing. (BT2 – Understand)
4. CLO4: Describe translation process and regulation of gene expression in bacteria. (BT2 – Understand)
5. CLO5: Explain types, molecular basis of mutations, and DNA repair mechanisms. (BT2 – Understand)
6. CLO6: Analyze genetic recombination processes in bacteria and their applications. (BT4 – Analyze)

Unit - 1: DNA/RNA as genetic material, Replication of DNA No. of Hours:9

1. Experimental evidences that established DNA and RNA as genetic material. Genome organization in prokaryotes and eukaryotes.
2. Replication of DNA in prokaryotes.: Bidirectional and unidirectional replication,
3. Semiconservative replication, Proof of Semiconservative replication (Messelson – Stahl Experiment). Mechanism of DNA Replication in Prokaryotes: step by step process, Enzymes and factors involved in replication- Primase, Helicase, Gyrase, DNA polymerases, DNA ligase, SSB proteins.
4. Extra chromosomal genetic elements: General characters, types and applications of Plasmids and transposons.

Unit - 2: Concept of gene, Transcription No. of Hours : 9

1. Classical Concept of gene: Muton, Recon and Cistron; One gene-one enzyme and one gene - one polypeptide and One gene – One Product hypotheses.
2. Modern concept of gene: Definition of gene; Open reading frame; structural, constitutive and regulatory genes; uninterrupted genes, Split genes- concept of introns and exons.
3. 2,3 Protein synthesis in Prokaryotes: Transcription- Definition, difference from replication, promoter, RNA Polymerase, mechanism of transcription. **RNA splicing in eukaryotes;**

Unit - 3: Translation and regulation of gene expression No. of Hours:9

1. Protein synthesis in Prokaryotes
2. Genetic code: Salient features, Wobble hypothesis.
3. Translation- Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides. Inhibitors of protein synthesis.
4. Regulation of gene expression in bacteria – lac operon.

Unit - 4: Mutations and DNA repair No. of Hours:9

1. Mutations: Definition and types of Mutations (Spontaneous and induced, Somatic and germline); Physical and chemical mutagens;
2. Molecular basis of mutations (base pair changes, frame shifts, deletions, inversions, tandem duplications, insertions); Functional mutants (loss and gain of function mutants); Uses of mutations.
3. Outlines of DNA repair mechanisms: Direct repair, Excision repair, Mismatch Repair, Recombination Repair, SOS Repair.

Unit - 5: Genetic recombination in bacteria No. of Hours:9

1 Conjugation - discovery, F-factor, F+ & Hfr, mechanism of conjugation, applications of conjugation;
2. Transformation- Discovery, mechanism of transformation, Competence Factors affecting transformation and application of transformation.
3. Transduction- discovery, mechanism and types of transduction.

II. Skill Outcomes:

1. performing cell lysis and purification, quantifying DNA, and recognizing the importance of genomic DNA isolation.
2. Estimate DNA using UV Spectrophotometer include preparing DNA samples, measuring absorbance at 260 nm, calculating DNA concentration, and assessing DNA purity.
3. Solve Problems related to DNA and RNA characteristics, Transcription and Translation. 4. Analyze and solve problems related to DNA and RNA structure, understanding transcription and translation processes, and interpreting the impact of mutations on protein synthesis.
4. Prepare gels, loading DNA samples, visualizing DNA bands, analyzing fragment size, and understanding the principles of electrophoresis.
5. Understand Mutagenesis principles, perform UV exposure, assessing mutation frequency, and comprehend the effects of mutations on bacterial phenotypes.

IV SEMESTER

COURSE 9: - MOLECULAR BIOLOGY AND MICROBIAL GENETICS credits -1

Practical – CLOs

1. CLO1: Isolate genomic DNA from bacterial cells using standard protocols. (BT3 – Apply)
2. CLO2: Estimate DNA concentration using UV spectrophotometry. (BT3 – Apply)
3. CLO3: Perform agarose gel electrophoresis for DNA separation and visualization. (BT3 – Apply)
4. CLO4: Demonstrate bacterial transformation and mutagenesis techniques. (BT3 – Apply)
5. CLO5: Operate molecular biology instruments following biosafety practices. (BT3 – Apply)
6. CLO6: Analyze and interpret experimental data related to molecular genetics. (BT4 – Analyze)

LEARNING OUTCOMES

1. Isolation of genomic DNA from E. coli
2. Estimation of DNA using UV spectrophotometer (A260measurement).
3. Problems related to DNA and RNA characteristics, Transcription and Translation.
4. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
5. Problems related to DNA and RNA characteristics, Transcription and Translation.
6. Induction of mutations in bacteria by UV light.
7. Study of different conformations of plasmid DNA through agarose gel electrophoresis.
8. Demonstration of bacterial transformation
9. Instrumentation in molecular biology – Ultra centrifuge, Transilluminator, PCR
10. Study of different types of DNA and RNA using micrographs and model / schematic
11. representations
11. Study of semi-conservative replication of DNA through micrographs / schematic
12. Representations

References

Text books:

1. James D. Watson Tania A. Baker, Stephen P. Bell Alexander Gann, Michael Levine, Richard Losick, 2013, Molecular Biology of the Gene, 5th Edition, Pearson Edu Publishers.
2. Roger Y. Stanier, Edward A. Adelberg, John L. Ingraham, 1977, General Microbiology 5th edition, London Macmillan.
3. David Freifelder1986 Molecular Biology 3rd edition, Jones & Bartlett Publishers
4. T.A. Brown, Gene cloning and DNA analysis- An Introduction, 4thedition
5. Bernard R. Glick and Jack. J. Pasternak, Molecular Biotechnology. 3rd edition
6. David Freifelder.Essentials of molecular biology.Jones and Bartlett Publishers, 1998

7. **Co-Curricular Activities:**
8. Conduct poster presentations, oral presentations, and interactive sessions.
9. Visit laboratories employing molecular biology techniques

Life Sciences – Major Programmes B.Sc
COURSE 9: - MOLECULAR BIOLOGY AND MICROBIAL GENETICS
Microbiology honours

Blue Print for Question Papers

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B (MCQ/ True or False/ Fill in the blank) – No choice	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	2 mark (1 Questions)	10 M
Unit-2	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-3	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-4	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-5	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M

SECTION-A $5 \times 8 = 40$ Marks

Answer all the following questions. Draw labelled diagrams wherever necessary.

1. (a) or (b)
2. (a) or (b)
3. (a) or (b)
4. (a) or (b)
5. (a) or (b)

SECTION-B $5 \times 2 = 10$ Marks

Answer any 5 of the following questions.

1. From Unit-1
2. From Unit-1
3. From Unit-2
4. From Unit-2
5. From Unit-3
6. From Unit-3
7. From Unit-4
8. From Unit-5

Department of Microbiology
II B.Sc Microbiology Honours- IV SEMESTER
COURSE -9: MOLECULAR BIOLOGY AND MICROBIAL GENETICS
Model Question Paper for both Major & Minor

Time:2.30 Hrs **max. marks:50**

Section-A **5X8=40**

(Answer all the questions. Draw the labelled diagrams when necessary.)

Unit	Q. No	Questions	Marks	BL	CLO	PO
I	1	Interpret the experimental evidences that established DNA as genetic material	8	BL3	CLO 1	PO 4
		(OR)				
		Explain the mechanism of DNA replication in prokaryotes	8	BL2	CLO 2	PO 4
II	2	Conclude and contrast the classical concept of gene	8	BL4	CLO 4	PO 4
		(OR)				
		Illustrate the mechanism of transcription	8	BL2	CLO 4	PO 4
III	3	List the salient features of genetic code	8	BL1	CLO 5	PO 4
		(OR)				
		Evaluate gene expression in E. coli by Lac operon concept	8	BL4	CLO 5	PO 4
IV	4	Define mutations. Describe different types of physical and chemical mutagens	1+ 7	BL1, BL3	CLO 6	PO 4
		(OR)				
		Give outlines of different DNA repair mechanisms	8	BL2	CLO 6	PO 4
V	5	Differentiate F factor and Hfr strains. Explain conjugation in bacteria	8	BL4, BL2	CLO 7	PO 4
		(OR)				
		Interpret Lederberg and Zinder experiment and explain transduction	4+ 4	BL3, BL2	CLO 7	PO 4

Section -B
Answer the following questions 5x 2=10M

6 Any three differences between prokaryotes and Eukaryotes
7 cistron
8 Define gene
9 Promotor region
10 Open reading frame
11 70 s Ribosome
12 Transition and Transversion
13 Applications of transformation

Department of Microbiology
II B.Sc Microbiology Honours- IV SEMESTER
COURSE -9: MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Question bank for both Major & Minor

Section-A **5X8=40**

Unit	Q. N	Questions	Marks	BL	CO	PO
I	1	Interpret the experimental evidence that established DNA as genetic material	8	BL3	CO1	PO1, PO2
	2	Explain general characters of plasmids and transposons	8	BL2	CO3	PO1, PO2
	3	Explain the mechanism of DNA replication in prokaryotes	8	BL2	CO2	PO1, PO2
	4	Interpret the role of enzymes and factors involved in replication	8	BL3	CO2	PO1, PO2
II	1	Conclude and contrast the classical concept of gene	8	BL4	CO4	PO1, PO2, PO4
	2	Generalise the modern concept of gene in detail	8	BL3	CO4	PO1, PO2, PO4
	3	Illustrate the mechanism of transcription	8	BL3	CO4	PO1, PO2, PO4
	4	Differentiate uninterrupted genes & split genes; introns & exons	4+4	BL4	CO3	PO1, PO2
III	1	List the salient features of genetic code	8	BL3	CO5	PO1, PO2, PO4
	2	Outline the process of translation in prokaryotes	8	BL2	CO5	PO1, PO2, PO4
	3	Evaluate gene expression in E. coli by lac operon concept	8	BL4	CO5	PO1, PO2, PO4
	4	Outline wobble hypothesis and inhibitors of protein synthesis	4+4	BL2	CO5	PO1, PO2, PO4
IV	1	Define mutations and describe different physical mutagens	1+7	BL1, BL3	CO6	PO1, PO2, PO4
	2	Demonstrate the molecular basis of mutations	8	BL4	CO6	PO1, PO2, PO4
	3	Outline different DNA repair mechanisms	8	BL2	CO6	PO1, PO2, PO4

