



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-I, II, III, IV Semesters as per BOS Regulations w.e.f. 2025-26 , Single Major & Minor Semester V, VI as per BOS Regulations w.e.f. 2023-24.)

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DEPARTMENT OF MICROBIOLOGY
BOARD OF STUDIES – 2026–27
10 August 2026

BoS AGENDA, DISCUSSION AND RESOLUTIONS

AGENDA POINT – I: B.Sc. Microbiology Major Programme

Agenda:

Continuation and implementation of the B.Sc. Microbiology Major Programme for the academic year 2026–27, in accordance with the applicable NEP, APSCHE, University and Government of Andhra Pradesh guidelines.

Discussion:

The Board reviewed the curriculum applicable to different batches of the B.Sc. Microbiology Major Programme during the academic year 2026–27 and noted that:

- First Year (Semesters I & II) and Second Year (Semesters III & IV) shall follow the 4-Year UG Honours B.Sc. Microbiology Major curriculum w.e.f. 2025–26.
- Third Year (Semesters V & VI) shall continue to follow the B.Sc. Honours Microbiology Major curriculum w.e.f. 2023–24.

Resolution I.A

It is resolved to continue the B.Sc. Microbiology Major Programme during the academic year 2026–27 in accordance with the applicable regulations and guidelines.

Resolution I.B

It is resolved to approve the batch-wise applicability of the curriculum as follows:

Year	Semesters	Applicable Curriculum
First Year	I & II	Curriculum w.e.f. 2025–26
Second Year	III & IV	Curriculum w.e.f. 2025–26
Third Year	V & VI	Curriculum w.e.f. 2023–24

The respective curriculum shall continue to be followed by each batch until completion of the programme, as per the applicable regulations.

AGENDA POINT – II: Review of Student Feedback and Curriculum Improvement

Agenda:

Review of the Student Course Feedback Analysis for B.Sc. (Honours) Microbiology 2025–26 and consideration of measures for curriculum and teaching-learning improvement.

Discussion:

The Board reviewed the Student Course Feedback Analysis for 2025–26 and noted the overall satisfactory performance of the programme. The members discussed the major areas identified for improvement, including field visits, internships and industrial exposure, skill

development and entrepreneurship, syllabus content in relation to teaching hours and credits, digital learning resources, and Course Outcome attainment.

The Board suggested strengthening these areas through appropriate academic and curricular measures.

Resolution II.A

It is resolved to consider the recommendations arising from the Student Course Feedback Analysis 2025–26 while planning and implementing the curriculum and teaching-learning activities.

Resolution II.B

It is resolved to strengthen experiential and skill-based learning through field visits, industrial visits, internships, student projects and entrepreneurship-oriented activities, wherever feasible.

Resolution II.C

It is resolved to strengthen the use of Open Educational Resources (OER), LMS, e-content, educational videos and other digital learning resources.

Resolution II.D

It is resolved to periodically review the syllabus content, teaching hours, credits, Course Outcomes and CO attainment and take appropriate measures wherever required.

AGENDA POINT – III: Course Framework, Syllabus, Workload, PLOs, COs and Outcome Mapping

Agenda:

Approval of the Course Framework, Syllabus, Workload, Programme Level Outcomes (PLOs), Course Outcomes (COs) and Outcome Mapping for the B.Sc. Microbiology Major Programme.

Discussion:

The Board reviewed the course framework, syllabus, credits, teaching hours and workload for the B.Sc. Microbiology Major. The Subject Experts offered suitable suggestions regarding the relevance and organization of the course content.

The members also reviewed the Programme Level Outcomes (PLOs), Course Outcomes (COs) and Performance Indicators (PIs) and discussed their appropriate mapping to ensure alignment between course outcomes and programme-level learning outcomes.

Resolution III.A

It is resolved to approve the course framework, syllabus, credits, teaching hours and workload for the B.Sc. Microbiology Major Programme.

Resolution III.B

It is resolved to approve the syllabus for Semesters I to IV, as applicable for the academic year 2026–27.

Resolution III.C

It is resolved to approve the Programme Code and Course Codes assigned to the programme and respective courses.

Resolution III.D

It is resolved to approve the Programme Level Outcomes (PLOs), Course Outcomes (COs), Performance Indicators (PIs) and relevant outcome mapping for the B.Sc. Microbiology Major Programme.

AGENDA POINT – IV: Blended Teaching-Learning and Digital Resources**Agenda:**

Continuation of the blended teaching-learning approach and use of digital learning resources.

Discussion:

The Board discussed the continuation of the 80:20 blended teaching-learning approach, comprising 80% offline teaching and 20% online/digital learning. The online component may include LMS activities, online tests and quizzes, educational videos, e-content, simulations and Open Educational Resources (OER).

Resolution IV

It is resolved to continue the 80:20 blended teaching-learning approach and promote the effective use of LMS, OER, e-content and other appropriate digital learning resources.

Suggested change: I removed “approximately” because you have specified an 80:20 ratio. I also removed “online assessment resources” from the resolution because assessment is covered separately under Agenda V, which avoids repetition.

AGENDA POINT – V: Model Question Papers, Blueprints and Outcome-Based Assessment**Agenda:**

Approval of Model Question Papers, Question Paper Blueprints, Assignment Questions, Course Outcome (CO) mapping, Bloom’s Taxonomy levels and Performance Indicators (PIs).

Discussion:

The Board reviewed the question paper pattern, Model Question Papers, Blueprints and Assignment Questions. The members also discussed the alignment of assessment questions with Course Outcomes, Bloom’s Taxonomy levels and Performance Indicators for effective assessment of student learning.

Resolution V.A

It is resolved to approve the following question paper pattern for all applicable semesters:

- Section A: Five essay questions, one from each unit, with internal choice (a or b). Students shall answer one alternative from each unit. Each question carries 8 marks.
 $5 \times 8 = 40$ Marks
- Section B: Eight short-answer questions of 2 marks each, covering all five units. Students shall answer any five.
 $5 \times 2 = 10$ Marks

Total: 50 Marks

The detailed distribution of questions shall be as specified in the approved Question Paper Blueprint.

B.Sc Microbiology honor's

Major Programmes

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	5 × 8 = 40	5 × 2 = 10
Total	50 Marks	

BLUEPRINT FOR QUESTION PAPER

SECTION - A

5X8=40Marks

Draw labelled diagrams wherever necessary.

1. (a) – (b) - essay
2. (a) or (b) – essay
3. (a) or (b) – essay
4. (a) or (b) - essay
5. (a) or (b) – 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

Resolution V.B

It is resolved to approve the Model Question Papers, Question Paper Blueprints, Assignment Questions, CO mapping, Bloom's Taxonomy levels and Performance Indicators for the respective courses.

This version is cleaner and, importantly, it matches the blueprint and model question-paper pattern we just corrected.

AGENDA POINT – VI: Panel of Question Paper Setters and Examiners

Agenda:

Approval of the Panel of Question Paper Setters and Examiners for the academic year 2026–27.

Discussion:

The Board reviewed the proposed panel of Question Paper Setters and Examiners for the B.Sc. Microbiology Major Programme.

Resolution VI

It is resolved to approve the Panel of Question Paper Setters and Examiners for the academic year 2026–27.

AGENDA POINT – VII: Continuous Internal Assessment (CIA) and Semester-End Examination (SEE)

Agenda:

Approval of the 50:50 Continuous Internal Assessment (CIA) and Semester-End Examination (SEE) evaluation pattern, including the components and distribution of marks under CIA.

Discussion:

The Board discussed the 50:50 CIA and SEE evaluation pattern and the distribution of marks under Continuous Internal Assessment. The proposed evaluation pattern is as follows:

Component	Marks
Internal Examination	20
Online Test	10
Attendance	5
Seminar	5
Clean & Green	5
Assignment	5
Total CIA	50

Component	Marks
Semester-End Examination (SEE)	50
Total Marks	100

Resolution VII

It is resolved to approve the 50:50 CIA and SEE evaluation pattern for the B.Sc. Microbiology Major Programme. The CIA shall carry 50 marks, comprising Internal Examination (20), Online Test (10), Attendance (5), Seminar (5), SASA (5) and Assignment (5), while the SEE shall carry 50 marks, as per the applicable regulations.

AGENDA POINT – VIII: Extension, Experiential and Co-Curricular Activities

Agenda:

Strengthening experiential and co-curricular learning through Community Service, Field Trips, Study Tours, Student Study Projects, Industrial Visits, Extension Lectures, Lab-to-School activities and Green Initiatives.

Discussion:

The Board discussed strengthening field exposure, practical learning and experiential activities, particularly in response to student feedback. The members emphasized the importance of field visits, industrial exposure, student projects and extension activities in enhancing practical knowledge and application of Microbiology.

Resolution VIII

It is resolved to conduct field visits, industrial visits, study tours, student projects, extension activities, community service and other relevant co-curricular activities, wherever feasible, to strengthen experiential and practical learning.

AGENDA POINT – IX: SWAYAM/MOOCs and Additional Online Learning

Agenda:

Encouraging students to enrol in relevant SWAYAM/MOOC courses as supplementary learning opportunities.

Discussion:

The Board discussed encouraging students to enrol in relevant Microbiology, allied life-science, skill-development and IPR courses offered through SWAYAM/MOOCs to enhance their knowledge and skills.

Resolution IX

It is resolved to encourage and facilitate student enrolment in relevant SWAYAM/MOOC courses as supplementary learning opportunities.

AGENDA POINT – X: Any Other Matter with the Permission of the Chairperson

Agenda:

To consider any other academic matter or proposal with the permission of the Chairperson.

Discussion:

Any additional matter raised during the meeting shall be discussed with the permission of the Chairperson.

Resolution X

The resolution, if any, shall be recorded based on the matter discussed during the meeting.

Discussion: No additional matter was raised.

Resolution: Nil.

SCIENTIFIC SYLLABUS

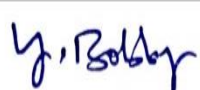
The scientific syllabus below is reproduced from the submitted BoS document without intentional alteration.

Signatures of Members:

1. 
2. 
3. 
4. 
5. 

Government college Autonomous Rajahmundry NAAC
A⁺

BOS Members 2026-2027
Department of Microbiology

S.no	Name	Signature
1.	Chairman : Smt. T. Sony Head, Department of Microbiology, Govt. College (A) – Rajamahendravaram.	
2.	Faculty Member : Kum. R. Jyothi Prasanna Lecturer in Microbiology Govt College (A) - Rajamahendravaram	
3.	Subject expert : Dr. T. Sujatha, SRR & CVR Government degree College(A), Krishna University , 9440392455, sujatha.taidala@gmail.com	
4.	Subject expert : Dr. K. Aruna, SRR & CVR Government degree College(A), Krishna University , 9490040657, kopuriarunadl@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.	Student Nominee : 1. Kum. Kanta Srilatha 2. Kum. Kodamanchili Hepsiba	

Rajahmundry

Date: 10-08-2026



Chairman

Government college Autonomous Rajahmundry NAAC A ⁺

BOS Meeting 2026-2027

Microbiology

List of paper setters & Examiners

S.No	Name of the lecturer	Papers	College
1	Dr. T. Sujatha, Lecturer in Microbiology		SRR & CVR Government degree College(A), Krishna University , 9440392455, sujatha.taidala@gmail.com
2	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
3	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
4	Smt.T.Sasikala Lecturer in Microbiology	All	ABN College, Kovvuru, 9885861088
5	Dr.K. Aruna Lecturer in Microbiology	All	SRR & CVR Government college, Vijayawada 9490040657, kopuriarunadl@gmail.com
6	Dr. Lalitha Lecturer in Microbiology	All	GDC Dr V S Krishna College (A) VISHAKAPATNAM 9491331865
7	Dr. Pallavi Lecturer in Microbiology	All	GDC ANANTAPUR, 9491233355, pallavi.pavan2003@gmail.com
8	Dr. Vimala Rhode Lecturer in Microbiology	All	Silver Jubilee college, GDC KURNOOL, 9030856521, microbiology@sjgckurnool.edu.in
9	Dr.CH. Madhavi Lecturer in Microbiology	All	GDC ANATAPUR, 9908658952, chavalimadhulatha@gmail.com
10	DR.CH. Shanti Devi, Lecturer in Microbiology	All	GDC Men Srikakulam, 9052177822, <u>Ch.shanthi123@gmail.com</u>
11	Dr. Maqsood, Lecturer in Microbiology	All	SKR Government degree college, Tilak Naga Gudur, Nellore 9849530338, <u>mdmaqsood.micro@gmail.com</u>
12	P. Aruna Lecturer in Microbiology	All	GDC Guntur WOMEN, <u>patchalaaruna@gmail.com</u>
13	Dr. K.Sucharita Lecturer in Microbiology	All	GDC (W) GUNTUR, 9963180561 sucharitak@gmail.com

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



CHAIRMAN

MEMBERS

1. 
2. 
3. 

CURRICULAR FRAMEWORK B.Sc HONOURS FROM THE A.Y. 2026-27
(Major + Minor with CSP & VI Semester Internship)

1st Year - Semester I

Sl.No	Category	Course No	No. of Hours		Total No. of Hours	No. of Credits		Total No. of Credits
			Theory	Practical		Theory	Practical	
1	Major - Core	I	3	2	5	3	1	4
2	Major - Core	II	3	2	5	3	1	4
4	Minor	0	0	0	0	0	0	0
5	AECC - English	I	4	0	4	3	0	3
6	AECC - MIL (Telugu/Hindi/Sanskrit)	I	4	0	4	3	0	3
7	Multidisciplinary Course	0	0	0	0	0	0	0
8	Skill Enhancement Course (SEC) Intro' to Artificial Intelligence	I	4	2 (Practice)	6	4	0	4
End of Semester I of 1st Year		5	18	6	24	16	2	18

1st Year - Semester II

Sl.No	Category	Course No	No. of Hours		Total No. of Hours	No. of Credits		Total No. of Credits
			Theory	Practical		Theory	Practical	
1	Major - Core	III	3	2	5	3	1	4
2	Major - Core	IV	3	2	5	3	1	4
4	Minor	0	0	0	0	0	0	0
5	English	II	4	0	4	3	0	3
6	MIL(Telugu/Hindi/Sanskrit)	II	4	0	4	3	0	3
7	Multidisciplinary Course	I	2	0	2	2	0	2
8	Skill Enhancement Course (SEC) Application of Artificial Intelligence (Discipline Specific)	II	4	2 (Practice)	6	4	0	4
9	Indian Knowledge System	I	2	0	2	0	0	0
10	Community Service Project (minimum of 80 hours with 1 Credit)						1	
End of Semester II of 1st Year		7	22	6	28	18	3	21

CURRICULAR FRAMEWORK B.Sc HONOURS FROM THE A.Y. 2026-27 (Major + Minor with CSP & VI Semester Internship)								
2nd Year - Semester III								
Sl. No	Category	Course No	No. of Hours		Total No. of Hours	No. of Credits		Total No. of Credits
			Theory	Practical		Theory	Practical	
1	Major - Core	VI	3	2	5	3	1	4
2	Major - Core	VII	3	2	5	3	1	4
3	Major - Core	VIII	3	2	5	3	1	4
4	Minor	I	3	2	5	3	1	4
5	AECC (Creative Writing/Business Writing in English)	III	4	0	4	3	0	3
6	AECC (Creative Writing/Journalistic Writing in MIL-Telugu/Hindi/Sanskrit)	III	4	0	4	3	0	3
7	Multidisciplinary Course	II	2	0	2	2	0	2
8	Skill Enhancement Course (SEC) Design Thinking/Problem Solving / Others	III	2	0	2	2	0	2
End of Semester III of 2nd Year		8	24	8	32	22	4	26
2nd Year - Semester IV								
Sl. No	Category	Course No	No. of Hours		Total No. of Hours	No. of Credits		Total No. of Credits
			Theory	Practical		Theory	Practical	
1	Major - Core	IX	3	2	5	3	1	4
2	Major - Core	X	3	2	5	3	1	4
3	Major - Core	XI	3	2	5	3	1	4
4	Minor	II	3	2	5	3	1	4
	Multidisciplinary Course	IV	2	0	2	2	0	2
7	Skill Enhancement Course (SEC) Design Thinking/Problem Solving / Others	IV	2	0	2	2	0	2
End of Semester IV of 2nd Year		6	16	8	24	16	4	20

CURRICULAR FRAMEWORK B.Sc HONOURS FROM THE A.Y. 2026-27
(Major + Minor with CSP & VI Semester Internship)

3rd Year - Semester V

Sl. No	Category	Course No	No. of Hours		Total No. of Hours	No. of Credits		Total No. of Credits
			Theory	Practical		Theory	Practical	
1	Major - Core	V	3	2	5	3	1	4
2	Major - Elective	XII	3	2	5	3	1	4
3	Major - Elective	XIII	3	2	5	3	1	4
4	Minor	III	3	2	5	3	1	4
5	Minor	IV	3	2	5	3	1	4
6	Environmental Education	I	2	0	2	2	0	2
End of Semester V of 3rd Year		6	17	10	27	17	5	22

3rd Year - Semester VI

Sl. No	Category	Course No	No. of Hours		Total No. of Hours	No. of Credits		Total No. of Credits
			Theory	Practical		Theory	Practical	
1	Major - Elective	XIV	3	2	5	3	1	4
2	Major - Elective	XV	3	2	5	3	1	4
3	Minor	VII	3	2	5	3	1	4
4	Minor	VIII	3	2	5	3	1	4
5	Semester Internship (minimum of 180 hours with 3 Credits)					3		
End of Semester VI of 3rd Year		4	12	8	20	12	7	19

- Credit Framework for 3-year UG Program
- Credits for Major – $11 \times 4 = 44 + 4 \times 4 = 16$.
Total 60 Credits Credits for Minor – $6 \times 4 = 24$ Credits
- Credits for AECC (Languages) – $3 \times 3 = 9$ for Eng + $3 \times 3 = 9$ for MIL.
Total = 18 Credits for Multidisciplinary Courses – $3 \times 2 = 6$ Credits
- Credits for Skill Enhancement Courses – $2 \times 4 = 8$ for AI + 2×2 for others. Total 12 Credits Credits for Value Added Courses – Env.Edn 2 Credits
- Credits for Internships – 4 Credits
- TOTAL CREDITS FOR 3-YEAR UG PROGRAMME – 126 Credits.
- For Mathematics and Statistics, the number of instructional hours shall be five (5) for courses involving problem-solving, and four (4) for courses comprising only theory.