	4	Define functional mutants and describe chemical mutagens	2+6	BL1, BL3	CO6	PO1, PO2, PO4
V	1	Differentiate F factor and Hfr strains and explain conjugation	8	BL4, BL2	CO7	PO1, PO2, PO5
	2	Explain transformation and its applications	4+4	BL2, BL3	CO7	PO1, PO2, PO5
	3	Define transduction and discuss types of transduction	2+6	BL1, BL2	CO7	PO1, PO2, PO5
	4	Interpret Lederberg & Zinder experiment and explain transduction	4+4	BL3, BL2	CO7	PO1, PO2, PO5

Section –B

Unit – 1
1. Any three differences between prokaryotes and Eukaryotes
2. What is semiconservative mode of replication
3. Plasmids
4. cistron

Unit-II
1. Muton
2. Define gene
3. cistron
4. Promotor region

Unit-III
1. Wobble hypothesis
2. Open reading frame
3. 70 s Ribosome
4. tRNA

Unit-IV
1. r RNA
2. Uses of mutations
3. Transition and Transversion
4. Mismatch repair

Unit-v
1. F factor
2. Applications of conjugation
3. Applications of transformation
4. Applications of transduction

IV SEMESTER - Major & Minor

COURSE 10: - MICROBIAL PHYSIOLOGY AND METABOLISM

credits -_3 **SYLLABUS**

I. Course Outcomes:

On successful completion of the course, the students will be able to

Theory – CLOs

1. CLO1: Explain nutritional requirements of microorganisms and types of growth media. (BT2 – Understand)
2. CLO2: Describe microbial growth kinetics, phases, and factors affecting growth. (BT2 – Understand)
3. CLO3: Explain thermodynamic concepts and energy generation in biological systems. (BT2 – Understand)
4. CLO4: Describe pathways involved in carbohydrate metabolism in microorganisms. (BT2 – Understand)
5. CLO5: Explain aerobic, anaerobic respiration, fermentation, and chemoautotrophy. (BT2 – Understand)
6. CLO6: Analyze differences between oxygenic and anoxygenic photosynthesis in bacteria. (BT4 – Analyze)

UNIT I: Microbial Nutrition - No. of hours: 9

1. Nutritional requirements of Microorganisms
2. Methods of uptake of nutrients by cells- Primary and secondary active transport, concept of uniport, symport and antiport **Group translocation; Iron uptake**
3. Nutritional groups of microorganisms-based on C, energy and electron. sources
4. Growth media - synthetic, nonsynthetic, selective, enrichment and differential media.

UNIT II: Microbial Growth -No. of hours:9

1. Microbial Growth- Definitions of growth, generation time and specific growth rate; different phases of growth in batch cultures;
2. Synchronous, continuous, biphasic growth.
3. Factors influencing microbial growth
4. Methods for measuring microbial growth - Direct microscopy, viable count estimates, turbidometry and biomass.

UNIT IV: Thermodynamics; Breakdown of Carbohydrates No.of hours: 9

1. Thermodynamics in biological systems - Concept of free energy, Enthalpy, Standard Free Energy change of reaction, Entropy. First and Second law of Thermodynamics. Open and Closed system.
2. Structure and properties of ATP, Standard Free energy change of hydrolysis of ATP and other high energy compounds. Biological oxidation-reduction reactions. Structure and Function of NAD and FAD.
3. Breakdown of carbohydrates· Glycolytic pathways- EMP**, HMP shunt/pentose phosphate pathway and ED; TCA cycle.**

UNIT V: Microbial Respiration and Fermentation No. of hours: 9

1. Aerobic respiration - ETS and oxidative phosphorylation
2. Anaerobic respiration, chemoautotrophy - oxidation of inorganic compounds - N, S, Fe and H.
3. Fermentative modes in microorganisms with special reference to alcoholic, Lactic acid fermentations

UNIT V: Bacterial Photosynthesis No. of hours:9

1. Photosynthetic pigments, Photosynthetic apparatus in prokaryotes
2. Outline of oxygenic photosynthesis in bacteria
3. Outline of anoxygenic photosynthesis in bacteria

II. Skill Outcomes:

On successful completion of the course, the students will be able to

1. Understand the impact of temperature and pH on bacterial growth and metabolism.
2. Gain proficiency in colony counting techniques for microbial enumeration.
3. Analyze and interpret growth curve data to understand bacterial growth dynamics.
4. Develop skills in observing and identifying cyanobacteria under the microscope.
5. Apply knowledge of microbial growth factors and techniques to interpret and analyze experimental results.

IV SEMESTER - Major & Minor

COURSE 10: - MICROBIAL PHYSIOLOGY AND METABOLISM credits -1

Practical – CLOs

CLO1: Evaluate the effect of temperature and pH on microbial growth. (BT4 – Analyze)

CLO2: Perform colony count techniques for microbial enumeration. (BT3 – Apply)

CLO3: Plot and interpret bacterial growth curves using standard methods. (BT4 – Analyze)

CLO4: Observe and identify cyanobacteria using microscopic techniques. (BT3 – Apply)

CLO5: Apply microbial growth measurement techniques to experimental studies. (BT3 – Apply)

CLO6: Interpret physiological and metabolic experimental data. (BT4 – Analyze)

LEARNING OUTCOMES

1. Effect of Temperature on bacterial growth 2.Effect of pH on bacterial growth
2. Colony count in Plates
3. Study and plot the growth curve of E. coli by turbidometric and standard plate count methods
4. Observation and identification of permanent slides of cyanobacteria

IV References:

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company Caldwell, D.R. (1995). Microbial Physiology and Metabolism, W.C. Brown Publications,Iowa, USA.
2. Lehninger, A.L., Nelson, D.L. and Cox, M.M. (1993). Principles of Biochemistry, 2 nd Edition, CBS Publishers and Distributors, New Delhi.
3. Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.
4. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed.,
5. W.H.Freeman
6. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
7. White, D. (1995). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York.

V Co-Curricular Activities:

1. Assignments in nutrient utilization, energy production, metabolic pathways,
2. Students can study microbial growth curves, metabolic pathways, or physiological responses to environmental factors.
3. Organize seminars where students can deliver presentations on specific topics in microbial physiology and metabolism.
4. Create visual representations of microbial metabolic pathways.

COURSE 10: - MICROBIAL PHYSIOLOGY AND METABOLISM

Major & Minor - Blue Print for Question Papers

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B Short Answers (with Choice)	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	2 mark (1 Questions)	10 M
Unit-2	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-3	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-4	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-5	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M

SECTION-A $5 \times 8 = 40$ Marks

Answer all the following questions. Draw labelled diagrams wherever necessary.

1. (a) or (b)
2. (a) or (b)
3. (a) or (b)
4. (a) or (b)
5. (a) or (b)

SECTION-B $5 \times 2 = 10$ Marks

Answer any 5 of the following questions.

1. From Unit-1
2. From Unit-1
3. From Unit-2
4. From Unit-2
5. From Unit-3
6. From Unit-3
7. From Unit-4
8. From Unit-5

COURSE 10: - MICROBIAL PHYSIOLOGY AND METABOLISM

Major & Minor - QUESTION BANK- ESSAY QUESTIONS

UNIT	Q.No	Questions	Marks	BL	CLO	PO
I	1	Explain nutritional requirements of microorganisms	8	BL2	CLO1	PO1, PO2
	2	Describe nutritional groups of microorganisms based on C, energy and electron sources	8	BL2	CLO1	PO1, PO2
	3	Explain primary and secondary active transport; uniport, symport and antiport	8	BL2	CLO1	PO1, PO2
	4	Explain growth media – synthetic, nonsynthetic, selective, enrichment and differential media	8	BL2	CLO1	PO1, PO2
II	1	Explain different phases of growth in batch cultures	8	BL2	CLO2	PO1, PO2
	2	Describe synchronous, continuous and biphasic growth	8	BL2	CLO2	PO1, PO2
	3	Write notes on factors influencing microbial growth	8	BL2	CLO2	PO1, PO2
	4	Describe methods for measuring microbial growth – microscopy, viable count, turbidometry, biomass	8	BL3	CLO2	PO1, PO2
III	1	Explain first and second laws of thermodynamics with examples and open/closed systems	8	BL2	CLO3	PO1, PO2, PO4
	2	Essay on ATP and high energy compounds	8	BL2	CLO3	PO1, PO2, PO4
	3	Structure and function of NAD and FAD	8	BL2	CLO3	PO1, PO2, PO4
	4	Explain glycolytic pathway and its significance	8	BL3	CLO3	PO1, PO2, PO4
IV	1	Anaerobic respiration with reference to oxidation of nitrogen	8	BL3	CLO4	PO1, PO2, PO4
	2	Anaerobic respiration with reference to oxidation of sulphur	8	BL3	CLO4	PO1, PO2, PO4
	3	Fermentative modes in microorganisms – alcoholic fermentation	8	BL3	CLO4	PO1, PO2, PO4
	4	Fermentative modes in microorganisms – lactic acid fermentation	8	BL3	CLO4	PO1, PO2, PO4

UNIT	Q.No	Questions	Marks	BL	CLO	PO
V	1	Explain photosynthetic pigments in prokaryotes	8	BL2	CLO5	PO1, PO2, PO5
	2	Explain photosynthetic apparatus in prokaryotes	8	BL2	CLO5	PO1, PO2, PO5
	3	Outline oxygenic photosynthesis in bacteria	8	BL3	CLO5	PO1, PO2, PO5
	4	Outline anoxygenic photosynthesis in bacteria	8	BL3	CLO5	PO1, PO2, PO5

SHORT ANSWERS FOR 2 MARKS

UNIT-1

1. Autotrophs.
2 Active Transport
3. Synthetic Media
4. Heterotrophs

UNIT-2

2. Microbial Growth
3. Phases Of Microbial Growth
4. Direct Microscopy Method
5. Viable Count Method

UNIT-3

1. The first law of thermodynamics.
2. The second law of thermodynamics
3. An open system in biology
4. Structure and function of ATP

UNIT-4

1. Aerobic respiration
2. Electron transport system (ets)
3. Oxidative phosphorylation
4. Anaerobic respiration

UNIT-5

1. Photosynthetic Pigments
2. Photosynthetic Apparatus In Prokaryotes
3 Oxygenic Photosynthesis
4. Anoxygenic Photosynthesis

IV SEMESTER

COURSE 10: - MICROBIAL PHYSIOLOGY AND METABOLISM

MODEL QUESTION PAPER

Q.No	Questions	Marks	BL	CLO	PO
1.a	Explain nutritional requirements of microorganisms	8	BL2	CLO1	PO1, PO2
1.b	Explain growth media – synthetic, nonsynthetic, selective, enrichment and differential media	8	BL2	CLO1	PO1, PO2
2.a	Explain different phases of growth in batch cultures	8	BL2	CLO2	PO1, PO2
2.b	Describe methods for measuring microbial growth – microscopy, viable count, turbidometry, biomass	8	BL3	CLO2	PO1, PO2
3.a	Explain first and second laws of thermodynamics; open and closed systems	8	BL2	CLO3	PO1, PO2, PO4
3.b	Explain glycolytic pathway and mention its significance	8	BL3	CLO3	PO1, PO2, PO4
4.a	Anaerobic respiration and chemoautotrophy – oxidation of inorganic nitrogen compounds	8	BL3	CLO4	PO1, PO2, PO4
4.b	Explain fermentative modes in microorganisms with reference to lactic acid fermentation	8	BL3	CLO4	PO1, PO2, PO4
5.a	Explain photosynthetic pigments in prokaryotes	8	BL2	CLO5	PO1, PO2, PO5
5.b	Outline anoxygenic photosynthesis in bacteria	8	BL3	CLO5	PO1, PO2, PO5

Section -B

Answer any FIVE onlythe following

(5x2=10)

1. Autotrophs.
2. Active Transport
3. Microbial Growth
4. Phases Of Microbial Growth
5. An open system in biology
6. Structure and function of ATP
7. Anaerobic respiration
8. Anoxygenic Photosynthesis

IV SEMESTER

COURSE 11: r DNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTIC

credits -_3 **SYLLABUS**

I. Course Outcomes:

On successful completion of the course, the students will be able to

Theory – CLOs

1. CLO1: Explain principles and techniques of recombinant DNA technology. (BT2 – Understand)
2. CLO2: Describe vectors, PCR, and applications of genetic engineering. (BT2 – Understand)
3. CLO3: Explain blotting techniques, DNA sequencing, and basics of intellectual property rights. (BT2 – Understand)
4. CLO4: Describe bioinformatics databases, tools, and sequence alignment methods. (BT2 – Understand)
5. CLO5: Explain concepts of central tendency, dispersion, and data presentation. (BT2 – Understand)
6. CLO6: Analyze biological data using biostatistical and bioinformatics tools. (BT4 – Analyze)

UNIT- I: Recombinant DNA Technology **No. of Hours: 9**

1. Basic principles of genetic engineering. Steps in gene cloning.
2. Restriction endonucleases- applications of Type II restriction enzymes in genetic engineering; DNA polymerases and ligases;Use of linkers and adaptors
3. Vectors – Cosmid , Bacteriophages , BAC, YAC
4. Transformation of DNA by Chemical method, Electroporation.

UNIT- II: Applications of r-DNA technology **No. of Hours: 9**

1. Genomic and C-DNA Libraries, RFLP, RAPD,
2. Basics of Polymerase chain Reaction
3. Application of genetic engineering in industry, agriculture and medicine, Hybirdoma Technology.

UNIT- III: Techniques in genetic engineering and IPR **No. of Hours: 9**

1. Blotting Techniques.
2. Labeling of DNA, DNA foot printing.
3. **DNA Sequencing-Sanger's method**
4. Outlines of Intellectual property Rights (Patents,Trademark,Copyright)

UNIT- IV:Bioinformatics **No. of Hours: 9**

1. Bioinformatic resources : NCBI, EBI, DDBJ, PUBMED, BIOMED.
2. Sequence Databases – GENBANK, BLAST, FASTA, ExPasy, PDB, NDB, UNIPROT – SWISS PROT.
3. Sequence alignment – Sequence homology, pairwise sequence alignment, **automated DNA sequencing, ChIP.**

UNIT- V: Biostatistics **No. of Hours: 9**

1. Measurement of central tendency : MEAN , MEDIAN, MODE.
2. Measurement of dispersion : RANGE, MEAN DEVIATION , STANDARD DEVIATION.
3. Use of Biostatistic softwares.
4. Sample and population ; Types of Data , methods of Data presentation.

III. Skill Outcomes: On successful completion of the course, the student will be able to

1. Perform plasmid DNA isolation, agarose gel electrophoresis
2. Understand the principles and applications of DNA fingerprinting for genetic profiling and identification.
3. Utilize nucleic acid and protein databases to access, retrieve, and analyze genetic and protein sequence information
4. Apply sequence alignment algorithms and tools
5. Develop skills using bioinformatics tools and databases

IV SEMESTER

COURSE 11: r DNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

credits -1

Practical – CLOs

1. CLO1: Isolate plasmid DNA and analyze it using agarose gel electrophoresis. (BT3 – Apply)
2. CLO2: Perform basic recombinant DNA techniques such as ligation. (BT3 – Apply)
3. CLO3: Retrieve and analyze nucleotide and protein sequences from databases. (BT3 – Apply)
4. CLO4: Perform sequence alignment and homology analysis. (BT3 – Apply)
5. CLO5: Apply biostatistical methods to analyze biological datasets. (BT3 – Apply)
6. CLO6: Interpret bioinformatics and biostatistical results scientifically. (BT4 – Analyze)

LEARNING OUTCOMES

1. Isolation of plasmid DNA by Agarose gel Electrophoresis.
2. Preparation of Recombinant vector by using T4 DNA Ligase.
3. To Understand the concept of DNA fingerprinting by Random Ampilification of Polymorphic DNA.
4. Nucleic acid and protein databases.
5. Sequence alignment
6. Sequence homology and Gene annotation.

References

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. WileyBlackwell. 3.Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates,Inc.
3. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
4. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge
5. University Press Glick BR, Pasternak JJ, and Patten CL (2010) Molecular
6. Biotechnology 4th edition, ASM Press Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications
7. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
8. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
9. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science
10. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.

V Co – curricular Activities:

1. Training of students and basic gene cloning methods.

2. Industrial visit on Recombinant products.
3. Prepearation of videos on labeling of DNA and DNA sequencing.
4. Students participation in seminars of the copyright, Patent, Trademark and IPR.
5. Assignments on PCR, Restriction enzymes , vectors , RFLP, RAPD, Hybridoma Technology, Sequence alignment tools of DNA , central tendancy , Data collection and presentation.
6. Conducting group discussion , Quiz, debate in related topics.

IV SEMESTER

COURSE 11: r DNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

Blue Print for Question Papers

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B Short Answers (with Choice)	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	2 mark (1 Questions)	10 M
Unit-2	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-3	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-4	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M
Unit-5	8 Marks / 2×4 Marks	2mark (1 Questions)	10 M

SECTION-A $5 \times 8 = 40$ Marks

Answer all the following questions. Draw labelled diagrams wherever necessary.

1. (a) or (b)
2. (a) or (b)
3. (a) or (b)
4. (a) or (b)
5. (a) or (b)

SECTION-B $5 \times 2 = 10$ Marks

Answer any 5 of the following questions.

1. From Unit-1
2. From Unit-1
3. From Unit-2
4. From Unit-2
5. From Unit-3
6. From Unit-3
7. From Unit-4
8. From Unit-5

IV SEMESTER -COURSE 11
rDNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS
QUESTION BANK

UNIT	Q. No	Question	Marks	BL	CLO	PO
I	1	Explain the basic principles of genetic engineering	8	BL2	CLO1	PO1, PO2
	2	Describe the steps involved in gene cloning	8	BL2	CLO1	PO1, PO2
	3	Explain restriction endonucleases, DNA polymerases, and ligases	8	BL2	CLO1	PO1, PO2
	4	Describe vectors – plasmids, cosmids, bacteriophages, BAC and YAC	8	BL2	CLO1	PO1, PO2
II	1	Explain the concept and construction of a genomic library	8	BL2	CLO2	PO1, PO2, PO5
	2	Describe the basic principles of PCR	8	BL2	CLO2	PO1, PO2, PO5
	3	Discuss applications of genetic engineering in agriculture	8	BL3	CLO2	PO1, PO2, PO5
	4	Discuss applications of genetic engineering in industry	8	BL3	CLO2	PO1, PO2, PO5
III	1	Explain Southern and Northern blotting techniques	8	BL2	CLO3	PO1, PO2, PO4
	2	Describe methods used for labeling of DNA	8	BL2	CLO3	PO1, PO2, PO4
	3	Explain the outlines of Intellectual Property Rights (IPR)	8	BL2	CLO3	PO1, PO2, PO4
	4	Differentiate between patents, trademarks and copyrights	8	BL3	CLO3	PO1, PO2, PO4
IV	1	Explain BLASTA and its applications	8	BL2	CLO4	PO2, PO3, PO4
	2	Explain FASTA and its applications	8	BL2	CLO4	PO2, PO3, PO4
	3	Explain GenBank as a bioinformatic database	8	BL2	CLO4	PO2, PO3, PO4
	4	Discuss role of NCBI and PubMed in bioinformatics	8	BL3	CLO4	PO2, PO3, PO4
V	1	Explain measures of central tendency – mean, median, mode	8	BL2	CLO5	PO2, PO4
	2	Differentiate between sample and population	8	BL3	CLO5	PO2, PO4
	3	Describe different types of data	8	BL2	CLO5	PO2, PO4
	4	Explain methods of data presentation	8	BL2	CLO5	PO2, PO4