CURRICULAR FRAMEWORK B.Sc HONOURS FROM THE A.Y. 2026-27
(Major + Minor with CSP & VI Semester Internship)

4th - Year - Semester VII

Sl. No	Category	Course No	No. of Hours		Total No. of Hours	No. of Credits		Total No. of Credits
			Theory	Practical		Theory	Practical	
	Major - Core	XII	3	2	5	3	1	4
	Major - Core	XIII	3	2	5	3	1	4
1	Major - Core	XIV	3	2	5	3	1	4
2	Major - Elective	V	3	2	5	3	1	4
	Major - Elective	VI	3	2	5	3	1	4
4	OOTC	I	2		2	2		2
	IKS	I	2		2		Audit Course	
End of Semester VII of 4th Year		7	19	10	29	17	5	22

4th - Year - Semester VIII

Sl. No	Category	Course No	No. of Hours		Total No. of Hours	No. of Credits		Total No. of Credits
			Theory	Practical		Theory	Practical	
	Major - Core	XII	3	2	5	3	1	4
	Major - Core	XIII	3	2	5	3	1	4
1	Major - Core	XIV	3	2	5	3	1	4
2	Major - Elective	V	3	2	5	3	1	4
	Major - Elective	VI	3	2	5	3	1	4
4	OOTC	I	2		2	2		2
	IKS	I	2		2		Audit Course	
End of Semester VIII of 4th Year		7	19	10	29	17	5	22

Curriculum Framework for B.Sc (Honours) from A.Y. 2025-26 Major+Minor with CSP & 6th sem Internship

Semester	Major (4 Cr)			Minor (4 Cr)			AECC (3 Cr)			Multi Disney' (2 Cr)			Skill Enhancement Courses (4Cr/2Cr)			OOTC			(VAC) IKS# Env. Edn* (2 Cr)			Total		
	C	H (T+P)	Cr	C	H (T+P)	Cr	C	H (T+P)	Cr	C	H (T+P)	Cr	C	H (T+P)	Cr	C	H (T+P)	Cr	C	H (T+P)	Cr	C	H (T+P)	Cr
Sem 1	2	6+4	8				2	8	6				1	4+2	4							5	24	18
Sem 2	2	6+4	8				2	8	6	1	2	2	1	4+2	4				1#	2	0	7	28	20
Community Service Project of a minimum of 80 hours with 1 Credits. Student is eligible for Exit Option-1 with the award of Certificate in respective discipline																								1
Sem 3	3	9+6	12	1	3+2	4	2	8	6	1	2	2	1	2	2							8	32	26
Sem 4	3	9+6	12	1	3+2	4				1	2	2	1	2	2							6	24	20
Sem 5	1+ 2	3+2 6+4	12	2	6+4	8													1*	2	2	6	27	22
Sem 6	2	6+4	8	2	6+4	8																4	20	16
Internship/Apprenticeship/OJT a minimum of 180 hours (8 weeks) with 3 Credits. Student is eligible for Exit Option-2 with the award of Degree in respective discipline																								3
	15		60	6		24	6			18	3		6	4		12				1+ 1	2	36		126
Sem 7	3	9+6	12										2	6+4	8	1	2	2	1#	2	0	7	29	22
Sem 8	3	9+6	12										2	6+4	8	1	2	2	1#	2	0	7	29	22
4-YR	21		84	6		24	6			18	3		6	8		28	2		4	4	2	50		170
C	Courses				H	Hours				Cr	Credits				OOTC			Open Online Transdisciplinary						
#	Indian Knowledge Systems - Audit Course										*	Environ Edn												

DEPARTMENT OF MICROBIOLOGY-BOARD OF STUDIES

Programme: B.Sc., Honours in MICROBIOLOGY

COURSE STRUCTURE

NEW SYLLABUS for 2025-28 Batch - MAJOR

Year	Semester	Course	Title of the Course	No. of Hrs/Week	No. of Credits
I	I	1	Introduction to Microbiology and Microbial Diversity	3	3
			Introduction to Microbiology and Microbial Diversity-Practical	2	1
		2	Principles of Bacteriology and Microbial Techniques	3	3
			Principles of Bacteriology and 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	Cell biology and Genetics	3	3
			Cell biology and Genetics-Practical	2	1
		6	Molecular biology and bacterial Genetics	3	3
			Molecular biology and bacterial Genetics-Practical	2	1
		7	r DNA Technology, Bioinformatics and Biostatistics	3	3
			r DNA Technology, Bioinformatics and Biostatistics-Practical	2	1
	IV	8	Basics of Immunology	3	3
			Basics of Immunology-Practical	2	1
		9	Medical Microbiology	3	3
			Medical Microbiology-Practical	2	1
		10	Agricultural Microbiology	3	3
			Agricultural Microbiology-Practical	2	1

OLD SYLLABUS FOR 2024-27 BATCH MAJOR

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 2026-27 AY

COURSE STRUCTURE

Year	Sem	Course	Title	Hr/ week	credits
III	VI	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

BLOOMS TAXONOMY

Bloom's Taxonomy (BT)	Performance Indicator (PI)
BT1 – Remember	PI1.1
BT2 – Understand	PI1.2
BT3 – Apply	PI2.1
BT4 – Analyze	PI2.2
BT5 – Evaluate	PI3.1
BT6 – Create	PI3.2

PROGRAMME LEVEL OUTCOMES (PLO)

Program Level Outcomes (PLOs)
PLO-1: Domain Expertise
1. Acquire comprehensive knowledge and skills
2. Apply knowledge innovatively
3. Address domain-specific issues effectively
PLO-2: Analytical Skills
1. Identify problems
2. Analyze problems
3. Draw logical conclusions
PLO-3: Critical Thinking and Complex Problem Solving
1. Predict and analyze problems
2. Frame hypotheses
3. Investigate and interpret empirical data
4. Plan and execute actions
PLO-4: Modern Tools Usage and Industry Readiness
1. Use technology intelligently
2. Identify goals, objectives, and competencies
3. Access and use authenticated information
PLO-5: Individual and Team Work
1. Work efficiently as an individual
2. Collaborate effectively in diverse teams
3. Prioritize collective goals
PLO-6: Project Management
1. Plan and organize projects
2. Lead teams effectively
3. Develop contingency strategies
PLO-7: Communication and Life Skills
1. Listen, understand, and express ideas effectively
2. Select appropriate communication media

3.	Present information clearly and concisely
PLO-8: Ethics	
1.	Apply ethical principles
2.	Exhibit professional ethics
3.	Ensure ethical practices for societal wellbeing
PLO-9: Lifelong Learning	
1.	Engage in self-directed learning
2.	Adapt to emerging professional demands
3.	Demonstrate inquisitiveness
PLO-10: Social and Environmental Awareness	
1.	Participate in social development
2.	Uphold national values
3.	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

PERFORMANCE INDICATOR

PI Code	Performance Indicator
PI1.1	Recall and define fundamental scientific concepts, principles and terminology.
PI1.2	Explain scientific concepts, theories and biological processes.
PI2.1	Apply microbiological principles to solve basic scientific problems.
PI2.2	Analyze biological data, observations and experimental results.
PI3.1	Evaluate scientific information and interpret results critically.
PI3.2	Design or develop solutions to biological or microbiological problems.
PI4.1	Perform laboratory experiments using standard microbiological techniques safely.
PI4.2	Analyze laboratory observations and prepare scientific reports.
PI5.1	Use modern laboratory instruments and computational tools effectively.

PI Code	Performance Indicator
PI5.2	Apply bioinformatics, statistical and ICT tools in biological studies.
PI6.1	Recognize ethical, environmental and societal responsibilities in microbiology.
PI6.2	Apply biosafety and biosecurity principles in laboratory and industrial practices.
PI7.1	Demonstrate effective written scientific communication.
PI7.2	Demonstrate effective oral presentation and interpersonal communication skills.
PI8.1	Work effectively as an individual and as a member of a multidisciplinary team.
PI8.2	Demonstrate leadership and professional responsibility.
PI9.1	Apply entrepreneurial skills and innovation in microbiology and biotechnology.
PI9.2	Demonstrate lifelong learning and professional development.

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).

3.3 Economic 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
10. Jain, A., Agarwal, J., & Venkatesh, V. (2019). *Microbiology practical manual* (1st ed.). Elsevier India.
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.

13. Madigan, M. T., Martinko, J. M., Bender, K., Buckley, D., & Stahl, D. (2021). *Brock Biology of Microorganisms* (16th ed.). Pearson Education.
14. Maheshwari, D. K. (2002). *Practical microbiology*. S. Chand Publishing.
15. Mehrotra, R. S., & Aneja, K. R. *An Introduction to Mycology*. New Age International Press, New Delhi.
16. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2009). *Microbiology: Concepts and Applications* (6th ed.). McGraw-Hill Education.
17. Prescott, L. M., Harley, J. P., & Klein, D. A. (2005). *Microbiology* (6th ed.). McGraw-Hill Education.
18. Sambamurty, V. S. S. (2010). *A Textbook of Algae*. I.K. International Publishing House Pvt. Ltd.
19. Tortora, G. J., Funke, B. R., & Case, C. L. (2020). *Microbiology: An Introduction* (13th ed.). Pearson Education.
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	PI
Unit 1	1	Essay on contributions of Louis Pasteur & Alexander Fleming	8	BL2	CLO1	PO1, PO2	1.2
	2	Describe Whittaker's five kingdom classification	8	BL2	CLO1	PO1, PO2	1.2
	3	Differentiate between prokaryotic and eukaryotic microorganisms	8	BL3	CLO1	PO1, PO2	2.1
	4	Write applications of microbiology	8	BL2	CLO1	PO1, PO2	3.1
Unit 2	1	General characteristics of bacteria – occurrence, morphology, reproduction and economic importance	8	BL2	CLO2	PO1, PO2	1.2
	2	General characteristics of Archaea – occurrence, morphology, reproduction and economic importance	8	BL2	CLO2	PO1, PO2	1.2
	3	General characteristics of viruses – morphology and reproduction	8	BL2	CLO2	PO1, PO2	1.2
	4	General features of bacteriophage T2 – structure and multiplication	8	BL3	CLO2	PO1, PO2	2.1
Unit 3	1	General characteristics of algae – morphology, pigments, reproduction and ecological role	8	BL2	CLO3	PO1, PO2, PO5	1.2
	2	Morphology, reproduction and applications of <i>Chlorella</i>	8	BL3	CLO3	PO1, PO2, PO5	2.1
	3	Morphology, reproduction and applications of <i>Spirulina</i>	8	BL3	CLO3	PO1, PO2, PO5	2.1
	4	Economic importance of microalgae	8	BL3	CLO3	PO1, PO2, PO5	3.1
Unit 4	1	Habitat, distribution, nutrition and fungal cell ultrastructure	8	BL2	CLO4	PO1, PO2, PO5	3.1
	2	Outline classification of fungi	8	BL2	CLO4	PO1, PO2, PO5	1.2
	3	Morphology, reproduction and applications of <i>Saccharomyces</i>	8	BL3	CLO4	PO1, PO2, PO5	2.1
	4	Economic importance of fungi in	8	BL3	CLO4	PO1, PO2, PO5	3.1

Unit	Q.No	Question	Marks	BL	CLO	PO	PI
		agriculture, food, industry and medicine				PO5	
Unit 5	1	General characteristics of protozoa – morphology, nutrition and reproduction	8	BL2	CLO5	PO1, PO2, PO5	3.1
	2	Morphology, locomotion and ecological role of <i>Amoeba</i>	8	BL3	CLO5	PO1, PO2, PO5	2.1
	3	Morphology and ecological role of slime molds	8	BL3	CLO5	PO1, PO2, PO5	2.1
	4	Economic importance of protozoa	8	BL3	CLO5	PO1, PO2, PO5	3.1

SHORT QUESTION & ANSWERS – 2M EACH

Unit	Q.N	Short Questions	Marks	Bloom's Level	CO	CLO	PI
I	1	Spontaneous Generation vs Biogenesis	2	BT2	CO1	CLO1	PI1.2
	2	Antonie van Leeuwenhoek	2	BT1	CO1	CLO1	PI1.1
	3	Robert koch	2	BT1	CO1	CLO1	PI1.1
	4	Carlwoes 3 kingdom classification	2	BT2	CO1	CLO1	PI1.2
II	1	HIV	2	BT1	CO2	CLO2	PI1.1
	2	Cultivation of Viruses	2	BT2	CO2	CLO2	PI1.2
	3	Discovery of viruses	2	BT1	CO2	CLO2	PI1.1
	4	Differences b/w Bacteria and Archae	2	BT3	CO2	CLO2	PI2.1
III	1	Algae as Biofertilizer	2	BT2	CO3	CLO3	PI3.1
	2	Algae as Biofuel	2	BT2	CO3	CLO3	PI3.1
	3	Algae in Food industry	2	BT2	CO3	CLO3	PI3.1
	4	Algae in Pharma industry	2	BT2	CO3	CLO3	PI3.1

Unit	Q.N	Short Questions	Marks	Bloom's Level	CO	CLO	PI
IV	1	Aspergillus in Industry	2	BT2	CO4	CLO4	PI3.1
	2	Importance of fungi in food	2	BT2	CO4	CLO4	PI3.1
	3	Importance of fungi in medicine	2	BT2	CO4	CLO4	PI3.1
	4	Importance of fungi in industry	2	BT2	CO4	CLO4	PI3.1
V	1	Protozoa as pathogens	2	BT2	CO5	CLO5	PI3.1
	2	Amoeba	2	BT1	CO5	CLO5	PI1.1
	3	Slime molds	2	BT2	CO5	CLO5	PI1.2
	4	Importance of Protozoa in waste management	2	BT2	CO5	CLO5	PI3.1

SEMESTER-I BLUE PRINT
COURSE 1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY Blue
BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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

COURSE 1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY
MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

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

Q.No	Question	Marks	BL	CLO	PO	PI
1 a.	Describe Whittaker's five kingdom classification	8	BL2	CLO1	PO1, PO2	1.2
	(OR)					
b.	Write applications of microbiology	8	BL2	CLO1	PO1, PO2	3.1
2 a.	General characteristics of bacteria – occurrence, morphology, reproduction and economic importance	8	BL2	CLO2	PO1, PO2	1.2
	(OR)					
b.	General characteristics of viruses – morphology and reproduction	8	BL2	CLO2	PO1, PO2	1.2
3 a.	General characteristics of algae – morphology, pigments, reproduction and ecological role	8	BL2	CLO3	PO1, PO2, PO5	1.2
	(OR)					
b.	Economic importance of microalgae	8	BL3	CLO3	PO1, PO2, PO5	3.1
4 a.	Habitat, distribution, nutrition and fungal cell ultrastructure	8	BL2	CLO4	PO1, PO2, PO5	3.1
	(OR)					
b.	Economic importance of fungi in agriculture, food, industry and medicine	8	BL3	CLO4	PO1, PO2, PO5	3.1
5 a.	General characteristics of protozoa – morphology, nutrition and reproduction	8	BL2	CLO5	PO1, PO2,	3.1

Q.No	Question	Marks	BL	CLO	PO	PI
					PO5	
	(OR)					
b.	Economic importance of protozoa	8	BL3	CLO5	PO1, PO2, PO5	3.1

SECTION-B

5 × 2 = 10 Marks

Answer any 5 the following questions.