QUESTION BANK - SHORT ANSWERS 2 MARKS

UNIT I – Recombinant DNA Technology

1. Genetic engineering
2. Gene cloning
3. Plasmids
4. Restriction endonucleases

UNIT II – Applications of r-DNA Technology

1. PCR
2. Genomic library
3. cDNA library
4. Hybridoma technology

UNIT III – Techniques in Genetic Engineering and IPR

1. Blotting technique
2. DNA labeling
3. Sanger DNA sequencing
4. Patent

UNIT IV – Bioinformatics

1. Bioinformatics
2. NCBI
3. GenBank
4. BLAST

UNIT V – Biostatistics

1. Mean
2. Median
3. Difference between sample and population
4. The methods of data presentation

IV SEMESTER

COURSE 11: r DNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

MODEL QUESTION PAPER

SECTION A

Answer all the following questions (5x8=40)

UNIT	Q.No	Question	Marks	BL	CLO	PO
I	1a	Explain the basic principles of genetic engineering	8	BL2	CLO1	PO1, PO2
	1b	Describe vectors – plasmids, cosmids, bacteriophages, BAC and YAC	8	BL2	CLO1	PO1, PO2
II	2a	Explain the concept and construction of a genomic library	8	BL2	CLO2	PO1, PO2, PO5
	2b	Discuss the applications of genetic engineering in industry	8	BL3	CLO2	PO1, PO2, PO5
III	3a	Explain Southern and Northern blotting techniques	8	BL2	CLO3	PO1, PO2, PO4
	3b	Differentiate between patents, trademarks and copyrights	8	BL3	CLO3	PO1, PO2, PO4
IV	4a	Explain BLASTA and its applications	8	BL2	CLO4	PO2, PO3, PO4
	4b	Discuss the role of NCBI and PubMed in bioinformatics	8	BL3	CLO4	PO2, PO3, PO4
V	5a	Explain measures of central tendency – mean, median and mode	8	BL2	CLO5	PO2, PO4
	5b	Explain methods of data presentation	8	BL2	CLO5	PO2, PO4

Section -B

Answer any FIVE only from the following

(5x2=10)

1. Genetic engineering
2. Gene cloning
3. cDNA library
4. Hybridoma technology
5. Blotting technique
6. DNA labeling
7. Bioinformatics
8. The methods of data presentation

V SEMESTER

COURSE 12 A: IMMUNOLOGY AND MEDICAL MICROBIOLOGY credits -3

Course outcomes:

By the Completion of the course the learner should able to–

Theory – CLOs

1. CLO1: Explain components and organization of the immune system. (BT2 – Understand)
2. CLO2: Describe innate and adaptive immune responses and their mechanisms. (BT2 – Understand)
3. CLO3: Explain structure, classes, and functions of immunoglobulins. (BT2 – Understand)
4. CLO4: Describe hypersensitivity reactions, autoimmunity, and immunodeficiency disorders. (BT2 – Understand)
5. CLO5: Explain principles of vaccination and immunological diagnostic tests. (BT2 – Understand)
6. CLO6: Analyze host–pathogen interactions in infectious diseases. (BT4 – Analyze)

Unit - 1: **Immune System No. of Hours:9**

1. Concept of Innate and Adaptive immunity
2. Primary and secondary organs of immune system - thymus, bursa fabricius, bone marrow, spleen, lymph nodes and lymphoid tissues
3. Cells of immune system- Identification and function of B and T lymphocytes, null cells, monocytes, macrophages, neutrophils, basophils and eosinophils Components of innate immunity;Complement system (in brief)

Unit - 2: **Immune response No. of Hours 9**

1. Characteristics of antigen (Foreignness, Molecular size, Heterogeneity and solubility) haptens.
2. Antibodies - basic structure and types.
3. Generation of Immune Response - Primary and Secondary Generation of Humoral Immune Response (Plasma and Memory cells), MHC Generation of Cell Mediated Immune Response
4. Immune complex formation and elimination -Agglutination,
5. Precipitation, Neutralisation, Complement fixation, Phagocytosis
6. Hypersensitivity- definition and types (in brief)

Unit - 3: Microbes in Health and Disease No. of Hours:9

1. Normal flora of human body.
2. Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Opportunistic infections, Nosocomial infections.
3. General account on microbial diseases - causal organism, pathogenesis, epidemiology, diagnosis, prevention and control of the following
4. Bacterial diseases - Tuberculosis, Typhoid, Botulism Fungal diseases - Candidiasis. Viral Diseases - Hepatitis- A and AIDS

Unit - 4: Principles of Diagnosis No. of Hours:9

1. General principles of diagnostic microbiology- Collection, transport of clinical samples
2. Identification by culturing
3. Identification by biochemical/physiological properties
4. Identification by molecular assays (PCR, DNA probes)
5. Identification by serological tests (ELISA, Immunofluorescence, **Agglutination based tests, Complement fixation**)

Unit - 5: Prevention and Treatment No. of Hours:9

1. Vaccines - Active (Natural and recombinant) and passive
2. Antimicrobial agents- General modes of action of antibacterial (Penicillin, Streptomycin), antifungal (Amphotericin and Griseofulvin), antiviral (Amantadine, Acyclovir)agents
3. Interferons
4. Antibiotic resistance -Tests for antimicrobial susceptibility (Disc diffusion)

Skill Outcomes:

1. By the completion of the course the learner should able to– 1.Perform some of the ag-ab reactions
2. Carry out the biochemical tests useful for identification of of bacteria
3. Perform antibiotic sensitivity test
4. Identify some common symptoms and relate them to etiology
5. Prepare some differential media routinely used for identification of bacteria

V SEMESTER

COURSE 12 A: IMMUNOLOGY AND MEDICAL MICROBIOLOGY credits -1

Practical – CLOs

1. CLO1: Perform antigen–antibody reactions using standard immunological techniques. (BT3 – Apply)
2. CLO2: Demonstrate blood grouping and serological testing methods. (BT3 – Apply)
3. CLO3: Identify medically important bacteria using staining and biochemical tests. (BT3 – Apply)
4. CLO4: Perform antimicrobial susceptibility testing. (BT3 – Apply)
5. CLO5: Apply aseptic techniques while handling clinical samples. (BT3 – Apply)
6. CLO6: Interpret immunological and microbiological laboratory results. (BT4 – Analyze)

LEARNING OUTCOMES

1. Identification of human blood groups.
2. Separate serum from the blood sample (demonstration).
3. Immunodiffusion by Ouchterlony method.
4. Identification of any of the bacteria (E. coli, Pseudomonas, Staphylococcus, Bacillus) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, urease production and catalase tests

5. Study of composition and use of important differential media for identification of
6. bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS Isolation of bacterial flora of skin by swab method.
7. Antibacterial sensitivity by Kirby-Bauer method
8. Determination of minimal inhibitory concentration of an antibiotic
9. Study symptoms of the diseases with the help of photographs: Anthrax,Polio, Herpes, chicken pox, HPV warts, Dermatomycoses (ring worms)
10. Isolation of Normal flora of human body (Hands, Feet, Nostrils, Teeth Surface) by swab method.

III References

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
4. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
5. Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
6. Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Microbiology. 4th edition. Elsevier Publication.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education Practical microbiology-
8. M.N.Reddy Practical microbiology-M.N.Reddy
9. Microbiology: a laboratory manual / James G. Cappuccino, Natalie.
10. Plant pathology and Microbiology-K.R.Aneja
11. Mackie & Mccartney Practical Medical Microbiology,

VI. Co-Curricular Activities:

1. Screening of Blood groups
2. Visit to Diagnostic /Laboratory
3. Competition on composition and sterile media preparation
4. Competition on Isolation and Identification of bacteria from a sample

Life Sciences – Major Programmes
B.Sc Microbiology honours
Blue Print for Question Papers from IV Semester

Unit Number	Section-A(Essay/ Split Essay) In either or pattern	Section-B (MCQ/ True or False/ Fill in the blank) –No choice	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-2	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-3	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-4	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-5	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks

SECTION-A **10 M 5 × 8 = 40 Marks**
Answer all the following questions.
Draw labelled diagrams wherever necessary.

1. (a) – (i) and (ii) Or (b) - (i) and (ii)
2. (a) or (b) – If an essay
3. (a) or (b) – If an essay
4. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
5. (a) or (b) – If an essay

SECTION-B **10X1=10 Marks**
Answer all the following questions.

6. From Unit-1
7. From Unit-1
8. From Unit-2
9. From Unit-2
10. From Unit-3
11. From Unit-3
12. From Unit-4
13. From Unit-4
14. From Unit-5
15. From Unit-5

III B.Sc Microbiology Honours -III Semester
Course-12 A (IMMUNOLOGY AND MEDICAL MICROBIOLOGY)
Question Bank
Essay type questions (Select any Two from each Unit for Internal Choice)

Unit	Q.No	Questions	Marks	BL	CO	PO
I	1	Define innate and acquired immunity and explain types of immunity	8	BL1 & BL2	CO1	PO1
I	2	Describe primary organs of the immune system	8	BL2	CO1	PO1
I	3	Describe secondary organs of the immune system	8	BL2	CO1	PO1
I	4	Generalise structure and functions of immune cells	8	BL3	CO1	PO1
II	1	Define antigen and hapten and explain characteristics of antigens	8	BL1 & BL2	CO2	PO2
II	2	Explain structure and types of antibodies	8	BL2	CO2	PO2
II	3	Generalise immune complex formation: precipitation, agglutination and neutralization	8	BL3	CO2	PO2
II	4	Define and outline hypersensitivity reactions	8	BL1	CO2	PO2
III	1	Review normal flora of the human body	8	BL6	CO3	PO3
III	2	Generalise opportunistic and nosocomial infections	4+4	BL3	CO3	PO3
III	3	Describe tuberculosis: causative organism, pathogenesis, diagnosis and prevention	8	BL2	CO3	PO3
III	4	Explain diagnosis and prevention of Hepatitis A and AIDS	4+4	BL2	CO3	PO3
IV	1	Explain collection, handling and processing of clinical samples	8	BL2	CO4	PO4
IV	2	Describe identification methods by culturing clinical samples	8	BL2	CO4	PO4
IV	3	Demonstrate PCR and DNA probe techniques for pathogen identification	8	BL3	CO4	PO4
IV	4	Illustrate role of serological tests in pathogen identification	8	BL2	CO4	PO4
V	1	Generalise types of vaccines	8	BL3	CO5	PO5
V	2	Explain mode of action of penicillin and streptomycin	8	BL2	CO5	PO5
V	3	Define antibiotic resistance and explain mechanisms of resistance	8	BL3	CO5	PO5
V	4	Describe tests to evaluate antibiotic susceptibility	8	BL2	CO5	PO5

OBJECTIVE

Unit-I :

1. B-cells and T-cells cells involved in acquired immunity (true/False)
2. Which form of immunity conveys the longer-lasting immunity against a infectious agent?
3. Example for natural passive immunity_____
4. What is haemopoiesis?
5. Give two examples for primary organs of lymphatic system----------

UNIT-II

1. Differentiate between epitope and paratope
2. How are the light and heavy chains bound together in antibody?
3. What is the role of MHC?
4. What is MAC in the complement system?
5. What is the nature of a memory cell?

Unit-III

1. Where do the Streptococcus mutans adhere to the body site?
2. Staphylococci are common resident flora of _____.
3. Define Virulence—----------
4. What is the casative agent of Candiosis—---------
5. What is the causative agent of Batulism—------

Unit-IV

1. Expand IMViC—---------
2. Give example of Selective Medium—-------
3. What is RT-PCR—--------
4. What is WIDAL test—---------
5. What is ELISA_____

Unit-V

1. Who discovered the technique of preparing vaccines from attenuated pathogens and in which year?
2. Give example of Antibiotic Function as Protein Synthesis Inhibitors—----
3. Interferons induce enzyme synthesis in the target cell (True / False)
4. What is antibiotic resistance?

III B.Sc Microbiology Honours -III Semester
Course-12 A (IMMUNOLOGY AND MEDICAL MICROBIOLOGY)
Model Question Paper

SECTION A

Answer all the following questions (5x8=40)

UNIT	Q.No	Question	Marks	BL	CLO	PO
I	1a	Define innate and acquired immunity and explain types of immunity	8	BL2	CLO1	PO1, PO2
	1b	Generalise structure and functions of immune cells	8	BL2	CLO1	PO1, PO2
II	2a	Explain structure and types of antibodies	8	BL2	CLO2	PO1, PO2, PO5
	2b	Generalise immune complex formation: precipitation, agglutination and neutralization	8	BL3	CLO2	PO1, PO2, PO5
III	3a	Generalise opportunistic and nosocomial infections	8	BL2	CLO3	PO1, PO2, PO4
	3b	Describe tuberculosis: causative organism, pathogenesis, diagnosis and prevention	8	BL3	CLO3	PO1, PO2, PO4
IV	4a	Explain collection, handling and processing of clinical samples	8	BL2	CLO4	PO2, PO3, PO4
	4b	Illustrate role of serological tests in pathogen identification	8	BL3	CLO4	PO2, PO3, PO4
V	5a	Explain mode of action of penicillin and streptomycin	8	BL2	CLO5	PO2, PO4
	5b	Describe tests to evaluate antibiotic susceptibility	8	BL2	CLO5	PO2, PO4

Section -B
Answer any FIVE only from the following
(10X1=10)

1. B-cells and T-cells cells involved in acquired immunity (true/False)
2. . Give two examples for primary organs of lymphatic system----------
3. What is the role of MHC?
4. What is the nature of a memory cell?
5. Staphylococci are common resident flora of _____.
6. What is the causative agent of Batulism—-----
7. Expand IMViC—----------
8. What is ELISA_____
9. Give example of Antibiotic Function as Protein Synthesis Inhibitors—---
10. What is antibiotic resistance?

V SEMESTER

COURSE 13 A: APPLIED MICROBIOLOGY credits -3

SYLLABUS

I. Course Outcomes:

By the completion of the course the learner should able to–

Theory – CLOs

1. CLO1: Explain principles of industrial microbiology and large-scale fermentation. (BT2 – Understand)
2. CLO2: Describe production of antibiotics, enzymes, and organic acids. (BT2 – Understand)
3. CLO3: Explain role of microorganisms in food processing and preservation. (BT2 – Understand)
4. CLO4: Describe principles of sewage treatment and waste management. (BT2 – Understand)
5. CLO5: Explain biofertilizers, biopesticides, and sustainable agriculture practices. (BT2 – Understand)
6. CLO6: Analyze applications of microorganisms in environmental and industrial sectors. (BT4 – Analyze)

Unit–I: Entrepreneurial skill No of Hours: 9

1. Entrepreneurial skills–Institutes involved, Government support to entrepreneurs, Incubation centers, risk assessment. Scope for small, medium and Large scale industries in Microbiology

Unit–II: Fermentation Products No of Hours: 9

1. Microbial cells as fermentation products-
2. Bakers yeast, food and feed yeasts, SCP, Bacterial Insecticides, Legume Inoculants, Algae.
3. Enzymes as fermentation products–
4. Bacterial and Fungal Amylases, **Proteolytic Enzymes**, Pectinases, Invertases, and other enzymes
5. Fermentation Economics

Unit–III: Bio-fertilisers and Mushrooms No of Hours: 9

1. Mushroom cultivation–Cultivation of Agaricus campestris,Calocyba indica, Agaricus bisporus, and Volvariella volvaciae; Preparation of compost, filling tray beds, spawning, maintaing optimal temperature, casing, watering, harvesting, storage.
2. Biofertilizers –Chemical fertilizers versus biofertilizers, organic farming. Production of biofertilisers-Rhizobium sp, Azospirillumsp, Azotobactersp.
3. Microbial consortia for composting and as biofertilisers

Unit–IV: Baking and Brewing processes No of Hours: 9

1. Brewing–Media components, preparation of medium, Microorganisms involved, maturation, carbonation, packaging, keeping quality, contamination, by products.
2. Bread making- Yeast activation,

Unit–V:DPR and Patents **No of Hours: 9**

1. Preparation of DPR (Detailed Project Report)
2. Patents and secret processes –History of patenting, composition, subject matter and characteristics of a patent, Inventor, Infringement, cost of patent

V SEMESTER COURSE 13 A: APPLIED MICROBIOLOGY credits -1

Practical – CLOs

1. CLO1: Isolate and identify industrially important microorganisms. (BT3 – Apply)
2. CLO2: Perform fermentation experiments for production of microbial products. (BT3 – Apply)
3. CLO3: Analyze food samples for microbial contamination. (BT3 – Apply)
4. CLO4: Demonstrate methods of water and sewage analysis. (BT3 – Apply)
5. CLO5: Evaluate microbial cultures used in biofertilizer preparation. (BT4 – Analyze)
6. CLO6: Interpret results of applied microbiology experiments. (BT4 – Analyze)

LEARNING OUTCOMES

1. Preparation of Microbial consortia for composting
2. Field visit and report preparation of Mushroom cultivation unit/ Biofertiliser production centre/or any other
3. Preparation of sample DPR

References:

1. Entrepreneurial Development in India -ByArora.
2. Sathyanarayana.U, Biotechnology.(2005)1stEd.BooksandAllied(P)Ltd.
3. Casida,LEJR,(2019). Industrial Microbiology.NewAge International Publishers
4. K.R.Aneja,ExperimentsinMicrobiology,Plantpathology,Tissuecultureand Mushroom productiontechnology,6thEd.SChandPublication
5. NdukaOkafor.ModernIndustrialMicrobiologyandBiotechnology.2007.CRCPre s s
6. MichaelJ.Waites,NeilL.Morgan,JohnS.Rockey,GaryHigton.IndustrialMicrobio l ogy: AnIntroduction.2013.WileyBlackwellPublishers.
7. A.H.Patel.IndustrialMicrobiology.2016.2ndEd.LaxmiPublications,NewDelhi.
8. DubeyRC.ATextbookofBiotechnology.(2014).SChand Publishers.
9. RobertD.Hisrich,MichaelP.Peters,“EntrepreneurshipDevelopment”,TataMcGr a w Hill

II. Co-Curricular Activities:

1. Prepare fermented foods
2. Workshop on project report preparation of mushroom cultivation unit
3. Visit to industry producing microbial products

V SEMESTER

COURSE 13 A: APPLIED MICROBIOLOGY

Blue Print for Question Papers from V Semester

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B (MCQ/ True or False/ Fill in the blank) – No choice	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-2	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-3	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-4	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-5	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks

SECTION-A **10 M 5 × 8 = 40 Marks**

Answer all the following questions.

Draw labelled diagrams wherever necessary.

1. (a) – (i) and (ii) Or (b) - (i) and (ii)
2. (a) or (b) – If an essay
3. (a) or (b) – If an essay
4. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
5. (a) or (b) – If an essay

SECTION-B **10X1=10 Marks**

Answer all the following questions.

6. From Unit-1
7. From Unit-1
8. From Unit-2
9. From Unit-2
10. From Unit-3
11. From Unit-3
12. From Unit-4
13. From Unit-4
14. From Unit-5
15. From Unit-5

13A

QUESTION BANK

Unit	Q.No	Questions	Marks	BL	CO	PO
I	1	Explain the scope of small, medium, and large industries in Microbiology	8	BL2	CO1	PO1, PO2
I	2	Describe the importance of Mudra loans and Stand-Up India scheme	8	BL2	CO1	PO1, PO2
I	3	Analyze government support to entrepreneurs in industrial microbiology	8	BL4	CO1	PO2, PO3
I	4	Evaluate Startup India and Credit Guarantee Scheme for entrepreneurship	8	BL5	CO1	PO3, PO4
II	1	Define microbial cells as fermentation products with examples	8	BL1	CO2	PO1
II	2	Discuss industrial applications of baker's yeast, food, and feed yeasts	8	BL4	CO2	PO2, PO3
II	3	Explain significance of Single Cell Protein (SCP)	8	BL2	CO2	PO1, PO2
II	4	Illustrate role of bacterial and fungal amylases	8	BL3	CO2	PO2, PO3
III	1	Describe mushroom cultivation of *Calocybe indica*	8	BL2	CO3	PO2, PO3
III	2	Differentiate chemical fertilizers and biofertilizers	8	BL4	CO3	PO2, PO4
III	3	Explain importance of organic farming	8	BL2	CO3	PO2, PO4
III	4	Demonstrate biofertilizer production using *Rhizobium*, *Azospirillum*, *Azotobacter*	8	BL3	CO3	PO3, PO4
IV	1	Explain brewing process and its industrial significance	8	BL2	CO4	PO1, PO2
IV	2	Describe bread making with yeast activation	8	BL2	CO4	PO1, PO2
V	1	Compare trade secrets and patents	8	BL6	CO5	PO4, PO5
V	2	List and explain characteristics of patents	8	BL1	CO5	PO4
V	3	Discuss role of inventors and cost of patent filing in India	8	BL4	CO5	PO4, PO5
V	4	Evaluate patent infringement cases with examples	8	BL5	CO5	PO4, PO5