Q.N	Short Questions	Marks	Bloom's Level	CO	CLO	PI
1	Spontaneous Generation vs Biogenesis	2	BT2	CO1	CLO1	PI1.2
2	Antonie van Leeuwenhoek	2	BT1	CO1	CLO1	PI1.1
3	Discovery of viruses	2	BT1	CO2	CLO2	PI1.1
4	Differences b/w Bacteria and Archae	2	BT3	CO2	CLO2	PI2.1
5	Algae in Food industry	2	BT2	CO3	CLO3	PI3.1
6	Algae in Pharma industry	2	BT2	CO3	CLO3	PI3.1
7	Aspergillus in Industry	2	BT2	CO4	CLO4	PI3.1
8	Amoeba	2	BT1	CO5	CLO5	PI1.1

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 archaeobacteria;
- 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	CLO	PI
I	1	Describe cell size, shape, arrangement, glycocalyx, capsule, flagella, fimbriae and pili	8	BL2	CO1	PO1, PO2	CLO1	PI1.2
	2	Differentiate between eubacteria and archaeobacteria	8	BL3	CO1	PO1, PO2	CLO1	PI2.1
	3	Explain cytoplasmic components – ribosomes, mesosomes, inclusion bodies, nucleoid, plasmids, endospore	8	BL2	CO1	PO1, PO2	CLO1	PI1.2
	4	Essay on effect of antibiotics and enzymes on cell wall	8	BL4	CO1	PO1, PO2	CLO1	PI2.2
II	1	Summarize <i>Anabaena</i>	8	BL2	CO2	PO1, PO2	CLO2	PI1.2
	2	Describe Mycoplasma and gliding bacteria (Myxobacteria)	8	BL2	CO2	PO1, PO2	CLO2	PI1.2
	3	Identify and explain salient features of fermentative bacteria	8	BL3	CO2	PO1, PO2	CLO2	PI2.1
	4	Describe and differentiate extremophiles – methanogens and halobacteria	8	BL3	CO2	PO1, PO2	CLO2	PI2.1
III	1	Explain principle, components, operation, resolution and uses of bright-field microscope	8	BL2	CO3	PO2, PO3	CLO3	PI1.2
	2	Compare bright-field and dark-field microscopy	8	BL4	CO3	PO2, PO3	CLO3	PI2.2
	3	Perform simple and negative staining techniques	8	BL3	CO3	PO2, PO3	CLO3	PI2.1
	4	Demonstrate and interpret Gram staining	8	BL3	CO3	PO2, PO3	CLO3	PI2.1
IV	1	Define sterilization, disinfection, antiseptic, germicide and sanitizer	8	BL1	CO4	PO1	CLO4	PI1.1
	2	Define and classify antimicrobial agents	8	BL1	CO4	PO1	CLO4	PI1.1
	3	Compare physical methods of microbial control	8	BL4	CO4	PO2, PO3, PO4	CLO4	PI2.2

	4	Analyze chemical methods and mode of action of disinfectants	8	BL4	CO4	PO2, PO3, PO4	CLO4	PI2.2
V	1	Perform pure culture isolation	8	BL3	CO5	PO2, PO3	CLO5	PI2.1
	2	Explain methods for maintenance and preservation of cultures	8	BL2	CO5	PO2, PO3, PO4	CLO5	PI1.2
	3	List and identify culture collection centers (MTCC, ATCC, DSMZ)	8	BL1	CO5	PO2	CLO5	PI1.1
	4	Explain and evaluate cultivation of anaerobic bacteria	8	BL4	CO5	PO2, PO3, PO4	CLO5	PI2.2

COURSE 2: PRINCIPLES OF BACTERIOLOGY & MICROBIAL TECHNIQUES

SHORT QUESTION & ANSWER – EACH 2M

Unit	Q.No.	Short Questions	Marks	BL	CO	CLO	PI
I	1	Differences b/w Gram positive and Gram Negative cell wall	2	BT3	CO1	CLO1	PI2.1
	2	Endospore	2	BT1	CO1	CLO1	PI1.1
	3	Protoplasts	2	BT1	CO1	CLO1	PI1.1
	4	Sphaeroplasts	2	BT1	CO1	CLO1	PI1.1
II	1	Purple Bacteria	2	BT1	CO2	CLO2	PI1.1
	2	Green Bacteria	2	BT1	CO2	CLO2	PI1.1
	3	Applications of Fermentative bacteria	2	BT2	CO2	CLO2	PI1.2
	4	Mycoplasmas	2	BT1	CO2	CLO2	PI1.1
III	1	Transmission Electron Microscope (TEM)	2	BT2	CO3	CLO3	PI1.2
	2	Scanning Electron Microscope (SEM)	2	BT2	CO3	CLO3	PI1.2
	3	Spore Staining	2	BT2	CO3	CLO3	PI1.2
	4	Flourescent Microscope	2	BT2	CO3	CLO3	PI1.2

Unit	Q.No.	Short Questions	Marks	BL	CO	CLO	PI
IV	1	Phenols	2	BT2	CO3	CLO3	PI1.2
	2	Alcohols	2	BT1	CO4	CLO4	PI1.1
	3	Fumigants	2	BT1	CO4	CLO4	PI1.1
	4	Halogens	2	BT1	CO4	CLO4	PI1.1
V	1	Serial dilution	2	BT2	CO5	CLO5	PI1.2
	2	Micro manipulator technique	2	BT2	CO5	CLO5	PI1.2
	3	Viable but not culturable bacteria	2	BT2	CO5	CLO5	PI1.2
	4	Enrichment Culture technique.	2	BT2	CO5	CLO5	PI1.2

SEMESTER-I BLUE PRINT
COURSE 2: PRINCIPLES OF BACTERIOLOGY & MICROBIAL TECHNIQUES

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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
COURSE 2: PRINCIPLES OF BACTERIOLOGY & MICROBIAL TECHNIQUES
MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

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

Q.No	Question	Marks	BL	CLO	CO	PI
1a	Describe cell size, shape, arrangement, glycocalyx, capsule, flagella, fimbriae and pili	8	BL2	CLO1	CO1	1.2
	(OR)					
1b	Differentiate between eubacteria and archaeobacteria	8	BL3	CLO1	CO1	2.1
2a	Essay on <i>Anabaena</i>	8	BL2	CLO2	CO2	1.2
	(OR)					
2b	Identify and explain salient features of fermentative bacteria	8	BL3	CLO2	CO2	2.1
	(OR)					
3a	Explain principle, components, operation, resolution and uses of bright-field microscope	8	BL2	CLO3	CO3	1.2
	(OR)					
3b	Perform simple and negative staining techniques	8	BL3	CLO3	CO3	2.1
4a	Define sterilization, disinfection, antiseptic, germicide and sanitizer	8	BL1	CLO4	CO4	1.1
	(OR)					
4b	Explain and compare physical methods of microbial control	8	BL3	CLO4	CO4	2.2
5a	Perform pure culture isolation	8	BL3	CLO5	CO5	2.1
	(OR)					
5b	Explain and evaluate cultivation of anaerobic bacteria	8	BL4	CLO5	CO5	2.2

SECTION-B**5× 2 = 10 Marks****Answer any 5 of the following questions.**

Q.No.	Short Questions	Marks	BL	CO	CLO	PI
1	Protoplasts	2	BT1	CO1	CLO1	PI1.1
2	Sphaeroplasts	2	BT1	CO1	CLO1	PI1.1
3	Purple Bacteria	2	BT1	CO2	CLO2	PI1.1
4	Green Bacteria	2	BT1	CO2	CLO2	PI1.1
5	Scanning Electron Microscope (SEM)	2	BT2	CO3	CLO3	PI1.2
6	Spore Staining	2	BT2	CO3	CLO3	PI1.2
7	Phenols	2	BT2	CO3	CLO3	PI1.2
8	Enrichment Culture technique.	2	BT2	CO5	CLO5	PI1.2

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. 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.

II SEMESTER - BLUEPRINT FOR QUESTION PAPER

COURSE -3: FUNDAMENTALS OF BIOCHEMISTRY AND ANALYTICAL TECHNIQUES

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	5 × 8 = 40	5 × 2 = 10
Total	50 Marks	

SECTION-A

5 × 8 = 40 Marks

Essay 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

COURSE -3: FUNDAMENTALS OF BIOCHEMISTRY AND ANALYTICAL TECHNIQUES

Question Bank

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	General characters and biological significance of carbohydrates.	8	BT1	CO1	CLO1	PI1.1
	2	Write about outline classification of carbohydrates.	8	BT2	CO1	CLO1	PI1.2
	3	Detailed structure and functions of starch and cellulose.	8	BT2	CO1	CLO1	PI1.2
	4	Define reducing and non-reducing sugars. Explain structure and functions of sucrose and lactose.	8	BT3	CO1	CLO1	PI2.1
II	1	Interpret the classification of lipids according to the complexity of the structure.	8	BT2	CO2	CLO2	PI1.2
	2	Write about structure and nomenclature of fatty acids.	8	BT2	CO2	CLO2	PI1.2
	3	Define triglycerides. Illustrate the structure and functions of triglycerides.	8	BT2	CO2	CLO2	PI1.2
	4	What are phospholipids? Explain structure, functions and their role in cell membrane.	8	BT2	CO2	CLO2	PI1.2
III	1	Explain general characters and functions of amino acids.	8	BT3	CO3	CLO3	PI2.1
	2	Discuss the structure and functions of amino acids.	8	BT3	CO3	CLO3	PI2.1
	3	Write a note on classification of amino acids.	8	BT1	CO3	CLO3	PI1.1
	4	Elucidate the structure of proteins.	8	BT2	CO3	CLO3	PI1.2
IV	1	Analyse the structure and types of DNA according to Watson and Crick.	8	BT4	CO4	CLO4	PI2.2
	2	State Chargaff's rule. Explain the forces that stabilize nucleic acid structures.	8	BT2	CO4	CLO4	PI1.2
	3	Give outlines on types and functions of RNA.	8	BT1	CO4	CLO4	PI1.1
	4	Generalise concept and types of vitamins and their role in metabolism.	8	BT3	CO4	CLO4	PI2.1
V	1	Explain principle, instrumentation and applications of UV-Visible spectrophotometer.	8	BT3	CO5	CLO5	PI2.1
	2	Principles and applications of paper	8	BT3	CO5	CLO5	PI2.1

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
		chromatography.					
	3	State principle of centrifugation. Differentiate types of centrifuge.	8	BT3	CO5	CLO5	PI2.1
	4	Explain components, working principle and applications of gel electrophoresis.	8	BT3	CO5	CLO5	PI2.1

SHORT ANSWER

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Monosaccharide	2	BT1	CO1	CLO1	PI1.1
	2	What bond forms between two monosaccharides?	2	BT1	CO1	CLO1	PI1.1
	3	Why can humans digest starch but not cellulose?	2	BT2	CO1	CLO1	PI1.2
	4	What is glycogen, and where is it stored in the body?	2	BT1	CO1	CLO1	PI1.1
II	1	What is the difference between saturated and unsaturated fatty acids?	2	BT2	CO2	CLO2	PI1.2
	2	Why are unsaturated fats usually liquid at room temperature?	2	BT2	CO2	CLO2	PI1.2
	3	What is the main function of triglycerides in the body?	2	BT1	CO2	CLO2	PI1.1
	4	What is the role of phospholipids in cell membranes?	2	BT2	CO2	CLO2	PI1.2
III	1	What is an amino acid?	2	BT1	CO3	CLO3	PI1.1
	2	What is a polypeptide?	2	BT1	CO3	CLO3	PI1.1
	3	What is the secondary structure of a protein?	2	BT2	CO3	CLO3	PI1.2
	4	What determines the shape and function of a protein?	2	BT2	CO3	CLO3	PI1.2
IV	1	What is a nucleotide?	2	BT1	CO4	CLO4	PI1.1
	2	What is the difference between DNA and RNA?	2	BT2	CO4	CLO4	PI1.2
	3	What is complementary base pairing?	2	BT2	CO4	CLO4	PI1.2
	4	What is a gene?	2	BT1	CO4	CLO4	PI1.1
V	1	What is chromatography?	2	BT1	CO5	CLO5	PI1.1
	2	What is ultracentrifugation?	2	BT1	CO5	CLO5	PI1.1
	3	What is isoelectric focusing?	2	BT1	CO5	CLO5	PI1.1
	4	What is agarose gel electrophoresis used for?	2	BT2	CO5	CLO5	PI1.2

SEMESTER-II
COURSE -3: FUNDAMENTALS OF BIOCHEMISTRY AND
ANALYTICAL TECHNIQUES

MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

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

S.No	Question	Marks	Bloom's Level (BT)	CO	CLO	PI
1. A	General characters and biological significance of carbohydrates.	8	BT1	CO1	CLO1	PI1.1
	(OR)					
B	Define reducing and non-reducing sugars. Explain structure and functions of sucrose and lactose.	8	BT3	CO1	CLO1	PI2.1
2. A	Interpret the classification of lipids according to the complexity of the structure.	8	BT2	CO2	CLO2	PI1.2
	(OR)					
B	What are phospholipids? Explain structure, functions and their role in cell membrane.	8	BT2	CO2	CLO2	PI1.2
3.A	Explain general characters and functions of amino acids.	8	BT3	CO3	CLO3	PI2.1
	(OR)					
B.	Elucidate the structure of proteins.	8	BT2	CO3	CLO3	PI1.2
4.A	Analyse the structure and types of DNA according to Watson and Crick.	8	BT4	CO4	CLO4	PI2.2
B	Generalise concept and types of vitamins and their role in metabolism.	8	BT3	CO4	CLO4	PI2.1
5.A	Explain principle, instrumentation and applications of UV-Visible spectrophotometer.	8	BT3	CO5	CLO5	PI2.1
B	Explain components, working principle and applications of gel electrophoresis.	8	BT3	CO5	CLO5	PI2.1

SECTION-B**5 × 2 = 10 Marks****Answer any 5 of the following questions.**

S.No	Question	Marks	(BT)	CO	CLO	PI
1	Monosaccharide	2	BT1	CO1	CLO1	PI1.1
2	What is glycogen, and where is it stored in the body?	2	BT1	CO1	CLO1	PI1.1
3	What is the difference between saturated and unsaturated fatty acids?	2	BT2	CO2	CLO2	PI1.2
4	Why are unsaturated fats usually liquid at room temperature?	2	BT2	CO2	CLO2	PI1.2
5	What is an amino acid?	2	BT1	CO3	CLO3	PI1.1
6	What is a polypeptide?	2	BT1	CO3	CLO3	PI1.1
7	What is a gene?	2	BT1	CO4	CLO4	PI1.1
8	What is chromatography?	2	BT1	CO5	CLO5	PI1.1

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

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

II SEMESTER

COURSE 4: MICROBIAL PHYSIOLOGY BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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

COURSE 4: MICROBIAL PHYSIOLOGY

QUESTION BANK-ESSAY QUESTIONS FOR 8 MARKS

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Explain nutritional requirements of microorganisms.	8	BT2	CO1	CLO1	PI1.2
	2	Describe nutritional groups of microorganisms based on carbon, energy and electron sources.	8	BT2	CO1	CLO1	PI1.2
	3	Explain primary and secondary active transport, uniport, symport and antiport.	8	BT2	CO1	CLO1	PI1.2
	4	Explain growth media – synthetic, nonsynthetic, selective, enrichment and differential media.	8	BT2	CO1	CLO1	PI1.2
II	1	Explain different phases of growth in batch cultures.	8	BT2	CO2	CLO2	PI1.2
	2	Describe synchronous, continuous and biphasic growth.	8	BT2	CO2	CLO2	PI1.2
	3	Write notes on factors influencing microbial growth.	8	BT2	CO2	CLO2	PI1.2
	4	Describe methods for measuring microbial growth – microscopy, viable count, turbidometry and biomass.	8	BT3	CO2	CLO2	PI2.1
III	1	Essay on properties of enzymes.	8	BT2	CO3	CLO3	PI1.2
	2	Outline classification and nomenclature of enzymes.	8	BT2	CO3	CLO3	PI1.2
	3	Mechanism of enzyme action – Lock and Key and Induced Fit hypothesis.	8	BT3	CO3	CLO3	PI2.1
	4	Factors affecting enzyme activity.	8	BT3	CO3	CLO3	PI2.1
IV	1	Explain glycolytic pathway and its significance.	8	BT3	CO4	CLO4	PI2.1
	2	Anaerobic respiration with reference to oxidation of sulphur.	8	BT3	CO4	CLO4	PI2.1
	3	Fermentative modes in microorganisms – alcoholic fermentation.	8	BT3	CO4	CLO4	PI2.1

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
	4	Fermentative modes in microorganisms – lactic acid fermentation.	8	BT3	CO4	CLO4	PI2.1
V	1	Explain photosynthetic pigments in prokaryotes.	8	BT2	CO5	CLO5	PI1.2
	2	Explain photosynthetic apparatus in prokaryotes.	8	BT2	CO5	CLO5	PI1.2
	3	Outline oxygenic photosynthesis in bacteria.	8	BT3	CO5	CLO5	PI2.1
	4	Outline anoxygenic photosynthesis in bacteria.	8	BT3	CO5	CLO5	PI2.1

Short Answers

Unit	S.No	Question	Marks	Bloom's Level (BT)	CO	CLO	PI
I	1	Autotrophs	2	BT1	CO1	CLO1	PI1.1
	2	Active Transport	2	BT1	CO1	CLO1	PI1.1
	3	Synthetic Media	2	BT1	CO1	CLO1	PI1.1
	4	Heterotrophs	2	BT1	CO1	CLO1	PI1.1
II	1	Microbial Growth	2	BT1	CO2	CLO2	PI1.1
	2	Phases of Microbial Growth	2	BT2	CO2	CLO2	PI1.2
	3	Direct Microscopy Method	2	BT2	CO2	CLO2	PI1.2
	4	Viable Count Method	2	BT2	CO2	CLO2	PI1.2
III	1	Enzyme	2	BT1	CO3	CLO3	PI1.1
	2	Coenzyme	2	BT1	CO3	CLO3	PI1.1
	3	Lock & Key Hypothesis	2	BT2	CO3	CLO3	PI1.2
	4	Competitive Inhibition	2	BT2	CO3	CLO3	PI1.2
IV	1	Glycolysis	2	BT1	CO4	CLO4	PI1.1
	2	Aerobic Respiration	2	BT1	CO4	CLO4	PI1.1
	3	Anaerobic Respiration	2	BT1	CO4	CLO4	PI1.1
	4	Fermentation	2	BT2	CO4	CLO4	PI1.2
V	1	Photosynthetic Pigments	2	BT1	CO5	CLO5	PI1.1
	2	Photosynthetic Apparatus in Prokaryotes	2	BT2	CO5	CLO5	PI1.2
	3	Oxygenic Photosynthesis	2	BT2	CO5	CLO5	PI1.2
	4	Anoxygenic Photosynthesis	2	BT2	CO5	CLO5	PI1.2

SEMESTER-II
COURSE 4: MICROBIAL PHYSIOLOGY
MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

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

S.No	Question	Marks	(BT)	CO	CLO	PI
1. a	Explain nutritional requirements of microorganisms.	8	BT2	CO1	CLO1	PI1.2
	(OR)					
b	Explain growth media – synthetic, nonsynthetic, selective, enrichment and differential media.	8	BT2	CO1	CLO1	PI1.2
2.a	Explain different phases of growth in batch cultures.	8	BT2	CO2	CLO2	PI1.2
	(OR)					
b	Write notes on factors influencing microbial growth.	8	BT2	CO2	CLO2	PI1.2
3.a	Outline classification and nomenclature of enzymes.	8	BT2	CO3	CLO3	PI1.2
	(OR)					
b	Factors affecting enzyme activity.	8	BT3	CO3	CLO3	PI2.1
4.a	Explain glycolytic pathway and its significance.	8	BT3	CO4	CLO4	PI2.1
	(OR)					
b	Fermentative modes in microorganisms – lactic acid fermentation.	8	BT3	CO4	CLO4	PI2.1

S.No	Question	Marks	(BT)	CO	CLO	PI
5.a.	Explain photosynthetic pigments in prokaryotes.	8	BT2	CO5	CLO5	PI1.2
	(OR)					
b.	Outline anoxygenic photosynthesis in bacteria.	8	BT3	CO5	CLO5	PI2.1

SECTION-B

5 × 2 = 10 Marks

Answer any 5 of the following questions.

S.No	Question	Marks	Bloom's Level (BT)	CO	CLO	PI
1	Autotrophs	2	BT1	CO1	CLO1	PI1.1
2	Heterotrophs	2	BT1	CO1	CLO1	PI1.1
3	Microbial Growth	2	BT1	CO2	CLO2	PI1.1
4	Viable Count Method	2	BT2	CO2	CLO2	PI1.2
5	Coenzyme	2	BT1	CO3	CLO3	PI1.1
6	Competitive Inhibition	2	BT2	CO3	CLO3	PI1.2
7	Glycolysis	2	BT1	CO4	CLO4	PI1.1
8	Photosynthetic Apparatus in Prokaryotes	2	BT2	CO5	CLO5	PI1.2

III SEMESTER

COURSE 5: CELL BIOLOGY AND GENETICS

Theory Credits: 3

3 hrs/week

Learning Objectives:

1. Explain cell theory, organelles, the cell cycle, and cytoskeleton functions.
2. Describe cell membrane, nuclear envelope, nucleolus, and basics of cancer development.
3. Illustrate protein sorting, signal transduction, apoptosis, and specialized chromosomes.
4. Apply Mendelian genetics, including crosses, inheritance patterns, and allele frequencies.
5. Understand linkage, crossing over, Hardy-Weinberg law, natural selection, genetic drift, and sex determination.

II. Course Outcomes:

On completion of this course students will be able to:

1. Distinguish prokaryotic and eukaryotic cell structures, describe major cell organelles and cytoskeletal elements, and explain the regulation of the cell cycle and mitosis.
2. Understand membrane structure and transport, nuclear organization, and basic concepts of cancer.
3. Learn about cell signaling mechanisms, protein transport pathways, and the regulation of apoptosis.
4. Gain knowledge of Mendelian inheritance and its extensions, including specialized chromosomes, pedigree analysis, multiple alleles, and epistasis.
5. Describe linkage and crossing over, apply population genetics principles, and differentiate modes of sex-linked and extranuclear inheritance.

III. Syllabus of Theory:

Unit 1

09 Hrs

- 1.1 Cell theory and cell organelles (Mitochondria, Chloroplasts, Lysosomes, Glyoxysomes and Peroxisomes, Golgi apparatus and ER).
- 1.2 Prokaryotic cell, eukaryotic cell (plant cell and Animal cell)
- 1.3 Cell cycle and its check points. Mitosis.
- 1.4 Cytoskeleton: Structure and organization. Role of actin, myosin and intermediate filaments, microtubules.

Unit 2

09 Hrs

- 2.1 Structure and functions Cell membrane, proton pumps ($\text{Na}^+ - \text{K}^+$ pump, Ca^{2+} -calmodulin, etc.) and their distribution.
- 2.2 Endocytosis: Phagocytosis, Pinocytosis, Exocytosis.
- 2.3 Nuclear envelope: Structure of nuclear pore complex, nuclear lamina, Nucleolus; Transport across nuclear membrane.
- 2.4 Elementary knowledge of cancer development and causes; Oncogenes and suppressor genes

Unit 3

09 Hrs

- 3.1 Basic structure of cell signalling systems; first messengers and intracellular secondary messengers.
- 3.2 Cell-to-cell signalling: Eukaryotes-endocrine hormone signalling, cytokine signalling; prokaryotes-quorum sensing, bacterial pheromones.
- 3.3 Protein sorting and Transport; Intracellular signal transduction pathways (GPCR, ERK Pathway)
- 3.4 Apoptosis: Programmed Cell Death; Brief note on Stem cells

UNIT 4**09 Hrs**

- 4.1 Mendelian Genetics: Mendel's Laws (Laws of dominance, segregation and Independent assortment).
- 4.2 Deviations from Mendel's laws: Incomplete dominance, co-dominance, epistasis.
- 4.3 Chromosome theory of inheritance: Multiple alleles, lethal alleles

Unit – 5**09 Hrs**

- 5.1 Linkage and Crossing over; Theories of linkage; Significance of Linkage. Crossing over; Types of crossing over and mechanism of crossing over. Difference between linkage and crossing over.
- 5.2 Sex determination; Sex linked inheritance;
- 5.3 Theory of Evolution: Natural selection; Genetic drift.

IV. Co-curricular activities:

- 1. Create 3D models of cell organelles and demonstrate their functions.
- 2. Observe mitosis, cell structures, and apoptosis using prepared slides.
- 3. Solve monohybrid, dihybrid, problems.
- 4. Use interactive software or games to explore linkage, crossing over, and sex-linked inheritance.

Reference Books:

- 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

SEMESTER-III
COURSE 5: CELL BIOLOGY AND GENETICS
Practical

Credits:1

2 hrs/week

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Observe and analyze cell structure, organelles, and cell viability.
2. Examine mitosis, meiosis, and identify cancer cells using microscopy.
3. Apply genetic principles to study linkage, recombination, and gene mapping.

I. Laboratory/Field exercises:

1. Yeast cell counting and Viability
2. Study a representative plant (Chlorella) and animal cell (Amoeba) by microscopy.
3. Study of ultrastructure of cell (Plasma membrane, Nucleus, Nuclear Pore Complex, Chloroplast, Mitochondrion, Golgi bodies, Lysosomes, SER and RER)
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B
5. Mitosis from onion root tips.
6. Meiosis of flower buds.
7. Identification and study of cancer cells by photomicrographs
8. Study of Linkage, recombination using marker-based data from Drosophila.

Life Sciences – Major Programmes - B.Sc

COURSE: 5 CELL BIOLOGY & GENETICS

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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-III
COURSE: 5 CELL BIOLOGY & GENETICS

MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

Answer all the following questions . Draw labelled diagrams wherever necessary

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1.a.	Define Cell Theory. Write an essay on cell organelles.	8	BT4	CO1	CLO1	PI2.2
	b.	Differentiate the prokaryotic and eukaryotic cells.	8	BT2	CO1	CLO1	PI1.2
II	2.a.	Illustrate the structure and functions of cell membrane.	8	BT2	CO2	CLO2	PI1.2
	b.	Write an essay on the nuclear membrane (nuclear envelope). Explain its structure, composition and functions.	8	BT3	CO2	CLO2	PI2.1
III	3.a.	Describe the basic structure of the cell signalling system. Explain the role of first messengers and secondary messengers in cell signalling.	8	BT1	CO3	CLO3	PI1.1
	b.	Give a detailed note on stem cell.	8	BT4	CO3	CLO3	PI2.2
IV	4.a.	Explain in detail about Mendelian Genetics and Mendel's Laws (Law of Dominance, Law of Segregation and Independent Assortment).	8	BT2	CO4	CLO4	PI1.2
	b.	Define multiple alleles and lethal genes. Explain the concept of multiple alleles and lethal genes.	8	BT5	CO4	CLO4	PI3.1
V	5.a.	Define linkage. Explain the theories of linkage along with its significance.	8	BT3	CO5	CLO5	PI2.1
	b.	Explain sex-linked inheritance with suitable examples.	8	BT6	CO5	CLO5	PI3.2

SECTION-B

(5x2=10 Marks)

Answer all the following questions.

S.No	Question	Marks	BT)	CO	CLO	PI
1	Mitosis	2	BT1	CO1	CLO1	PI1.1
2	Glyoxysomes	2	BT1	CO1	CLO1	PI1.1
3	Phagocytosis	2	BT1	CO2	CLO2	PI1.1
4	Exocytosis	2	BT2	CO2	CLO2	PI1.2
5	Quorum Sensing	2	BT1	CO3	CLO3	PI1.1
6	Bacterial Pheromones	2	BT1	CO3	CLO3	PI1.1
7	Limitations of Mendel's Laws	2	BT2	CO4	CLO4	PI1.2
8	Genetic Drift	2	BT2	CO5	CLO5	PI1.2

C5 CELL BIOLOGY & GENETICS
QUESTION BANK- ESSAY QUESTIONS (8 MARKS)

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Define Cell Theory. Write an essay on cell organelles.	8	BT4	CO1	CLO1	PI2.2
	2	Differentiate the prokaryotic and eukaryotic cells.	8	BT2	CO1	CLO1	PI1.2
	3	Explain in detail about Cell cycle and its check points.	8	BT4	CO1	CLO1	PI2.2
	4	Explain in detail about structure and organization of Cytoskeleton.	8	BT5	CO1	CLO1	PI3.1
II	1	Illustrate the structure and functions of cell membrane.	8	BT2	CO2	CLO2	PI1.2
	2	Essay on elementary knowledge of cancer development and its causes.	8	BT4	CO2	CLO2	PI2.2
	3	Explain the role of oncogenes and tumor suppressor genes in the development of cancer.	8	BT5	CO2	CLO2	PI3.1
	4	Write an essay on the nuclear membrane (nuclear envelope). Explain its structure, composition and functions.	8	BT3	CO2	CLO2	PI2.1
III	1	Describe the basic structure of the cell signalling system. Explain the role of first messengers and secondary messengers in cell signalling.	8	BT1	CO3	CLO3	PI1.1
	2	Explain Cell-to-Cell Signalling in Eukaryotes.	8	BT2	CO3	CLO3	PI1.2
	3	Give a detailed note on stem cell.	8	BT4	CO3	CLO3	PI2.2
	4	Explain in detail about Apoptosis (Programmed cell death).	8	BT5	CO3	CLO3	PI3.1
IV	1	Explain in detail about Mendelian Genetics and Mendel's Laws (Law of Dominance, Law of Segregation and Independent Assortment).	8	BT2	CO4	CLO4	PI1.2
	2	Explain the deviations from Mendel's laws of inheritance. Discuss incomplete dominance, co-dominance and epistasis with suitable examples.	8	BT3	CO4	CLO4	PI2.1
	3	Write an essay on the chromosome theory of inheritance. Explain its postulates and significance with suitable diagrams.	8	BT4	CO4	CLO4	PI2.2
	4	Define multiple alleles and lethal genes. Explain the concept of multiple alleles and lethal genes.	8	BT5	CO4	CLO4	PI3.1
V	1	Define linkage. Explain the theories of linkage along with its significance.	8	BT3	CO5	CLO5	PI2.1
	2	Define crossing over. Explain its types and mechanism.	8	BT3	CO5	CLO5	PI2.1
	3	Explain the mechanism of sex determination. Discuss the different types of sex determination with suitable examples.	8	BT4	CO5	CLO5	PI2.2
	4	Explain sex-linked inheritance with suitable examples.	8	BT6	CO5	CLO5	PI3.2

SHORT ANSWERS – 2MARKS

Unit	S.No	Question	Marks	BT)	CO	CLO	PI
I	1	Mitosis	2	BT1	CO1	CLO1	PI1.1
	2	Role of Actin	2	BT1	CO1	CLO1	PI1.1
	3	Cell Theory	2	BT1	CO1	CLO1	PI1.1
	4	Glyoxysomes	2	BT1	CO1	CLO1	PI1.1
II	1	Phagocytosis	2	BT1	CO2	CLO2	PI1.1
	2	Pinocytosis (Cell Drinking)	2	BT1	CO2	CLO2	PI1.1
	3	Exocytosis	2	BT2	CO2	CLO2	PI1.2
	4	Nucleolus	2	BT1	CO2	CLO2	PI1.1
III	1	Quorum Sensing	2	BT1	CO3	CLO3	PI1.1
	2	Bacterial Pheromones	2	BT1	CO3	CLO3	PI1.1
	3	Protein Sorting & Transport	2	BT2	CO3	CLO3	PI1.2
III	4	Intracellular Signal Transduction Pathways	2	BT2	CO3	CLO3	PI1.2
IV	1	Difference between Incomplete Dominance & Co-dominance	2	BT2	CO4	CLO4	PI1.2
	2	Difference between Multiple Alleles & Lethal Genes	2	BT2	CO4	CLO4	PI1.2
	3	Limitations of Mendel's Laws	2	BT2	CO4	CLO4	PI1.2
	4	Significance of Chromosome Theory of Inheritance	2	BT2	CO4	CLO4	PI1.2
V	1	Significance of Linkage	2	BT2	CO5	CLO5	PI1.2
	2	Difference between Linkage and Crossing Over	2	BT2	CO5	CLO5	PI1.2
	3	Natural Selection	2	BT1	CO5	CLO5	PI1.1
	4	Genetic Drift	2	BT2	CO5	CLO5	PI1.2

III SEMESTER

COURSE 6: MOLECULAR BIOLOGY AND BACTERIAL GENETICS

Theory Credits: 3

3 hrs/week

I. Learning Objectives:

1. Explore experiments demonstrating DNA/RNA as genetic material, prokaryotic replication, and plasmids/transposons.
2. Examine gene concepts, structure, and transcription in prokaryotes and eukaryotes.
3. Illustrate translation, genetic code, and bacterial gene regulation.
4. Analyze mutations, their molecular basis, and DNA repair mechanisms.
5. Investigate bacterial recombination through conjugation, transformation, and transduction.

Course Outcomes:

On completion of this course students will be able to:

1. Explain the experiments demonstrating DNA/RNA as genetic material, DNA replication, and plasmids/transposons.
2. Describe gene concepts, structure, and transcription.
3. Illustrate translation and bacterial gene regulation.
4. Classify mutations and summarize DNA repair.
5. Explain bacterial recombination and its applications.

Syllabus of Theory:

Unit - 1: DNA/RNA as genetic material, Replication of DNA

9 Hrs.

- 1.1 DNA and RNA as genetic material (Griffith, Avery-MacLeod-McCarty Experiment, Hershey & Chase) Genome organization in prokaryotes.
- 1.2 Replication of DNA in prokaryotes. Bidirectional and unidirectional replication, Semiconservative Replication: Proof Mechanism.
- 1.3 Extra chromosomal genetic elements: General characters, types and applications of Plasmids and transposons.