C 13A

Objective type questions-

1. _____ is a government initiative that provides financial and technical support to new entrepreneurs in India.*(Ans: Startup India).*
2. Large-scale microbiology industries often focus on _____ production, such as vaccines, antibiotics, and enzymes.
   (Answer: mass or commercial)
3. **True / False** – Incubation centers only provide funding and have no role in mentoring entrepreneurs.*(Answer: False)*
4. **True / False** – The biotechnology sector offers scope for both small-scale and large-scale industries in microbiology.*(Answer: True)*
5. **True / False** – Government schemes like MUDRA are not meant for supporting micro and small enterprises.*(Answer: False)*
6. _____ **yeast** is widely used in the baking industry to leaven bread through carbon dioxide production.*(Answer: Baker's)*
7. **Single Cell Protein (SCP)** refers to microbial biomass rich in _____ used as a protein supplement in food and feed.*(Ans: protein)*
8. Bacterial _____ like *Bacillus thuringiensis* are used in agriculture as eco-friendly pest control agents.
   (Answer: insecticides)
9. **True / False** – Proteolytic enzymes are used to break down fats into fatty acids.*(Answer: False)*
10. **True / False** – Pectinases are primarily used in the dairy industry for curdling milk.*(Answer: False)*
11. In mushroom cultivation, the process of mixing mushroom spawn into compost is called _____.*(Answer: spawning)*
12. **Rhizobium** forms symbiotic associations with leguminous plants and helps in _____ **fixation**.*(Answer: nitrogen)*
13. Biofertilizers are preferred in _____ **farming** as they are eco-friendly and maintain soil health.*(Answer: organic)*
14. **True / False** – Casing in mushroom cultivation helps in retaining moisture and supports fruit body formation.*(Answer: True)*
15. **True / False** – Microbial consortia used for composting can accelerate the decomposition of organic waste.*(Answer: True)*
16. In brewing, _____ is the process of aging beer to develop flavor and clarity.*(Answer: maturation)*
17. During bread making, warm water and sugar are used to activate yeast and produce _____, which helps the dough rise.*(Ans: carbon dioxide)*
18. _____ is the process of dissolving carbon dioxide in beer to give it fizz and improve texture.*(Answer: Carbonation)*
19. **True / False** – Bread dough does not need to rest after yeast activation.
    (Answer: False) – (Resting allows fermentation and rising.)
20. **True / False** – Contamination in brewing can alter taste, clarity, and shelf life of the product.*(Answer: True)*
21. A _____ is a comprehensive document that outlines all aspects of a business idea or industrial project, including financial and technical details.*(Answer: Detailed Project Report)*
22. The person who first conceives and develops an invention is known as the _____.*(Ans: inventor)*
23. A patent gives the inventor the **exclusive right** to make, use, or sell the invention for a period of _____ years in most countries.*(Ans: 20)*
24. **True / False** – Secret processes are disclosed in detail in the patent document.*(Answer: False)*
25. **True / False** – Once a patent expires, the invention enters the public domain and can be used freely.*(Answer: True)*

V SEMESTER COURSE 13 A: APPLIED MICROBIOLOGY

MODEL QUESTION PAPER

SECTION A

Answer all the following questions (5x8=40)

UNIT	Q.No	Question	Marks	BL	CLO	PO
I	1a	Explain the scope of small, medium, and large industries in Microbiology	8	BL2	CLO1	PO1, PO2
	1b	Analyze government support to entrepreneurs in industrial microbiology	8	BL2	CLO1	PO1, PO2
II	2a	Discuss industrial applications of baker's yeast, food, and feed yeasts	8	BL2	CLO2	PO1, PO2, PO5
	2b	Illustrate role of bacterial and fungal amylases	8	BL3	CLO2	PO1, PO2, PO5
III	3a	Describe mushroom cultivation of *Calocybe indica*	8	BL2	CLO3	PO1, PO2, PO4
	3b	Explain importance of organic farming	8	BL3	CLO3	PO1, PO2, PO4
IV	4a	Describe bread making with yeast activation	8	BL2	CLO4	PO2, PO3, PO4
	4b	Describe bread making with yeast activation	8	BL3	CLO4	PO2, PO3, PO4
V	5a	List and explain characteristics of patents	8	BL2	CLO5	PO2, PO4
	5b	Evaluate patent infringement cases with examples	8	BL2	CLO5	PO2, PO4

Section -B

Answer any FIVE only from the following

(10X1=10)

1. _____ is a government initiative that provides financial and technical support to new entrepreneurs in India.
2. True / False – The biotechnology sector offers scope for both small-scale and large-scale industries in microbiology.*(*
3. Single Cell Protein (SCP) refers to microbial biomass rich in _____ used as a protein supplement in food and feed.*(*
4. In mushroom cultivation, the process of mixing mushroom spawn into compost is called _____.
5. Biofertilizers are preferred in _____ **farming** as they are eco-friendly and maintain soil health.
6. In brewing, _____ is the process of aging beer to develop flavor and clarity.
7. **True / False** – Bread dough does not need to rest after yeast activation.
8. **True / False** – Contamination in brewing can alter taste, clarity, and shelf life of the product.
9. **True / False** – Once a patent expires, the invention enters the public domain and can be used freely.

V SEMESTER

COURSE 14 A: INDUSTRIAL MICROBIOLOGY credits -3

Theory – CLOs **SYLLABUS**

1. CLO1: Explain principles and scope of industrial microbiology and bioprocessing. (BT2 – Understand)
2. CLO2: Describe types and design of bioreactors and fermenters. (BT2 – Understand)
3. CLO3: Explain upstream and downstream processing techniques in industries. (BT2 – Understand)
4. CLO4: Describe production of industrial products such as antibiotics, enzymes, and vaccines. (BT2 – Understand)
5. CLO5: Explain quality control, biosafety, and regulatory aspects in bioprocess industries. (BT2 – Understand)
6. CLO6: Analyze challenges and future prospects of industrial microbiology. (BT4 – Analyze)

UNIT I: Microorganisms of industrial importance No. of hours: 9

1. Brief history and developments in industrial microbiology.
2. Microorganisms of industrial importance -yeasts (Saccharomyces cerevisiae), molds (Aspergillus niger) bacteria (E.coli), actinomycetes (Streptomyces griseus).
3. Industrially important Primary and secondary microbial metabolites- Techniques involved in selection of industrially important metabolites from microbes.

UNIT II : Screening and Strain Improvement No. of hours: 9

1. Primary and secondary screening. Preservation and maintenance of industrial strains
2. Outlines of strain improvement.
3. Fermentation media (Crude and synthetic media; molasses, corn- steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates)

UNIT III: Bioreactors No. of hours: 9

1. Components of a typical continuously stirred tank bioreactor.
2. Types of fermenters – laboratory, pilot-scale and production fermenters.
3. Types of fermentation processes- solid state, liquid state; batch, fed- batch, continuous; aerobic, anaerobic; submerged, surface

UNIT IV: Fermentation and Downstream processes No. of hours: 9

1. Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration
2. Downstream processing - filtration, centrifugation, cell disruption, solvent extraction.
3. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes.

UNIT V: Microbial Productions No. of hours: 9

1. Production of citric acid, ethanol and penicillin.

2. Production of Glutamic acid and vitamin B12
3. Industrial production and uses of amylases, proteases, **lipases and cellulases**.

Skill Outcomes:

1. By the completion of the course the learner should able to–
2. Comprehend the significance of and demonstrate microbial diversity by isolating microorganisms from natural environments.
3. Microscopically demonstrate the microorganisms found in fermented food; prepare some of the fermented products(wine) in the laboratory to observe the associated physical and chemical changes.
4. Carry out microbial productions in small scale (citric acid) and estimate the product.

V SEMESTER

COURSE 14 A INDUSTRIAL MICROBIOLOGY credits -1

Practical – CLOs

1. CLO1: Prepare and sterilize media for industrial fermentation processes. (BT3 – Apply)
2. CLO2: Perform batch fermentation using standard microbial cultures. (BT3 – Apply)
3. CLO3: Monitor fermentation parameters such as pH, temperature, and growth. (BT3 – Apply)
4. CLO4: Recover and partially purify microbial products from fermentation broth. (BT3 – Apply)
5. CLO5: Apply good laboratory and safety practices in industrial microbiology labs. (BT3 – Apply)
6. CLO6: Analyze and interpret fermentation data and process outcomes. (BT4 – Analyze)

LEARNING OUTCOMES

1. Microbial fermentation for the production and estimation of ethanol
2. Isolation of amylase producing microorganisms from soil
3. Production of amylase from bacteria and fungi
4. Assay of amylase
5. Demonstration of fermenter
6. Production of wine from grapes
7. Growth curve and kinetics of any two industrially important microorganisms.
8. Microbial fermentation for the production and estimation of citric acid

References:

1. Stanbury, P.F., Whitaker, A. and Hall, S.J. (1997). Principles of Fermentation Technology, Aditya Books (P) Ltd. New Delhi.
2. Doyle, M.P., Beuchat, L.R. and Montville, T.J. (1997). Food
3. Microbiology: Fundamentals and Frontiers. ASM Press, Washington D.C., USA.
4. **Co-Curricular Activities**:
5. Lectures/ Seminar on current trends in industrial microbiology
6. Field visit to related industry
7. Assignments on identifying and procuring industrially important microorganisms

Blue Print for Question Papers from V Semester

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B (MCQ/ True or False/ Fill in the blank) – No choice	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-2	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-3	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-4	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-5	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks

SECTION-A **10 M 5 × 8 = 40 Marks**

Answer all the following questions.

Draw labelled diagrams wherever necessary.

16. (a) – (i) and (ii) Or (b) - (i) and (ii)
17. (a) or (b) – If an essay
18. (a) or (b) – If an essay
19. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
20. (a) or (b) – If an essay

SECTION-B **10X1=10 Marks**

Answer all the following questions.