Unit - 2: Concept of gene, Transcription

9 Hrs

- 2.1 Classical Concept of gene: Mutton, Recombination and Cistron; One gene-one enzyme, one gene-one polypeptide.
- 2.2 Modern concept of gene: Definition of gene; Open reading frame; Types of genes (structural, Constitutive and regulatory genes; Gene Slicing –concept of introns and exons
- 2.3 Transcription-Definition, mechanism of transcription.

Unit - 3: Translation and regulation of gene expression

9 Hrs.

- 3.1 Genetic code: Salient features, Wobble hypothesis.
- 3.2 Translation- Mechanisms of initiation, elongation and termination of polypeptides. Inhibitors of protein synthesis.
- 3.3 Regulation of gene expression in bacteria – lac operon.

Unit - 4: Mutations and DNA repair

9 Hrs

- 4.1 Mutations: Definition and types of Mutations (Spontaneous and induced, Somatic and germline); Physical and chemical mutagens;

4.2 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.
4.3 Outlines of DNA repair mechanisms: Direct, Excision, Mismatch, Recombination Repair, SOS Repair.

Unit - 5: Genetic recombination in bacteria

9 Hrs

- 5.1 Conjugation- Definition, F-factor, F⁺ & Hfr, mechanism of conjugation, applications of conjugation;
- 5.2 Transformation- Discovery, mechanism of transformation, factors affecting transformation and application of transformation.
- 5.3 Transduction- discovery, mechanism and types of transduction.

Co-curricular activities:

- 1. Prepare and present a poster or model illustrating DNA replication, plasmids, and transposons.
- 2. Perform a simulation or virtual lab on transcription, translation, and bacterial gene regulation.
- 3. Conduct a case study or discussion on mutations, DNA repair, and bacterial recombination, highlighting real-world applications.

Reference 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 Freifelder 1986 Molecular Biology 3rd edition, Jones & Bartlett Publishers
- 4. T.A. Brown, Gene cloning and DNA analysis- An Introduction, 4th edition
- 5. Bernard R. Glick and Jack. J. Pasternak, Molecular Biotechnology. 3rd edition
- 6. David Freifelder. Essentials of molecular biology. Jones and Bartlett Publishers, 1998

SEMESTER-III
COURSE 6: MOLECULAR BIOLOGY AND BACTERIAL GENETICS
Practical

Credits: 1

2 hrs/week

I. Course Outcomes:

On successful completion of this practical course, student shall be able to:

1. Isolate and visualize DNA/RNA and plasmids using electrophoresis micrographs and schematic representations.
2. Solve DNA/RNA, transcription, translation problems and study bacterial mutations.
3. Demonstrate molecular biology equipment like transformation, PCR, and ultracentrifugation.

II. Laboratory/Field exercises:

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

Life Sciences – Major Programmes B.Sc

COURSE 6: - MOLECULAR BIOLOGY AND BACTERIAL GENETICS

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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

COURSE -6: MOLECULAR BIOLOGY AND BACTERIAL GENETICS**Model Question Paper****Time:2.30 Hrs****max. marks:50****Section-A****5X8=40M****Answer all the questions. Draw the labelled diagrams when necessary.**

S.No	Question	Marks	BT	CO	CLO	PI
1.a.	Compare and analyze genome organization in prokaryotes and eukaryotes.	8	BT4	CO1	CLO1	PI2.2
	(OR)					
b.	Discuss and evaluate extra chromosomal genetic elements: general characters, types and applications of plasmids.	8	BT5	CO1	CLO1	PI3.1
2.a.	Describe and justify modern concept of gene.	8	BT5	CO2	CLO2	PI3.1
	(OR)					
b.	Explain in detail about protein synthesis in prokaryotes.	8	BT3	CO2	CLO2	PI2.1
	(OR)					
3.a.	List and recall salient features of genetic code.	8	BT1	CO3	CLO3	PI1.1
b.	Outline and explain the process of translation in prokaryotes.	8	BT2	CO3	CLO3	PI1.2
	(OR)					
4.a.	Define and explain mutations and their types.	8	BT2	CO4	CLO4	PI1.2
b.	Describe and evaluate physical and chemical mutagens.	8	BT5	CO4	CLO4	PI3.1
	(OR)					
5.a.	Explain and apply mechanism of conjugation in bacteria.	8	BT3	CO5	CLO5	PI2.1
	(OR)					
b.	Compare, analyze and evaluate transformation, conjugation and transduction.	8	BT6	CO5	CLO5	PI3.2

Section -B**Answer any five questions only****2X5=10**

S.No	Question	Marks	Unit	Bloom's Level (BT)	CO	CLO	PI
1	Enzymes involved in DNA replication	2	I	BT1	CO1	CLO1	PI1.1
2	Transposons	2	I	BT1	CO1	CLO1	PI1.1
3	Introns and Exons (Split genes)	2	II	BT2	CO2	CLO2	PI1.2
4	RNA Splicing	2	II	BT2	CO2	CLO2	PI1.2
5	Translation	2	III	BT2	CO3	CLO3	PI1.2
6	Lac operon regulation in bacteria	2	III	BT2	CO3	CLO3	PI1.2
7	DNA Repair Mechanisms	2	IV	BT2	CO4	CLO4	PI1.2
8	Applications of Conjugation	2	V	BT2	CO5	CLO5	PI1.2

COURSE -6: MOLECULAR BIOLOGY AND BACTERIAL GENETICS

QUESTION BANK- ESSAY QUESTIONS

Unit	S.No	Question	Marks	BT	CO	CLO	PI
I	1	Compare and analyze genome organization in prokaryotes and eukaryotes.	8	BT4	CO1	CLO1	PI2.2
	2	Explain and illustrate bidirectional and unidirectional replication.	8	BT2	CO1	CLO1	PI1.2
	3	Describe and interpret proof of semiconservative replication (Meselson–Stahl Experiment).	8	BT4	CO1	CLO1	PI2.2
	4	Discuss and evaluate extra chromosomal genetic elements: general characters, types and applications of plasmids.	8	BT5	CO1	CLO1	PI3.1
II	1	Explain and classify classical concept of gene – muton, recon and cistron.	8	BT2	CO2	CLO2	PI1.2
	2	Discuss and analyze one gene–one enzyme, one gene–one polypeptide and one gene–one product hypotheses.	8	BT4	CO2	CLO2	PI2.2
	3	Describe and justify modern concept of gene.	8	BT5	CO2	CLO2	PI3.1
	4	Explain in detail about protein synthesis in prokaryotes.	8	BT3	CO2	CLO2	PI2.1
III	1	List and recall salient features of genetic code.	8	BT1	CO3	CLO3	PI1.1
	2	Outline and explain the process of translation in prokaryotes.	8	BT2	CO3	CLO3	PI1.2
	3	Explain and analyze inhibitors of protein synthesis.	8	BT4	CO3	CLO3	PI2.2
	4	Evaluate and justify gene expression in <i>Escherichia coli</i> using lac operon concept.	8	BT5	CO3	CLO3	PI3.1
IV	1	Define and explain mutations and their types.	8	BT2	CO4	CLO4	PI1.2
IV	2	Demonstrate and apply molecular basis of mutations.	8	BT3	CO4	CLO4	PI2.1
	3	Outline and analyze different DNA repair mechanisms.	8	BT4	CO4	CLO4	PI2.2
	4	Describe and evaluate physical and chemical mutagens.	8	BT5	CO4	CLO4	PI3.1
V	1	Explain and apply mechanism of conjugation in bacteria.	8	BT3	CO5	CLO5	PI2.1
	2	Explain and illustrate mechanism of transformation.	8	BT3	CO5	CLO5	PI2.1
	3	Define, discuss and analyze transduction and its types.	8	BT4	CO5	CLO5	PI2.2
	4	Compare, analyze and evaluate transformation, conjugation and transduction.	8	BT6	CO5	CLO5	PI3.2

SHORT ANSWERS

Unit	S.No	Question	Marks	Bloom's Level (BT)	CO	CLO	PI
I	1	Experimental evidences that DNA is genetic material	2	BT2	CO1	CLO1	PI1.2
	2	RNA as genetic material	2	BT2	CO1	CLO1	PI1.2
	3	Enzymes involved in DNA replication	2	BT1	CO1	CLO1	PI1.1
	4	Transposons	2	BT1	CO1	CLO1	PI1.1
II	1	Muton, Recon and Cistron	2	BT1	CO2	CLO2	PI1.1
	2	One gene–one enzyme, one gene–one polypeptide	2	BT2	CO2	CLO2	PI1.2
	3	Introns and Exons (Split genes)	2	BT2	CO2	CLO2	PI1.2
	4	RNA Splicing	2	BT2	CO2	CLO2	PI1.2
III	1	Genetic Code	2	BT1	CO3	CLO3	PI1.1
	2	Wobble Hypothesis	2	BT2	CO3	CLO3	PI1.2
	3	Translation	2	BT2	CO3	CLO3	PI1.2
	4	Lac operon regulation in bacteria	2	BT2	CO3	CLO3	PI1.2
IV	1	Physical and Chemical Mutagens	2	BT1	CO4	CLO4	PI1.1
	2	Molecular Basis of Mutations	2	BT2	CO4	CLO4	PI1.2
	3	Functional Mutants	2	BT1	CO4	CLO4	PI1.1
	4	DNA Repair Mechanisms	2	BT2	CO4	CLO4	PI1.2
V	1	Conjugation Mechanism	2	BT2	CO5	CLO5	PI1.2
	2	Applications of Conjugation	2	BT2	CO5	CLO5	PI1.2
	3	Transformation in Bacteria	2	BT2	CO5	CLO5	PI1.2
	4	Factors Affecting Transformation	2	BT2	CO5	CLO5	PI1.2

SEMESTER-III
COURSE 7: r-DNA TECHNOLOGY, BIOINFORMATICS AND
BIostatISTICS

Theory Credits: 3

3 hrs/week

1. Learning Objectives:

1. To learn principles, tools, and vectors used in gene cloning.
2. To understand blotting, DNA sequencing, PCR, and RFLP techniques.
3. To impart knowledge about gene libraries, recombinant DNA applications, and intellectual property rights.
4. To explore bioinformatic databases, tools, sequence alignment, and ChIP.
5. To understand measures of central tendency, dispersion, and data presentation.

2. Course Outcomes:

On completion of this course students will be able to:

1. Explain the fundamental principles and tools of genetic engineering, including gene cloning steps, vectors, and DNA transformation methods.
2. Outline genomic techniques and explain major applications of recombinant DNA technology in various fields.
3. Describe key genetic engineering techniques and recognize the importance of intellectual property rights in biotechnology.
4. Utilize major bioinformatics databases and tools for sequence retrieval, alignment, and analysis.
5. Apply basic biostatistical methods for data analysis and effectively use statistical software for biological data interpretation.

3. Syllabus of Theory:

UNIT- 1: Gene cloning- Tools and techniques

9 Hrs.

- 1.1 Steps in gene cloning.
- 1.2 Cloning tools: Restriction endonucleases Type II, DNA polymerases, ligases, Exonucleases, DNase, polynucleotide kinase, Alkaline phosphatase; Use of linkers and adaptors.
- 1.3 Cloning Vectors: Plasmid (PBR 322), Bacteriophages, Cosmid, BAC, YAC, Expression vector- E.coli lac promoter-based vector.
- 1.4 Brief account on transformation of DNA (Chemical method, Electroporation).

UNIT- 2: Techniques in genetic engineering

9 Hrs.

- 2.1 Blotting Techniques: Southern, Northern and Western blotting techniques
- 2.2 DNA Sequencing-Sanger's method
- 2.3 Basics of Polymerase chain Reaction; RFLP.

UNIT- 3: Gene libraries, Applications of r-DNA technology and IPR 9 Hrs.

- 3.1 Genomic and c-DNA Libraries: Preparation and uses
- 3.2 Application of genetic engineering in industry, agriculture and medicine, Hybridoma Technology.
 1. Outlines of Intellectual property Rights: Patents, Trademark, Copyright.

UNIT- 4: Bioinformatics

9 Hrs

- 4.1. Bioinformatic resources: NCBI, EMBL, DDBJ, PUBMED, BIOMED.

4.2 Sequence Databases – GENBANK, BLAST, FASTA, ExPasy, PDB, NDB, UNIPROT – SWISS PROT.

4.3 Sequence alignment – Sequence homology, pairwise sequence alignment, automated DNA sequencing, ChIP.

UNIT- 5: Biostatistics

9 Hrs

5.1 Measurement of central tendency: Mean, Median, Mode.

5.2 Measurement of dispersion: Standard Deviation, Standard error, t-test and Chi square test

5.3 Sample and population: Types of Data, methods of Data presentation.

5.4 Use of Biostatistics software: IBM- SPSS or Minitab

IV. Co-curricular activities:

1. Create a model or poster showing cloning steps and vectors.

2. Demonstrate PCR or virtual blotting techniques in a workshop.

3. Prepare a chart/poster on r-DNA applications and IPR concepts.

4. Hands-on session using BLAST or GenBank for sequence analysis.

V. Reference Books:

1. Brown, T. A. (2010). Gene Cloning and DNA Analysis (6th ed.). Blackwell Publishing, Oxford, UK.

2. Campbell, A. M., & Heyer, L. J. (2006). Discovering Genomics, Proteomics and Bioinformatics (2nd ed.). Benjamin Cummings.

3. Clark, D. P., & Pazdernik, N. J. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA.

4. Ghosh, Z., & Bibekanand, M. (2008). Bioinformatics: Principles and Applications. Oxford University Press.

5. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular Biotechnology (4th ed.). ASM Press.

6. Gupta, P. K. (2009). Elements of Biotechnology (2nd ed.). Rastogi Publications.

7. Pevsner, J. (2009). Bioinformatics and Functional Genomics (2nd ed.). Wiley-Blackwell.

8. Primrose, S. B., & Twyman, R. M. (2008). Genomics: Applications in Human Biology. Blackwell Publishing, Oxford, UK.

9. Ratledge, C., & Kristiansen, B. (2001). Basic Biotechnology (2nd ed.). Cambridge University Press.

10. Sambrook, J., & Russell, D. (2001). Molecular Cloning: A Laboratory Manual (3rd ed.). Cold Spring Harbor Laboratory Press.

11. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.

SEMESTER-III
COURSE 7: r-DNA TECHNOLOGY, BIOINFORMATICS AND
BIOSTATISTICS

Practical Credits: 1

2 hrs/week

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Isolate, digest, ligate, and amplify DNA using standard molecular biology techniques.
2. Analyse DNA fragments, interpret sequencing data, and perform RFLP analysis.
3. Retrieve and align sequences using bioinformatics tools like BLAST and Clustal W.

II. Laboratory/Field exercises:

1. Isolation of plasmid DNA by Agarose gel Electrophoresis.
2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
3. Ligation of DNA fragments by using T4 DNA Ligase.
4. Amplification of DNA by PCR
5. Demonstrate RFLP
6. Interpretation of sequencing gel electropherograms.
7. Introduction to bioinformatics databases: NCBI, EMBL
8. Sequence retrieval using BLAST.
9. Sequence alignment using clustal W.

III SEMESTER

COURSE 7: r DNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

5 × 8 = 40 Marks

Essay questions. Draw labelled diagrams wherever necessary.

14. (a) or (b)
15. (a) or (b)
16. (a) or (b)
17. (a) or (b)
18. (a) or (b)

SECTION-B

5 × 2 = 10 Marks

Answer Any 5 of the following questions.

19. From Unit-1
20. From Unit-1
21. From Unit-2
22. From Unit-2
23. From Unit-3
24. From Unit-3
25. From Unit-4
26. From Unit-5

IV SEMESTER -COURSE 7
rDNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

QUESTION BANK

Unit	S.No	Question	Marks	BT	CO	CLO	PI
I	1	What is Gene Cloning? What are the steps involved in Gene Cloning?	8	BT4	CO1	CLO1	PI2.2
	2	Explain about various cloning tools used in Gene Cloning method.	8	BT2	CO1	CLO1	PI1.2
	3	Give a brief account on transformation of DNA (Chemical method, Electroporation).	8	BT4	CO1	CLO1	PI2.2
	4	Explain in detail about types of cloning vectors—plasmids, cosmids, bacteriophages, BAC and YAC.	8	BT5	CO1	CLO1	PI3.1
II	1	Explain about blotting techniques and state their applications.	8	BT2	CO2	CLO2	PI1.2
	2	Explain PCR technique and the steps involved in PCR.	8	BT4	CO2	CLO2	PI2.2
	3	Explain in detail about DNA sequencing – Sanger's method.	8	BT5	CO2	CLO2	PI3.1
	4	Explain in detail about RFLP.	8	BT3	CO2	CLO2	PI2.1
III	1	Explain Hybridoma technique and the steps involved in Hybridoma technique.	8	BT1	CO3	CLO3	PI1.1
	2	What are Intellectual Property Rights (IPR)? Explain its types.	8	BT2	CO3	CLO3	PI1.2
	3	Explain about various applications of Genetic Engineering.	8	BT4	CO3	CLO3	PI2.2
	4	Differentiate between patents, trademarks and copyrights.	8	BT5	CO3	CLO3	PI3.1
IV	1	Explain about BLAST. Mention its applications in Bioinformatics.	8	BT2	CO4	CLO4	PI1.2
	2	Explain GenBank as a Bioinformatics database.	8	BT3	CO4	CLO4	PI2.1
	3	Validate the importance of NCBI and PubMed as Bioinformatics resources.	8	BT4	CO4	CLO4	PI2.2
	4	Explain about FASTA. Mention its applications in Bioinformatics.	8	BT5	CO4	CLO4	PI3.1
V	1	Define mean, median and mode with suitable examples.	8	BT3	CO5	CLO5	PI2.1
	2	Explain various methods of data presentation.	8	BT3	CO5	CLO5	PI2.1
	3	Explain about the uses of Biostatistics	8	BT4	CO5	CLO5	PI2.2

Unit	S.No	Question	Marks	BT	CO	CLO	PI
		software.					
	4	Differentiate between sample and population.	8	BT6	CO5	CLO5	PI3.2

Short Questions

Unit	S.No	Question	Marks	BT	CO	CLO	PI
I	1	Use of Linkers and Adaptors	2	BT1	CO1	CLO1	PI1.1
	2	Cosmids	2	BT1	CO1	CLO1	PI1.1
	3	Exonucleases	2	BT1	CO1	CLO1	PI1.1
	4	Bacteriophages	2	BT1	CO1	CLO1	PI1.1
II	1	RFLP	2	BT1	CO2	CLO2	PI1.1
	2	Restriction Enzymes	2	BT1	CO2	CLO2	PI1.1
	3	Applications of PCR	2	BT2	CO2	CLO2	PI1.2
	4	Blotting Technique	2	BT2	CO2	CLO2	PI1.2
III	1	c-DNA Library	2	BT1	CO3	CLO3	PI1.1
	2	Genomic Library	2	BT1	CO3	CLO3	PI1.1
	3	Patent	2	BT1	CO3	CLO3	PI1.1
	4	Trade Secret	2	BT1	CO3	CLO3	PI1.1
IV	1	Sequence Databases	2	BT1	CO4	CLO4	PI1.1
	2	Sequence Alignment	2	BT2	CO4	CLO4	PI1.2
	3	Gene Bank	2	BT1	CO4	CLO4	PI1.1
	4	UNIPROT–SWISS PROT	2	BT1	CO4	CLO4	PI1.1
V	1	Standard Deviation	2	BT1	CO5	CLO5	PI1.1
	2	Standard Error	2	BT2	CO5	CLO5	PI1.2
	3	Chi-square Test	2	BT2	CO5	CLO5	PI1.2
	4	Biostatistics	2	BT1	CO5	CLO5	PI1.1

SEMESTER-III
C 7 rDNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

Answer all the following questions . Draw labelled diagrams wherever necessary

S.No	Question	Marks	BT	CO	CLO	PI
1.a.	What is Gene Cloning? What are the steps involved in Gene Cloning?	8	BT4	CO1	CLO1	PI2.2
	(OR)					
b.	Give a brief account on transformation of DNA (Chemical method, Electroporation).	8	BT4	CO1	CLO1	PI2.2
2.a.	Explain PCR technique and the steps involved in PCR.	8	BT4	CO2	CLO2	PI2.2
	(OR)					
b.	Explain in detail about DNA sequencing – Sanger's method.	8	BT5	CO2	CLO2	PI3.1
	(OR)					
3.a.	What are Intellectual Property Rights (IPR)? Explain its types.	8	BT1	CO3	CLO3	PI1.1
	(OR)					
b.	Explain about various applications of Genetic Engineering.	8	BT4	CO3	CLO3	PI2.2
4.a.	Explain about BLAST. Mention its applications in Bioinformatics.	8	BT2	CO4	CLO4	PI1.2
	(OR)					
b.	Explain GenBank as a Bioinformatics database.	8	BT3	CO4	CLO4	PI2.1
	(OR)					
5.a.	Define mean, median and mode with suitable examples.	8	BT3	CO5	CLO5	PI2.1
	(OR)					
b.	Differentiate between sample and population.	8	BT6	CO5	CLO5	PI3.2

Section -B
Answer any FIVE only from the following (5x2=10)

S.No	Question	Marks	Unit	BT	CO	CLO	PI
1	Cosmids	2	I	BT1	CO1	CLO1	PI1.1
2	Bacteriophages	2	I	BT1	CO1	CLO1	PI1.1
3	RFLP	2	II	BT1	CO2	CLO2	PI1.1
4	Restriction Enzymes	2	II	BT1	CO2	CLO2	PI1.1
5	c-DNA Library	2	III	BT1	CO3	CLO3	PI1.1
6	Genomic Library	2	III	BT1	CO3	CLO3	PI1.1
7	Sequence Databases	2	IV	BT1	CO4	CLO4	PI1.1
8	Biostatistics	2	V	BT1	CO5	CLO5	PI1.1

SEMESTER-IV

COURSE 8: BASICS OF IMMUNOLOGY

Theory: Credits: 3

3 hrs/week

I. Learning Objectives:

1. Outline the basics of immunity, immune cells, and organs.
2. Describe properties, types, and interactions of antigens and antibodies.
3. Illustrate primary and secondary immune responses through cell-mediated and humoral pathways.
4. Classify hypersensitivity, autoimmune, and immunodeficiency disorders.
5. Evaluate vaccination principles, immunological diagnostic techniques, and monoclonal antibody production.

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

1. Differentiate innate and adaptive immunity, major immune cells, and lymphoid organs.
2. Describe antigens, antibody classes and structures, and antigen-antibody interactions.
3. Illustrate MHC function, T and B cell activation, and effector mechanisms of CTLs, NK cells, antibodies, and complement.
4. Categorize hypersensitivity reactions and summarize autoimmune and immunodeficiency diseases.
5. Distinguish types of vaccines, implement immunological techniques, and assess applications of monoclonal antibodies.

III. Syllabus of Theory:

Unit 1: Introduction to Immunology:

9 Hrs

1.1. Definition, Contributions of the scientists – Edward Jenner, Karl Landsteiner, Elie Metchnikoff, MacFarlane Burnet, Neils K Jerne and Susumu Tonegawa.

Types of Immunity: Innate and acquired Immunity.

1.2 Cells of the Immune System: Structure and functions of Macrophages, Neutrophils, Basophils

and Eosinophils, Lymphocytes (B cells, T cells, NK cells), Dendritic Cells.

1.3 Organs of the Immune System: Primary (Bone marrow, Thymus, bursa fabricius) and Secondary (Lymph nodes, Spleen and lymphoid tissues) Lymphoid organs.

Unit 2: Antigens and Antibodies

9Hrs

2.1 Antigens: Definition, Types (Exogenous, Endogenous, Autoantigens), Characteristics (Foreignness, Molecular size, Heterogeneity and solubility); Haptens, Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

2.2 Antibodies (Immunoglobulins): Basic structure (Heavy and Light Chains, Fab and Fc regions); Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); Classes Of Immunoglobulins (IgG, IgM, IgA, IgE, IgD)

2.3 Antigen-Antibody Interaction: Specificity, Avidity, Affinity; Functions of Antibodies: Immune complex formation and elimination -Agglutination, Precipitation, Neutralisation; Complement fixation, Phagocytosis

Unit 3: Generation of Immune Response

9 Hrs

3.1 Primary and Secondary Immune Response; concept on Major Histocompatibility Complex.
3.2 Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co-stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance
3.2 Humoral Immunity: Generation of Humoral Immune Response (Plasma and Memory cells)
Complement System in brief: Components and functions of complement (lysis, opsonization, and inflammation)

Unit 4: Hypersensitivity and Immunological Disorders

9 Hrs

4.1 Hypersensitivity Reactions (Gell and Coombs Classification):
4.2 Autoimmune Disorders: Rheumatoid Arthritis, Systemic Lupus Erythematosus
4.3 Immunodeficiency Disorders: Primary (e.g., SCID) and Secondary (e.g., AIDS) immunodeficiencies

Unit 5: Vaccines and Immunotechnology

9 Hrs

5.1 Principles of Vaccination: Active vs Passive Immunization; Types of Vaccines (Live Attenuated, Inactivated, Subunit, mRNA-based); Adjuvants in Vaccines
5.2 Diagnostic Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, ELISA, Immunofluorescence.
5.3 Monoclonal Antibodies: Production (Hybridoma technology); Applications in diagnostics And Therapy.

IV. Co-curricular activities:

1. Participate in quizzes or debates on vaccines, autoimmune diseases, or emerging immunology topics.
2. Create 3D models or posters of immune cells, antigen-antibody interactions, or hypersensitivity mechanisms.
3. Visit a diagnostic lab or vaccine research center, or attend a guest lecture by an immunologist.

V. Reference Books:

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2007). Cellular and Molecular Immunology (6th ed.). Saunders Publication, Philadelphia.
2. Delves, P., Martin, S., Burton, D., & Roitt, I. M. (2006). Roitt's Essential Immunology (11th ed.). Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby, R. A., Kindt, T. J., & Osborne, B. A. (2007). Kuby's Immunology (6th ed.). W.H. Freeman and Company, New York.
4. Murphy, K., Travers, P., & Walport, M. (2008). Janeway's Immunobiology (7th ed.). Garland Science Publishers, New York.
5. Peakman, M., & Vergani, D. (2009). Basic and Clinical Immunology (2nd ed.). Churchill Livingstone Publishers, Edinburgh.
6. Richard, C., & Geoffrey, S. (2009). Immunology (6th ed.). Wiley-Blackwell Publication.

SEMESTER-IV

COURSE 8: BASICS OF IMMUNOLOGY

Practical Credits: 1

2 hrs/week

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Identify human blood groups and perform serum separation.
2. Conduct total and differential leukocyte counts.
3. Apply immunological techniques such as immunodiffusion and DOT-ELISA.

II. Laboratory/Field exercises:

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum from the blood sample (demonstration).
5. Perform immunodiffusion by RID/ Ouchterlony method.
6. Perform Dot ELISA.

IV SEMESTER

COURSE 8: BASICS OF IMMUNOLOGY

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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

COURSE 8: BASICS OF IMMUNOLOGY

Essay type questions

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Explain Innate Immunity.	8	BT2	CO1	CLO1	PI1.2
	2	Explain Adaptive Immunity and differentiate active and passive immunity.	8	BT2	CO1	CLO1	PI1.2
	3	Explain and classify Primary and Secondary Lymphoid Organs.	8	BT2	CO1	CLO1	PI1.2
	4	Explain and classify the Cells of the Immune System.	8	BT2	CO1	CLO1	PI1.2
II	1	Define and evaluate the characteristics of antigens and haptens.	8	BT2	CO2	CLO2	PI1.2
	2	With a neatly labelled diagram, illustrate the structure of antibodies.	8	BT2	CO2	CLO2	PI1.2
	3	Classify and describe the types of antibodies.	8	BT2	CO2	CLO2	PI1.2
	4	Explain functions of antibodies: agglutination, precipitation, neutralisation, complement fixation and phagocytosis.	8	BT2	CO2	CLO2	PI1.2
III	1	Compare the Primary and Secondary Immune Responses with suitable examples.	8	BT4	CO3	CLO3	PI2.2
	2	Explain the concept of the Major Histocompatibility Complex (MHC) and differentiate between MHC Class I and MHC Class II.	8	BT4	CO3	CLO3	PI2.2
	3	Illustrate the Cell-Mediated Immune Response with a neat diagram.	8	BT2	CO3	CLO3	PI1.2
	4	Describe the generation of the Humoral Immune Response with suitable examples.	8	BT2	CO3	CLO3	PI1.2
IV	1	Classify the hypersensitivity reactions according to the Gell & Coombs classification.	8	BT3	CO4	CLO4	PI2.1
	2	Compare Rheumatoid Arthritis and Systemic Lupus Erythematosus (SLE).	8	BT3	CO4	CLO4	PI2.1
	3	Explain Primary Immunodeficiency Disorders with reference to SCID.	8	BT3	CO4	CLO4	PI2.1
	4	Describe Secondary Immunodeficiency Disorders with reference to AIDS.	8	BT3	CO4	CLO4	PI2.1
V	1	Differentiate between Active and Passive Immunization.	8	BT3	CO5	CLO5	PI2.1

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
	2	Describe the types of vaccines with suitable examples.	8	BT3	CO5	CLO5	PI2.1
	3	Explain ELISA and Immunofluorescence as diagnostic immunological techniques.	8	BT3	CO5	CLO5	PI2.1
V	4	Describe the production and diagnostic applications of Monoclonal Antibodies.	8	BT2	CO5	CLO5	PI1.2

Short questions – 2 marks each

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	What is Immunology?	2	BT2	CO1	CLO1	PI1.2
	2	Write a note on Edward Jenner.	2	BT2	CO1	CLO1	PI1.2
	3	Write a note on Karl Landsteiner.	2	BT2	CO1	CLO1	PI1.2
	4	Write a note on Elie Metchnikoff.	2	BT2	CO1	CLO1	PI1.2
II	1	What is an Epitope?	2	BT2	CO2	CLO2	PI1.2
	2	What are T-cell and B-cell Epitopes?	2	BT2	CO2	CLO2	PI1.2
	3	What is Affinity?	2	BT2	CO2	CLO2	PI1.2
	4	What is Avidity?	2	BT2	CO2	CLO2	PI1.2
III	1	What are Cytotoxic T Lymphocytes (CTLs)?	2	BT2	CO3	CLO3	PI1.2
	2	What is Immune Tolerance?	2	BT2	CO3	CLO3	PI1.2
	3	What is the Complement System?	2	BT2	CO3	CLO3	PI1.2
	4	What is Lysis?	2	BT2	CO3	CLO3	PI1.2
IV	1	What is Hypersensitivity?	2	BT3	CO4	CLO4	PI2.1
	2	What are Immunodeficiency Disorders?	2	BT3	CO4	CLO4	PI2.1
	3	What are Primary Immunodeficiency Disorders?	2	BT3	CO4	CLO4	PI2.1
	4	What is AIDS?	2	BT3	CO4	CLO4	PI2.1
V	1	What is an Inactivated (Killed) Vaccine?	2	BT3	CO5	CLO5	PI2.1
	2	What is an mRNA Vaccine?	2	BT3	CO5	CLO5	PI2.1
	3	What are Adjuvants?	2	BT3	CO5	CLO5	PI2.1
	4	What are Monoclonal Antibodies?	2	BT2	CO5	CLO5	PI1.2

SEMESTER-IV
COURSE 8: BASICS OF IMMUNOLOGY
MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

Answer all the following questions . Draw labelled diagrams wherever necessary

S.No	Question	Marks	(BT)	CO	CLO	PI
1.a.	Explain Innate Immunity.	8	BT2	CO1	CLO1	PI1.2
	(OR)					
b.	Explain and classify the Cells of the Immune System.	8	BT2	CO1	CLO1	PI1.2
2.a.	Define and evaluate the characteristics of antigens and haptens.	8	BT2	CO2	CLO2	PI1.2
	(OR)					
b.	Explain functions of antibodies: agglutination, precipitation, neutralisation, complement fixation and phagocytosis.	8	BT2	CO2	CLO2	PI1.2
3.a.	Compare the Primary and Secondary Immune Responses with suitable examples.	8	BT4	CO3	CLO3	PI2.2
	(OR)					
b.	Describe the generation of the Humoral Immune Response with suitable examples.	8	BT2	CO3	CLO3	PI1.2
4.a.	Classify the hypersensitivity reactions according to the Gell & Coombs classification.	8	BT3	CO4	CLO4	PI2.1
	(OR)					
b.	Describe Secondary Immunodeficiency Disorders with reference to AIDS.	8	BT3	CO4	CLO4	PI2.1
5a.	Differentiate between Active and Passive Immunization.	8	BT3	CO5	CLO5	PI2.1
	(OR)					
b.	Describe the production and diagnostic applications of Monoclonal Antibodies.	8	BT2	CO5	CLO5	PI1.2

SECTION-B**5 × 2 = 10 Marks****Answer any 5 of the following questions.**

S.No	Question	Marks	(BT)	CO	CLO	PI
1	What is Immunology?	2	BT2	CO1	CLO1	PI1.2
2	Write a note on Elie Metchnikoff.	2	BT2	CO1	CLO1	PI1.2
3	What is an Epitope?	2	BT2	CO2	CLO2	PI1.2
4	What are T-cell and B-cell Epitopes?	2	BT2	CO2	CLO2	PI1.2
5	What are Cytotoxic T Lymphocytes (CTLs)?	2	BT2	CO3	CLO3	PI1.2
6	What is Immune Tolerance?	2	BT2	CO3	CLO3	PI1.2
7	What is Hypersensitivity?	2	BT3	CO4	CLO4	PI2.1
8	What is an Inactivated (Killed) Vaccine?	2	BT3	CO5	CLO5	PI2.1

SEMESTER-IV

COURSE 9: MEDICAL MICROBIOLOGY

Theory Credits: 3

3 hrs/week

I. Learning Objectives:

1. To summarize the role of normal microflora and host–pathogen interactions.
2. To demonstrate methods for collecting, transporting, and diagnosing microbial pathogens.
3. To describe key bacterial and viral diseases, their transmission, and control measures.
4. To classify protozoan and fungal diseases and outline their transmission and control.
5. To compare antimicrobial agents, their actions, and resistance mechanisms.