21. From Unit-1
22. From Unit-1
23. From Unit-2
24. From Unit-2
25. From Unit-3
26. From Unit-3
27. From Unit-4
28. From Unit-4
29. From Unit-5
30. From Unit-5

V SEMESTER COURSE 14 A: INDUSTRIAL MICROBIOLOGY

MODEL QUESTION PAPER

SECTION A

Answer all the following questions (5x8=40)

UNIT	Q.No	Question	Marks	BL	CLO	PO
I	1a	Describe industrially important yeast (*Saccharomyces cerevisiae*)	8	BL2	CLO1	PO1, PO2
	1b	Discuss role of bacteria (*Escherichia coli*) in industrial microbiology	8	BL2	CLO1	PO1, PO2
II	2a	Explain preservation and maintenance of industrial strains	8	BL2	CLO2	PO1, PO2, PO5
	2b	Evaluate fermentation media (crude vs synthetic, molasses, CSL, whey)	8	BL3	CLO2	PO1, PO2, PO5
III	3a	List components of a continuously stirred tank bioreactor	8	BL2	CLO3	PO1, PO2, PO4
	3b	Differentiate batch, fed-batch and continuous fermentation	8	BL3	CLO3	PO1, PO2, PO4
IV	4a	Describe measurement and control of fermentation parameters (pH, temperature, DO, etc.)	8	BL2	CLO4	PO2, PO3, PO4
	4b	Illustrate immobilization methods and advantages	8	BL3	CLO4	PO2, PO3, PO4
V	5a	Describe steps in ethanol production	8	BL2	CLO5	PO2, PO4
	5b	Assess production and uses of amylases and proteases	8	BL2	CLO5	PO2, PO4

Section -B

Answer any FIVE only from the following (10X1=10)

1. Primary metabolites are produced during the stationary phase of microbial growth.(True/False)
2. Streptomyces griseus is known for producing the antibiotic _____.
3. Fermentation media must always contain only synthetic components for optimal microbial growth. (True/False)
4. A widely used method for long-term preservation of industrial strains is _____, which involves freezing cultures in liquid nitrogen.
5. Batch fermentation is a closed system where all nutrients are added at the beginning. (True/ False)
6. In enzyme immobilization, the method where enzymes are physically trapped inside a gel matrix is called _____.
7. Anaerobic fermentation requires continuous aeration for microbial growth. (True/ False)
8. Batch fermentation is a closed system where all nutrients are added at the beginning. (True/ False)
9. Amylases are enzymes that catalyze the breakdown of _____ into simpler sugars.
10. Glutamic acid is produced using the bacterium _____ *glutamicum*.

V SEMESTER
COURSE 14 A INDUSTRIAL MICROBIOLOGY

QUESTION BANK

Unit	Q.No	Questions	Marks	BL	CO	PO
I	1	Describe industrially important yeast (*Saccharomyces cerevisiae*)	8	BL2	CO1	PO1, PO2
I	2	Explain industrial importance of molds (*Aspergillus niger*)	8	BL2	CO1	PO1, PO2
I	3	Discuss role of bacteria (*Escherichia coli*) in industrial microbiology	8	BL4	CO1	PO2, PO3
I	4	Differentiate primary and secondary metabolites with examples	8	BL4	CO4	PO1, PO2
II	1	Define primary and secondary screening methods	8	BL1	CO2	PO1
II	2	Explain preservation and maintenance of industrial strains	8	BL2	CO2	PO2
II	3	Illustrate outlines of strain improvement	8	BL3	CO2	PO2, PO3
II	4	Evaluate fermentation media (crude vs synthetic, molasses, CSL, whey)	8	BL5	CO2	PO2, PO3, PO4
III	1	List components of a continuously stirred tank bioreactor	8	BL1	CO5	PO1
III	2	Explain differences between laboratory, pilot and production fermenters	8	BL2	CO3	PO2, PO3
III	3	Compare solid-state and submerged (liquid-state) fermentation	8	BL4	CO3	PO2, PO3
III	4	Differentiate batch, fed-batch and continuous fermentation	8	BL4	CO3	PO2, PO3
IV	1	Describe measurement and control of fermentation parameters (pH, temperature, DO, etc.)	8	BL2	CO5	PO2, PO3
IV	2	Explain downstream processing methods (filtration, centrifugation, extraction)	8	BL2	CO5	PO2, PO3
IV	3	Illustrate immobilization methods and advantages	8	BL3	CO5	PO2, PO3, PO4
IV	4	Evaluate applications of immobilized enzymes	8	BL5	CO5	PO3, PO4
V	1	Explain industrial production of citric acid	8	BL2	CO3	PO2, PO3
V	2	Describe steps in ethanol production	8	BL2	CO3	PO2, PO3
V	3	Discuss production of glutamic acid	8	BL4	CO3	PO2, PO3
V	4	Assess production and uses of amylases and proteases	8	BL5	CO3	PO2, PO3, PO4

OBJECTIVES

1. Aspergillus niger is widely used for citric acid production in the food and pharmaceutical industries.(True)
2. E. coli is only used as a model organism in research and has no industrial applications.(False)
3. Primary metabolites are produced during the stationary phase of microbial growth.(False)
4. Streptomyces griseus is known for producing the antibiotic _____. (Streptomycin)
5. The process of selecting microbial strains that produce high yields of industrial metabolites is called _____.(Strain improvement)
6. Molasses, corn-steep liquor, and whey are examples of synthetic fermentation media. (False **)**
7. Fermentation media must always contain only synthetic components for optimal microbial growth. (False)
8. A widely used method for long-term preservation of industrial strains is _____, which involves freezing cultures in liquid nitrogen.(Cryopreservation)
9. Strain improvement techniques include mutation, genetic engineering, and _____ to enhance microbial productivity.(Recombinant DNA technology)
10. _____ is a byproduct of the sugar industry and is commonly used as a crude fermentation medium.(Molasses)
11. The _____ in a continuously stirred tank bioreactor ensures proper mixing of the contents and maintains uniform conditions.**(impeller)**
12. A _____ fermenter is typically used in research laboratories for small-scale experiments.**(laboratory)**
13. In _____ fermentation, microorganisms grow on solid substrates without free-flowing water.**(Answer: solid-state)**
14. Anaerobic fermentation requires continuous aeration for microbial growth. **(False)**
15. Batch fermentation is a closed system where all nutrients are added at the beginning. **(True)**
16. In enzyme immobilization, the method where enzymes are physically trapped inside a gel matrix is called _____.**(entrapment)**
17. Immobilized enzymes are often used in _____ reactors for continuous production processes.**(packed-bed)**
18. Excessive _____ during fermentation can hinder microbial growth and reduce product yield.**(foaming)**
19. Immobilization of enzymes increases their stability and allows reuse in multiple cycles.**(True)**
20. Filtration is an ideal method for separating fine intracellular products from lysed cells.**(False)**
21. **Amylases** are enzymes that catalyze the breakdown of _____ into simpler sugars.**(Answer: starch)**
22. **Glutamic acid** is produced using the bacterium _____ *glutamicum*. **(Answer: Corynebacterium)**
23. Vitamin B12 can only be synthesized chemically and not by microbial fermentation.**(False)**
24. Cellulases are used in the biofuel industry to convert plant biomass into fermentable sugars.**(True)**
25. Ethanol can be produced by yeast fermentation of sugars under anaerobic conditions.**(True)**

V SEMESTER

COURSE 15 A: FOOD AND DAIRY MICROBIOLOGY credits -3

SYLLABUS

Course Outcomes:

By the Completion of the course the learner should able to–

Theory – CLOs

1. CLO1: Explain the scope and importance of food and dairy microbiology in food safety and quality control. (BT2 – Understand)
2. CLO2: Describe the role of microorganisms in food fermentation and preservation. (BT2 – Understand)
3. CLO3: Explain sources, types, and significance of food spoilage microorganisms. (BT2 – Understand)
4. CLO4: Describe food-borne pathogens and their impact on public health. (BT2 – Understand)
5. CLO5: Explain principles of milk microbiology, pasteurization, and dairy processing. (BT2 – Understand)
6. CLO6: Analyze quality control measures and regulatory standards in food and dairy industries. (BT4 – Analyze)

Unit1: Microbes in Food and Dairy No. of Hours: 9

1. Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.
2. Microflora associated with milk and milk products and their importance. Sources of microbial contamination of raw milk and butter
3. Sources of microbial contamination and spoilage of vegetables, fruits, meat, eggs, bread, canned Foods;

Unit 2: Food Preservation No. of Hours: 9

1. Principles of food preservation: temperature, canning, drying, irradiation, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, citrates, benzoates,nitrite and nitrates etc.
2. Microbial and chemical changes in raw milk during chilling and refrigeration.
3. Naturally occurring preservative systems in milk like LP system, Immunoglobulins, Lysozyme, Lactoferrin. Food grade Biopreservatives (GRAS), Bacteriocins of lactic acid bacteria; Nisin and other antimicrobials produced by Lactic Acid Bacteria (LAB)

Unit 3: Fermented foods No. of Hours: 9

1. Dairy starter cultures, fermented dairy products: yogurt, **acidophilus milk, kumiss, kefir, dahi** and cheese
2. Other fermented foods: dosa, sauerkraut, soy sauce and tempeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.
3. Utilization and disposal of dairy by-products – whey.

Unit 4: Food borne diseases No. of Hours: 9

1. Food borne diseases (causative agents, foods involved, symptoms and preventive measures)
2. Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins;
3. Food infections: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis,
4. Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni

Unit 5: Food Sanitation No. of Hours: 9

1. Food sanitation and control; HACCP; National and International microbiological standards for dairy products (BIS, ICMSF, Codex Alimentarius Standards.
2. Cultural and rapid detection methods of food borne pathogens and introduction to predictive microbiology.
3. Genetically modified foods, Nutraceuticals, Biosensors in
4. food, Applications of microbial enzymes in dairy industry [Protease, Lipases].