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

1. Identify normal microflora, define infection-related terms, and differentiate opportunistic and nosocomial infections.
2. Demonstrate sample collection, apply pathogen identification techniques, and interpret diagnostic results.
3. Summarize symptoms, transmission, and prevention of tuberculosis, COVID-19, typhoid, and hepatitis A.
4. Outline symptoms, transmission, and control of malaria, amoebiasis, candidiasis, and aspergillosis.
5. Classify antimicrobial agents, describe resistance mechanisms, and perform susceptibility testing.

IV. Syllabus of Theory:

Unit 1 Normal microflora of the human body and host pathogen interaction

- 1.1 Normal microflora of the human body: Importance of normal microflora, normal Microflora of skin, throat, gastrointestinal tract, urogenital tract
- 1.2 Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Transmission of infection
- 1.3 Opportunistic infections, Nosocomial infections.

Unit - 2: Bacterial and Viral diseases

Detailed study of the following diseases covering Symptoms, mode of transmission, pathogenesis, diagnosis, prophylaxis and control

- 2.1 Respiratory Diseases: Tuberculosis (*Mycobacterium tuberculosis*) and COVID-19 (SARS-CoV-2)
- 2.2 Gastrointestinal Diseases: Typhoid (*Salmonella typhi*) and Hepatitis (Hepatitis A)
- 2.3 Sexually transmitted diseases: Gonorrhea (*Neisseria gonorrhoeae*) and AIDS (Human Immunodeficiency Virus – HIV)

Unit - 3: Fungal diseases & Protozoa

Detailed study of the following diseases covering Symptoms, mode of transmission, pathogenesis, diagnosis, prophylaxis and control

3.1 Candidiasis

3.2 Aspergillosis

3.3 Amoebiasis (*Entamoeba histolytica*)

3.4 Malaria (*Plasmodium* spp.)

Unit 4 Sample collection, transport and diagnosis

4.1 Collection and transport of clinical samples,

4.2 Culturing, isolation, and identification of pathogens based on cultural characteristics, microscopy and biochemical/physiological properties

4.3 principles of diagnostic tests ELISA, Immunofluorescence, Agglutination, Complement fixation, molecular assays (PCR, DNA probes).

Unit - 5: Antimicrobial agents

5.1 Antimicrobial agents- General modes of action of antibacterial agents (Penicillin, Streptomycin), antifungal agents (Amphotericin and Griseofulvin), Antiviral agents (Amantadine, Acyclovir) agents, Interferons.

5.2. Antibiotic resistance: Definition, causes, brief mechanisms (Enzymatic degradation, Target site alteration, Efflux pumps, Reduced permeability), examples (MRSA, Multidrug-resistant TB), consequences, and prevention strategies.

5.3 MIC Tests for antimicrobial susceptibility (Disc diffusion).

IV. Suggested extracurricular activities:

1. Visit a hospital or diagnostic lab to observe infection identification and discuss case studies.
2. Practice mock collection, labeling, and transport of clinical samples and discuss contamination prevention.
3. Create posters or digital presentations on diseases, highlighting symptoms, transmission, and prevention.
4. Design posters or digital content on proper antibiotic use, resistance, and prevention strategies.

V. Reference Books:

1. Ananthanarayan R. & Paniker C.K.J. (2009). Textbook of Microbiology (8th ed.). University Press.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A., & Mietzner, T.A. (2013). Jawetz, Melnick, and Adelberg's Medical Microbiology (26th ed.). McGraw Hill.
3. Goering R., Dockrell H., Zuckerman M., & Wakelin D. (2007). Mims' Medical Microbiology (4th ed.). Elsevier.
4. Willey J.M., Sherwood L.M., & Woolverton C.J. (2013). Prescott, Harley and Klein's Microbiology (9th ed.). McGraw Hill.
5. Madigan M.T., Martinko J.M., Dunlap P.V., & Clark D.P. (2014). Brock Biology of Microorganisms (14th ed.). Pearson.
6. Patrick R. Murray (2023). Murray's Basic Medical Microbiology: Foundations and

Clinical Cases (2nd ed.). Elsevier. ISBN: 978-0323878104.

7. Patrick R. Murray (2023). Medical Microbiology (10th ed.). Elsevier. ISBN: 978-0443261336.

SEMESTER-IV

COURSE 9: MEDICAL MICROBIOLOGY

Practical Credits: 1

2 hrs/week

I. Course Outcomes: On successful completion of this practical course, student shall be able to:
Laboratory/Field exercises:

1. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
2. Isolation of Normal flora of human body (Hands, Feet, Nostrils, Teeth Surface) by swab method.
3. Identify bacteria (any three of E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus)
4. Using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC,
5. TSI, nitrate reduction, urease production and catalase tests
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken, Pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
7. Study of various stages of malarial parasite in RBCs using permanent mounts
8. Antibacterial sensitivity by Kirby-Bauer method
9. Determination of minimal inhibitory concentration of an antibiotic (Streptomycin).

V SEMESTER

Course 9: MEDICAL MICROBIOLOGY

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

5 × 8 = 40 Marks

Essay 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

II B.Sc. SEMESTER IV
Course 9: MEDICAL MICROBIOLOGY
QUESTION BANK

Essay - 8 MARKS

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Describe the normal microflora of the skin, throat, gastrointestinal tract and urogenital tract.	8	BT2	CO1	CLO1	PI1.2
	2	Analyze the concepts of host–pathogen interaction.	8	BT4	CO1	CLO1	PI2.2
	3	Explain opportunistic infections with suitable examples.	8	BT2	CO1	CLO1	PI1.2
	4	Examine nosocomial infections with suitable examples.	8	BT4	CO1	CLO1	PI2.2
II	1	Explain tuberculosis caused by <i>Mycobacterium tuberculosis</i> .	8	BT2	CO2	CLO2	PI1.2
	2	Describe COVID-19 caused by SARS-CoV-2.	8	BT2	CO2	CLO2	PI1.2
	3	Explain typhoid caused by <i>Salmonella typhi</i> .	8	BT2	CO2	CLO2	PI1.2
	4	Illustrate pathogenesis of AIDS.	8	BT3	CO2	CLO2	PI2.1
III	1	Explain aspergillosis.	8	BT2	CO3	CLO3	PI1.2
	2	Describe candidiasis.	8	BT2	CO3	CLO3	PI1.2
	3	Explain malaria.	8	BT2	CO3	CLO3	PI1.2
	4	Describe amoebiasis.	8	BT2	CO3	CLO3	PI1.2
IV	1	Demonstrate collection and transport of clinical samples.	8	BT3	CO4	CLO4	PI2.1
	2	Analyze culturing, isolation and identification.	8	BT4	CO4	CLO4	PI2.2
	3	Compare ELISA and Immunofluorescence.	8	BT4	CO4	CLO4	PI2.2
	4	Explain PCR.	8	BT2	CO4	CLO4	PI1.2
V	1	Compare Penicillin and Amphotericin B.	8	BT4	CO5	CLO5	PI2.2
	2	Evaluate antibiotic resistance.	8	BT5	CO5	CLO5	PI3.1
	3	Describe MIC test.	8	BT2	CO5	CLO5	PI1.2
	4	Demonstrate Kirby–Bauer test.	8	BT3	CO5	CLO5	PI2.1

Short Answers 2-Mark Questions

Unit	S.No	Question	Marks	Bloom's Level (BT)	CO	CLO	PI
I	1	What is a Pathogen?	2	BT1	CO1	CLO1	PI1.1
	2	What is Infection?	2	BT1	CO1	CLO1	PI1.1
	3	What are Carriers?	2	BT1	CO1	CLO1	PI1.1
	4	Modes of Transmission?	2	BT1	CO1	CLO1	PI1.1
II	1	What is Hepatitis A?	2	BT1	CO2	CLO2	PI1.1
	2	What is Gonorrhoea?	2	BT1	CO2	CLO2	PI1.1

Unit	S.No	Question	Marks	Bloom's Level (BT)	CO	CLO	PI
	3	What is Pathogenesis?	2	BT1	CO2	CLO2	PI1.1
II	4	What is Prophylaxis?	2	BT1	CO2	CLO2	PI1.1
III	1	What is Candidiasis?	2	BT1	CO3	CLO3	PI1.1
	2	What is Aspergillosis?	2	BT1	CO3	CLO3	PI1.1
	3	What is Amoebiasis?	2	BT1	CO3	CLO3	PI1.1
	4	What is Malaria?	2	BT1	CO3	CLO3	PI1.1
IV	1	What is a Clinical Sample?	2	BT1	CO4	CLO4	PI1.1
	2	Importance of Transport?	2	BT1	CO4	CLO4	PI1.1
	3	Culturing of Pathogens?	2	BT1	CO4	CLO4	PI1.1
	4	Isolation of Pathogens?	2	BT1	CO4	CLO4	PI1.1
V	1	What is Streptomycin?	2	BT1	CO5	CLO5	PI1.1
	2	What is Griseofulvin?	2	BT1	CO5	CLO5	PI1.1
	3	What is Acyclovir?	2	BT1	CO5	CLO5	PI1.1
	4	What are Interferons?	2	BT1	CO5	CLO5	PI1.1

SEMESTER-IV
Course 9: MEDICAL MICROBIOLOGY
MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

Answer all the following questions . Draw labelled diagrams wherever necessary

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1.a.	Describe the normal microflora of the skin, throat, gastrointestinal tract and urogenital tract.	8	BT2	CO1	CLO1	PI1.2
		(OR)					
	b.	Examine nosocomial infections with suitable examples.	8	BT4	CO1	CLO1	PI2.2
II	2.a.	Explain tuberculosis caused by <i>Mycobacterium tuberculosis</i> .	8	BT2	CO2	CLO2	PI1.2
		(OR)					
	b.	Illustrate pathogenesis of AIDS.	8	BT3	CO2	CLO2	PI2.1
III	3.a.	Explain aspergillosis.	8	BT2	CO3	CLO3	PI1.2
		(OR)					
	b.	Describe candidiasis.	8	BT2	CO3	CLO3	PI1.2
IV	4.a.	Demonstrate collection and transport of clinical samples.	8	BT3	CO4	CLO4	PI2.1
		(OR)					
	b.	Analyze culturing, isolation and identification.	8	BT4	CO4	CLO4	PI2.2
V	5.a.	Compare Penicillin and Amphotericin B.	8	BT4	CO5	CLO5	PI2.2
		(OR)					
	b.	Demonstrate Kirby–Bauer test.	8	BT3	CO5	CLO5	PI2.1

SECTION-B

5 × 2 = 10 Marks

Answer any 5 of the following questions.

S.No	Question	Marks	Bloom's Level (BT)	CO	CLO	PI
1	What is a Pathogen?	2	BT1	CO1	CLO1	PI1.1
2	Modes of Transmission?	2	BT1	CO1	CLO1	PI1.1
3	What is Hepatitis A?	2	BT1	CO2	CLO2	PI1.1
4	What is Prophylaxis?	2	BT1	CO2	CLO2	PI1.1
5	What is Amoebiasis?	2	BT1	CO3	CLO3	PI1.1
6	What is Malaria?	2	BT1	CO3	CLO3	PI1.1
7	What is a Clinical Sample?	2	BT1	CO4	CLO4	PI1.1
8	What are Interferons?	2	BT1	CO5	CLO5	PI1.1

SEMESTER-IV

COURSE 10: AGRICULTURAL MICROBIOLOGY

Theory Credits: 3

3 hrs/week

I. Learning Objectives:

1. Explore soil as a microbial habitat and summarize microbial diversity and interactions.
2. Classify microbial and viral virulence factors and illustrate plant defense mechanisms.
3. Compare strategies for controlling plant diseases, including chemical, biological, and genetic methods.
4. Identify plant diseases caused by fungi, bacteria, viruses, and viroids, and outline their symptoms and spread.
5. Evaluate the role of beneficial microbes in promoting plant growth and managing pests.

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

1. Summarize soil properties, explore microbial diversity, and outline microbe interactions.
2. Categorize virulence factors and depict plant defense mechanisms.
3. Compare disease management strategies and demonstrate GM crop applications.
4. Recognize major plant diseases and examine their symptoms and spread.
5. Differentiate biofertilizers and bioinsecticides and appraise their use in agriculture.

III. Syllabus of Theory:

Unit 1: Soil Microbiology

1. Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil.
2. Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus.
3. Microbial interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions.

Unit 2: Host Pathogen Interaction

- 2.1. Microbial Pathogenicity: Bacterial virulence factors- enzymes, toxins (host-specific and non-specific), growth regulators; Viral virulence factors: replicase, coat protein, silencing suppressors
- 2.2. Effects on Host Physiology: Impact on photosynthesis, respiration, cell membrane permeability, nutrient and water translocation, growth, and reproduction.
- 2.3. Defence Mechanisms in Plants: Concepts of constitutive defences; Inducible structural defenses: cork layer, abscission layer, tyloses, gums; Inducible biochemical defenses: hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins; pathogenesis related (PR) proteins.

Unit 3: Plant Diseases control

9 Hrs

- 3.1. Principles and Practices of Disease Management: Regulatory methods- quarantine, avoidance of pathogens, use of pathogen-free propagative material; Cultural methods: host eradication, crop rotation, sanitation. Chemical methods: systemic fungicides, antibiotics; development of pathogen resistance.
- 3.2. Biological Control: Antagonistic microbes (bacteria and fungi).
- 3.3. Genetic Engineering of Disease-Resistant Plants: Use of plant-derived and pathogen-derived genes; Development of genetically modified (GM) crops(BT)

Unit: 4: Study of Plant diseases

Study of selected plant diseases with emphasis on etiological agent, symptoms, epidemiology, and control:

4.1 Diseases Caused by Fungi:

- a) Black stem rust of wheat – *Puccinia graminis tritici*
- b) Wilt of tomato – *Fusarium oxysporum* f. sp. *Lycopersici*
- c) Early blight of potato – *Alternaria solani*

4.2 Diseases Caused by Phytopathogenic Bacteria: bacterial blight of rice, crown galls, bacterial cankers of citrus

4.3. Diseases caused by viruses and viroids: Papaya ring spot, tomato yellow leaf curl.

diseases caused by viroids: Potato spindle tuber, coconut cadang- cadang

Unit 5: Biofertilization, Phytostimulation, Bioinsecticides No of Hrs: 9

5.1. Plant growth promoting bacteria and biofertilizers – symbiotic (*Bradyrhizobium*, *Rhizobium*), Non Symbiotic (*Azospirillum*, Phosphate solubilizers)

5.2. Mycorrhizal Inoculum: Types of mycorrhizae, associated plants, Mass production of VAM (Vesicular-Arbuscular Mycorrhiza), field applications of Ectomycorrhizae and VAM.

5.3. Bioinsecticides: Advantages over synthetic pesticides, *Bacillus thuringiensis*-production and field applications; Viruses-Baculoviruses cultivation and field applications.

III. Co-curricular activities:

- 1. Collect soil samples, observe microbial diversity, and present findings.
- 2. Create posters or models of disease control strategies and present them.
- 3. Prepare charts of plant diseases or visit a farm to observe and discuss them.

V. Reference Books:

- 1. Agarwal, S. K. (2005). Advanced Environmental Biotechnology. APH Publishing.
- 2. Agrios, G. N. (2006). Plant Pathology (5th ed.). Academic Press, San Diego.
- 3. Bagyaraj, D. J., & Rangaswami, G. (2005). Agricultural Microbiology. Prentice Hall of India Pvt. Ltd.
- 4. James, A. (2021). Soil and Agricultural Microbiology. Ed-Tech Press.
- 5. Lacomme, C. (Ed.). (2025). Plant Pathology: Techniques and Protocols (2nd ed.). Springer.
- 6. Lucas, J. A. (1998). Plant Pathology and Plant Pathogens (3rd ed.). Blackwell Science, Oxford.
- 7. Mahindra, K. Rai. (2005). Handbook of Microbial Biofertilizers. The Haworth Press, New York.
- 8. Mehrotra, R. S. (1994). Plant Pathology. Tata McGraw-Hill Limited.
- 9. Reddy, S. M., et al. (2002). Bioinoculants for Sustainable Agriculture and Forestry. Scientific Publishers.
- 10. Rangaswami, G. (2005). Diseases of Crop Plants in India (4th ed.). Prentice Hall India Pvt. Ltd., New Delhi.
- 11. Salem, F., & Shakoory, A. R. (2012). Development of Bioinsecticide. Lap Lambert Academic Publishing GmbH KG.
- 12. Singh, K. P., Jahagirdar, S., & Sarma, B. K. (Eds.). (2020). Emerging Trends in Plant Pathology. Springer.
- 13. Singh, R. S. (1998). Plant Diseases Management (7th ed.). Oxford & IBH, New Delhi.
- 14. Subba Rao, N. S. (1995). Soil Microorganisms and Plant Growth. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- 15. Subba Rao, N. S. (2009). Soil Microbiology. Oxford and IBH Publishing Company.