Skill Outcomes:

1. Mastering the MBRT method and standard plate count technique, interpreting MPN results, assessing milk quality based on microbial load, and understanding the significance of microbial analysis in ensuring milk safety.
2. Check the efficiency of pasteurization of milk include understanding the principle of the test, performing the enzymatic reaction, interpreting results, and assessing the effectiveness of milk pasteurization in ensuring food safety.
3. Mastering aseptic techniques, perform sample preparation and isolation techniques, identify potential pathogens and spoilage microorganisms, and understand the role of microorganisms in food safety and spoilage.
4. Follow yogurt fermentation protocols, controlling fermentation conditions, assessing yogurt quality, and understanding the role of microbial cultures in yogurt production.

V SEMESTER

COURSE 15 A : FOOD AND DAIRY MICROBIOLOGY credits -1

Practical – CLOs

1. CLO1: Perform microbiological analysis of milk and dairy products. (BT3 – Apply)
2. CLO2: Isolate and enumerate microorganisms from food samples. (BT3 – Apply)
3. CLO3: Detect food spoilage and food-borne pathogens using standard methods. (BT3 – Apply)
4. CLO4: Evaluate microbial quality of fermented food products. (BT4 – Analyze)
5. CLO5: Apply aseptic techniques and safety practices in food microbiology laboratories. (BT3 – Apply)
6. CLO6: Interpret experimental data related to food and dairy microbiology. (BT4 – Analyze)

LEARNING OUTCOMES

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any foodborne bacteria from food products. Isolation of spoilage microorganisms from spoiled vegetables/fruits.

4. Isolation of spoilage microorganisms from bread. 5.Preparation of Yogurt/Dahi.

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Co-Curricular Activities:

1. Food Microbiology Workshops
2. Assign projects or lab exercises where students analyze food and dairy products for microbial quality and safety.
3. Organize visits to food processing facilities or dairy
4. Seminars on Food Safety and Quality Assurance, food regulations, and quality management systems.

Blue Print for Question Papers from V Semester

Unit Number	Section-A (Essay/ Split Essay) In either or pattern	Section-B (MCQ/ True or False/ Fill in the blank) – No choice	Weightage of marks
Unit-1	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-2	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-3	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-4	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks
Unit-5	8 Marks / 2×4 Marks	1 mark (2 Questions)	10 Marks

SECTION-A **10 M 5 × 8 = 40 Marks**

Answer all the following questions.

Draw labelled diagrams wherever necessary.

31. (a) – (i) and (ii) Or (b) - (i) and (ii)
32. (a) or (b) – If an essay
33. (a) or (b) – If an essay
34. (a) – (i) and (ii) or (b) - (i) and (ii) – if split essay
35. (a) or (b) – If an essay

SECTION-B **10X1=10 Marks**

Answer all the following questions.

36. From Unit-1
37. From Unit-1
38. From Unit-2
39. From Unit-2
40. From Unit-3
41. From Unit-3
42. From Unit-4
43. From Unit-4
44. From Unit-5
45. From Unit-5

COURSE 15 A: FOOD AND DAIRY MICROBIOLOGY

MODEL QUESTION PAPER 15 A

SECTION-A **5 × 8 = 40 Marks**

Answer all the following questions. Draw labelled diagrams wherever necessary.

Unit	Q.No	Questions	Marks	BL	CO	PO
I	1a	Explain intrinsic and extrinsic factors affecting growth and survival of microbes in foods	8	BL2	CO1	PO1, PO2
I	1b	Analyze sources of microbial contamination and spoilage of vegetables, meat and canned foods	8	BL4	CO4	PO2, PO3
II	2a	Explain chemical methods of food preservation with examples	8	BL1	CO2	PO1, PO2
II	2b	Illustrate natural preservative systems in milk (LP system, immunoglobulins, lysozyme, lactoferrin)	8	BL5	CO2	PO2, PO3, PO4
III	3a	Describe dairy starter cultures and fermented products (yogurt, cheese)	8	BL1	CO5	PO1, PO2
III	3b	Discuss utilization and disposal of dairy by-products (whey)	8	BL4	CO3	PO2, PO3
IV	4a	Describe major foodborne diseases: causative agents, symptoms and prevention	8	BL2	CO5	PO2, PO3, PO4
IV	4b	Analyze role and effects of mycotoxins in food safety	8	BL5	CO5	PO3, PO4
V	5a	Explain food sanitation and control measures including HACCP	8	BL2	CO3	PO2, PO3, PO4
V	5b	Evaluate impact of genetically modified foods on health and safety	8	BL5	CO3	PO3, PO4, PO5

SECTION – B **10 × 1 = 10 Marks**

Answer all the following questions.

1. _____factors such as temperature, pH, and moisture content significantly influence microbial growth in foods.**(Intrinsic)**
2. Bread spoilage is most often caused by bacterial contamination rather than fungal growth.(**False**)
3. _is a natural antimicrobial protein in milk that binds iron, limiting bacterial growth.**(Lactoferrin)**
4. Benzoates are ineffective as food preservatives in acidic foods.(**False**)
5. _is a fermented dairy product made using *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.**(Yogurt)**
6. Whey can be used in making health drinks and animal feed, reducing waste in dairy industries.(**True)**
7. **Staphylococcus aureus** causes food intoxication by producing heat-stable _____ in contaminated foods.*(Enterotoxins)*
8. **True / False** – Clostridium botulinum causes symptoms primarily due to infection, not toxins.*(False)*
9. **HACCP** stands for **Hazard Analysis and** _____**Control Points**, a system for ensuring food safety. *(Answer: Critical)*
10. **True / False** – Nutraceuticals are foods or food components that provide only nutritional value

without any health benefits. *(False*

COURSE 15 A: FOOD AND DAIRY MICROBIOLOGY

QUESTION BANK 15 A

15 A

Unit No.	Q. No.	Question	Marks	BL
Unit I	1	Explain intrinsic and extrinsic factors that affect growth and survival of microbes in foods.	8	BL2
	2	Describe natural flora and sources of contamination of foods in general.	8	BL2
	3	Analyze sources of microbial contamination and spoilage of vegetables, meat, and canned foods.	8	BL4
	4	Compare sources of microbial contamination and spoilage of fruits, meat, eggs, and bread.	8	BL4
Unit II	1	List the physical methods of food preservation.	8	BL1
	2	Explain chemical methods of food preservation with examples.	8	BL2
	3	Illustrate naturally occurring preservative systems in milk (LP system, Immunoglobulins, Lysozyme, Lactoferrin).	8	BL3
	4	Evaluate the use of food grade biopreservatives (GRAS).	8	BL5
Unit III	1	Describe dairy starter cultures and fermented dairy products like yogurt and cheese.	8	BL2
	2	Explain the preparation of other fermented foods such as dosa and sauerkraut.	8	BL2
	3	Assess the health benefits and types of microorganisms used as probiotics.	8	BL5
	4	Discuss utilization and disposal methods of dairy by-products such as whey.	8	BL4
Unit IV	1	Describe major foodborne diseases – causative agents, foods involved, symptoms, and preventive measures.	8	BL2
	2	Explain food intoxication caused by Clostridium botulinum.	8	BL2
	3	Analyze the role and effects of mycotoxins in food safety.	8	BL4
	4	Differentiate food infections caused by E. coli, Salmonella, and Shigella.	8	BL4
Unit V	1	Explain food sanitation and control measures, including HACCP.	8	BL2
	2	Illustrate cultural and rapid detection methods of foodborne pathogens and predictive microbiology.	8	BL3
	3	Evaluate the impact of genetically modified foods on health and safety.	8	BL5
	4	Discuss the role of nutraceuticals in human health.	8	BL4

Objectives 15A

1. _____ factors such as temperature, pH, and moisture content significantly influence microbial growth in foods.**(Intrinsic)**
2. The natural microbial population found in foods is referred to as _____.**(natural flora)**
3. The main microbial contaminants in raw milk include species of _____, _____, and yeasts.**(Lactobacillus, Pseudomonas)**
4. High sugar and acid content in fruits makes them less susceptible to bacterial spoilage than molds and yeasts.(**True)**
5. Bread spoilage is most often caused by bacterial contamination rather than fungal growth.(**False**)
6. _____ is a natural antimicrobial protein in milk that binds iron, limiting bacterial growth.**(Lactoferrin)**
7. _____ is a bacteriocin produced by Lactic Acid Bacteria and is widely used as a food-grade biopreservative.**(Nisin)**
8. The _____ system in milk involves the action of lactoperoxidase enzyme to inhibit microbial growth.**(LP or Lactoperoxidase)**
9. Drying removes water from food, making it unavailable for microbial growth.(**True)**
10. Benzoates are ineffective as food preservatives in acidic foods.(**False**)
11. _____ is a fermented dairy product made using *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.**(Yogurt)**
12. _____ is a traditional Indian fermented food made from rice and black gram batter.**(Dosa)**
13. _____ are live microorganisms which, when consumed in adequate amounts, provide health benefits to the host.**(Probiotics)**
14. Kumiss is a fermented dairy product made from cow's milk and contains both bacteria and yeast.(**False)**
15. Whey can be used in making health drinks and animal feed, reducing waste in dairy industries.(**True)**
16. **Staphylococcus aureus** causes food intoxication by producing heat-stable _____ in contaminated foods.*(Enterotoxins)*
17. **Botulism**, a severe form of food poisoning, is caused by the bacterium _____. *(Clostridium botulinum)*
18. **Salmonellosis** is a food infection often transmitted through undercooked _____ and poultry. *(eggs)*
19. **True / False** – Mycotoxins are produced by bacteria under anaerobic conditions. *(False)*
20. **True / False** – Clostridium botulinum causes symptoms primarily due to infection, not toxins.*(False)*
21. **HACCP** stands for **Hazard Analysis and _____ Control Points**, a system for ensuring food safety. *(Answer: Critical)*
22. The **Codex Alimentarius** is a collection of internationally recognized _____, guidelines, and codes of practice related to food safety.
    → *(Answer: standards)*
23. **BIS** stands for the Bureau of _____ Standards, which provides national quality guidelines for food and dairy products in India.
    → *(Answer: Indian)*
24. **True / False** – Genetically modified foods involve the alteration of the DNA of organisms used in food production. *(True)*
25. **True / False** – Nutraceuticals are foods or food components that provide only nutritional value without any health benefits. *(False)*