16. Kannaiyan, S. (2003). Biotechnology of Biofertilizers. CHIPS, Texas.
17. Academic Press. (2025). Textbook of Agricultural Microbiology & Phytoremediation Academic Press.

SEMESTER-IV

COURSE 10: AGRICULTURAL MICROBIOLOGY

Practical Credits: 1

2 hrs/week

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Observe and analyse soil properties and microbial diversity.
2. Apply techniques for isolating and characterizing beneficial soil microbes.
3. Identify plant pathogens and examine disease symptoms through microscopic observations and Koch's postulates.

II. Laboratory/Field exercises:

1. Study of soil profile, water activity, pH.
2. Study microflora of different types of soils.
3. Rhizobium as soil inoculant, characteristics and field application.
4. Azotobacter as soil inoculant, characteristics and field application.
5. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
6. Isolation of cellulose degrading organism
7. Study of important diseases of crop plants by cutting sections of infected plant material (microscopic observations)- Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.

IV SEMESTER

COURSE 10: AGRICULTURAL MICROBIOLOGY

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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-IV

C-10 AGRICULTURE MICROBIOLOGY

EESAY QUESTION BANK-8 MARKS

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Describe soil as a microbial habitat.	8	BT2	CO1	CLO1	PI1.2
	2	Explain interactions among soil microorganisms.	8	BT2	CO1	CLO1	PI1.2
	3	Examine mineralization.	8	BT4	CO1	CLO1	PI2.2
	4	Assess microbe–plant interactions.	8	BT5	CO1	CLO1	PI3.1
II	1	Describe bacterial virulence factors.	8	BT2	CO2	CLO2	PI1.2
	2	Explain plant defense.	8	BT2	CO2	CLO2	PI1.2
	3	Analyze pathogen effects.	8	BT4	CO2	CLO2	PI2.2
	4	Assess viral virulence.	8	BT5	CO2	CLO2	PI3.1
III	1	Describe disease management.	8	BT2	CO3	CLO3	PI1.2
	2	Illustrate biological control.	8	BT3	CO3	CLO3	PI2.1
	3	Compare chemical control.	8	BT4	CO3	CLO3	PI2.2
	4	Assess genetic engineering.	8	BT5	CO3	CLO3	PI3.1
IV	1	Describe fungal diseases.	8	BT2	CO4	CLO4	PI1.2
	2	Explain bacterial diseases.	8	BT2	CO4	CLO4	PI1.2
	3	Differentiate viral and viroid diseases.	8	BT4	CO4	CLO4	PI2.2
	4	Assess disease control.	8	BT5	CO4	CLO4	PI3.1
V	1	Describe biofertilizers.	8	BT2	CO5	CLO5	PI1.2
	2	Explain mycorrhiza.	8	BT2	CO5	CLO5	PI1.2
	3	Illustrate <i>Bacillus thuringiensis</i> (Bt).	8	BT3	CO5	CLO5	PI2.1
	4	Evaluate baculoviruses.	8	BT5	CO5	CLO5	PI3.1

Short Answers - 2 marks

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Define soil as microbial habitat.	2	BT1	CO1	CLO1	PI1.1
	2	What is humus?	2	BT1	CO1	CLO1	PI1.1
	3	Mutualism	2	BT1	CO1	CLO1	PI1.1
	4	Mineralization	2	BT1	CO1	CLO1	PI1.1
II	1	Virulence factors	2	BT1	CO2	CLO2	PI1.1
	2	HR (Hypersensitive Response)	2	BT1	CO2	CLO2	PI1.1
	3	SAR (Systemic Acquired Resistance)	2	BT1	CO2	CLO2	PI1.1
	4	Effects of pathogens	2	BT1	CO2	CLO2	PI1.1
III	1	Plant disease management	2	BT1	CO3	CLO3	PI1.1

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
	2	Crop rotation	2	BT1	CO3	CLO3	PI1.1
	3	Biological control	2	BT1	CO3	CLO3	PI1.1
	4	GM crops	2	BT1	CO3	CLO3	PI1.1
IV	1	Black Stem Rust	2	BT1	CO4	CLO4	PI1.1
	2	Bacterial Blight	2	BT1	CO4	CLO4	PI1.1
	3	Papaya Ring Spot	2	BT1	CO4	CLO4	PI1.1
	4	Potato Spindle	2	BT1	CO4	CLO4	PI1.1
V	1	Biofertilizers	2	BT1	CO5	CLO5	PI1.1
	2	Mycorrhiza	2	BT1	CO5	CLO5	PI1.1
	3	Bt (<i>Bacillus thuringiensis</i>)	2	BT1	CO5	CLO5	PI1.1
	4	Baculoviruses	2	BT1	CO5	CLO5	PI1.1

SEMESTER-IV
C-10 AGRICULTURE MICROBIOLOGY

MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

Answer all the following questions . Draw labelled diagrams wherever necessary

S.No	Question	Marks	(BT)	CO	CLO	PI
1.a.	Describe soil as a microbial habitat.	8	BT2	CO1	CLO1	PI1.2
	(OR)					
b.	Explain interactions among soil microorganisms.	8	BT2	CO1	CLO1	PI1.2
2.a.	Describe bacterial virulence factors.	8	BT2	CO2	CLO2	PI1.2
	(OR)					
b.	Assess viral virulence.	8	BT5	CO2	CLO2	PI3.1
3.a.	Describe disease management.	8	BT2	CO3	CLO3	PI1.2
	(OR)					
b.	Assess genetic engineering.	8	BT5	CO3	CLO3	PI3.1
4.a.	Describe fungal diseases.	8	BT2	CO4	CLO4	PI1.2
	(OR)					
b.	Assess disease control.	8	BT5	CO4	CLO4	PI3.1
5.a.	Describe biofertilizers.	8	BT2	CO5	CLO5	PI1.2
	(OR)					
b.	Explain mycorrhiza.	8	BT2	CO5	CLO5	PI1.2

Short Answers - 2 marks

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Define soil as microbial habitat.	2	BT1	CO1	CLO1	PI1.1
	2	What is humus?	2	BT1	CO1	CLO1	PI1.1
II	1	Virulence factors	2	BT1	CO2	CLO2	PI1.1
	2	HR (Hypersensitive Response)	2	BT1	CO2	CLO2	PI1.1
III	1	Plant disease management	2	BT1	CO3	CLO3	PI1.1
	4	GM crops	2	BT1	CO3	CLO3	PI1.1
IV	1	Black Stem Rust	2	BT1	CO4	CLO4	PI1.1

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
	2	Bacterial Blight	2	BT1	CO4	CLO4	PI1.1
V	1	Biofertilizers	2	BT1	CO5	CLO5	PI1.1
	2	Mycorrhiza	2	BT1	CO5	CLO5	PI1.1
	3	Bt (<i>Bacillus thuringiensis</i>)	2	BT1	CO5	CLO5	PI1.1
	4	Baculoviruses	2	BT1	CO5	CLO5	PI1.1

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 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, Dermatormycoses (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

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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

III B.Sc Microbiology Honours -III Semester

Course-12 A (IMMUNOLOGY AND MEDICAL MICROBIOLOGY)

QUESTION BANK

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Explain Innate Immunity.	8	BT2	CO1	CLO1	PI1.2
	2	Explain Adaptive Immunity and differentiate active and passive immunity.	8	BT2	CO1	CLO1	PI1.2
	3	Explain and classify Primary and Secondary Lymphoid Organs.	8	BT2	CO1	CLO1	PI1.2
	4	Explain and classify the Cells of the Immune System.	8	BT2	CO1	CLO1	PI1.2
II	1	Define and evaluate the characteristics of antigens and haptens.	8	BT4	CO2	CLO2	PI2.2
	2	With a neatly labelled diagram, illustrate the structure of antibodies.	8	BT2	CO2	CLO2	PI1.2
	3	Classify and describe the types of antibodies.	8	BT2	CO2	CLO2	PI1.2
	4	Classify and describe the hypersensitivity reactions.	8	BT3	CO2	CLO2	PI2.1
III	1	Define Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity and Opportunistic infections.	8	BT2	CO3	CLO3	PI1.2
	2	Explain the pathogenesis, diagnosis and control of Tuberculosis.	8	BT2	CO3	CLO3	PI1.2
	3	Analyze the transmission, diagnosis and prevention of AIDS.	8	BT4	CO3	CLO3	PI2.2
	4	Discuss the etiology, symptoms, treatment and prevention of Botulism.	8	BT4	CO3	CLO3	PI2.2
IV	1	Explain the process of collection, handling and processing of clinical samples.	8	BT3	CO4	CLO4	PI2.1
	2	Explain the identification of microorganisms by culturing.	8	BT2	CO4	CLO4	PI1.2
	3	Analyze the principle, procedure and uses of Polymerase Chain Reaction (PCR).	8	BT4	CO4	CLO4	PI2.2
	4	Discuss the principle, procedure and applications of ELISA.	8	BT4	CO4	CLO4	PI2.2
V	1	Describe the types, characteristics and importance of vaccines.	8	BT2	CO5	CLO5	PI1.2
	2	Explain the mode of action and clinical	8	BT2	CO5	CLO5	PI1.2

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
		significance of penicillin.					
	3	Analyze the mechanism of action, uses and adverse effects of Amphotericin B.	8	BT4	CO5	CLO5	PI2.2
	4	Analyze the principle, procedure and interpretation of antimicrobial susceptibility testing by the disc diffusion method.	8	BT4	CO5	CLO5	PI2.2

Short questions – 2 marks each

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Write four differences between Innate and Adaptive Immunity.	2	BT2	CO1	CLO1	PI1.2
	2	Differentiate between B Cells and T Cells.	2	BT2	CO1	CLO1	PI1.2
	3	What is the Complement System?	2	BT2	CO1	CLO1	PI1.2
	4	How does the Complement System help in Immunity?	2	BT2	CO1	CLO1	PI1.2
II	1	What is the Primary Immune Response?	2	BT1	CO2	CLO2	PI1.1
	2	What is the Secondary Immune Response?	2	BT1	CO2	CLO2	PI1.1
	3	What is MHC?	2	BT1	CO2	CLO2	PI1.1
	4	What is Neutralization?	2	BT1	CO2	CLO2	PI1.1
III	1	What is Normal Flora?	2	BT1	CO3	CLO3	PI1.1
	2	What are Nosocomial Infections?	2	BT1	CO3	CLO3	PI1.1
	3	What is MRSA?	2	BT1	CO3	CLO3	PI1.1
	4	Name the causative organism of Candidiasis.	2	BT1	CO3	CLO3	PI1.1
IV	1	What is Identification by Biochemical Tests?	2	BT1	CO4	CLO4	PI1.1
	2	Give two examples of Biochemical Tests.	2	BT1	CO4	CLO4	PI1.1
	3	Write two applications of DNA Probes.	2	BT2	CO4	CLO4	PI1.2
	4	What is Immunofluorescence?	2	BT1	CO4	CLO4	PI1.1
V	1	What is Streptomycin?	2	BT1	CO5	CLO5	PI1.1
	2	What is Griseofulvin?	2	BT1	CO5	CLO5	PI1.1
	3	What is Amantadine?	2	BT1	CO5	CLO5	PI1.1
	4	What are Interferons?	2	BT1	CO5	CLO5	PI1.1

SEMESTER-IV
Course-12 A (IMMUNOLOGY AND MEDICAL MICROBIOLOGY
MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

Answer all the following questions . Draw labelled diagrams wherever necessary

S.No	Question	Marks	(BT)	CO	CLO	PI
1.a.	Explain Innate Immunity.	8	BT2	CO1	CLO1	PI1.2
	(OR)					
b.	Explain and classify the Cells of the Immune System.	8	BT2	CO1	CLO1	PI1.2
2.a.	Define and evaluate the characteristics of antigens and haptens.	8	BT4	CO2	CLO2	PI2.2
	(OR)					
b.	Classify and describe the hypersensitivity reactions.	8	BT3	CO2	CLO2	PI2.1
3.a.	Define Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity and Opportunistic infections.	8	BT2	CO3	CLO3	PI1.2
	(OR)					
b.	Discuss the etiology, symptoms, treatment and prevention of Botulism.	8	BT4	CO3	CLO3	PI2.2
4.a.	Explain the process of collection, handling and processing of clinical samples.	8	BT3	CO4	CLO4	PI2.1
	(OR)					
b.	Discuss the principle, procedure and applications of ELISA.	8	BT4	CO4	CLO4	PI2.2
5.a.	Describe the types, characteristics and importance of vaccines.	8	BT2	CO5	CLO5	PI1.2
	(OR)					
b.	Analyze the principle, procedure and interpretation of antimicrobial susceptibility testing by the disc diffusion method.	8	BT4	CO5	CLO5	PI2.2

Short questions – 2 marks each

S.No	Question	Marks	Bloom's Level (BT)	CO	CLO	PI
1	Write four differences between Innate and Adaptive Immunity.	2	BT2	CO1	CLO1	PI1.2
2	Differentiate between B Cells and T Cells.	2	BT2	CO1	CLO1	PI1.2
3	What is the Primary Immune Response?	2	BT1	CO2	CLO2	PI1.1
4	What is Neutralization?	2	BT1	CO2	CLO2	PI1.1
5	What is Normal Flora?	2	BT1	CO3	CLO3	PI1.1
6	Name the causative organism of Candidiasis.	2	BT1	CO3	CLO3	PI1.1
7	What is Immunofluorescence?	2	BT1	CO4	CLO4	PI1.1
8	What are Interferons?	2	BT1	CO5	CLO5	PI1.1

V SEMESTER
COURSE 13 A: APPLIED MICROBIOLOGY
SYLLABUS

credits -3

I. Course Outcomes:

By the completion of the course the learner should be 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 volvacea; Preparation of compost, filling tray beds, spawning, maintaining optimal temperature, casing, watering, harvesting, storage.
2. Biofertilizers –Chemical fertilizers versus biofertilizers, organic farming. Production of biofertilisers–Rhizobium sp, Azospirillum sp, Azotobacter sp.
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 -By Arora.
2. Sathyanarayana.U, Biotechnology.(2005)1stEd.Books and Allied(P)Ltd.
3. Casida,LEJR,(2019). Industrial Microbiology.New Age International Publishers
4. K.R.Aneja,Experiments in Microbiology,Plant pathology,Tissue culture and Mushroom production technology,6th Ed.S Chand Publication
5. Nduka Okafor.Modern Industrial Microbiology and Biotechnology.2007.CRC Press
6. Michael J.Waites,Neil L.Morgan,John S.Rockey,Gary Higton.Industrial Microbiology: An Introduction.2013.Wiley Blackwell Publishers.
7. A.H.Patel.Industrial Microbiology.2016.2nd Ed.Laxmi Publications,New Delhi.
8. Dubey RC.A Textbook of Biotechnology.(2014).S Chand Publishers.
9. Robert D.Hisrich,Michael P.Peters,“Entrepreneurship Development”,Tata McGraw 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

BLUEPRINT FOR QUESTION PAPER

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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

COURSE 13 A: APPLIED MICROBIOLOGY

QUESTION BANK- 8 MARKS ESSAY

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Explain the scope of small, medium and large industries in Microbiology.	8	BT2	CO1	CLO1	PI1.2
	2	Describe the importance of Mudra loans.	8	BT2	CO1	CLO1	PI1.2
	3	Write a note on the Stand-Up India scheme.	8	BT2	CO1	CLO1	PI1.2
	4	Analyze the role of government support to entrepreneurs in promoting industrial microbiology.	8	BT4	CO1	CLO1	PI2.2
II	1	Define microbial cells as fermentation products with suitable examples.	8	BT2	CO2	CLO2	PI1.2
	2	Discuss the industrial applications of baker's yeast, food and feed yeasts.	8	BT4	CO2	CLO2	PI2.2
	3	Explain the significance of Single Cell Protein (SCP) in nutrition and industry.	8	BT2	CO2	CLO2	PI1.2
	4	Illustrate the role of bacterial and fungal amylases as fermentation products.	8	BT3	CO2	CLO2	PI2.1
III	1	Describe the steps involved in mushroom cultivation of <i>Calocyba indica</i> .	8	BT2	CO3	CLO3	PI1.2
	2	Differentiate between chemical fertilizers and biofertilizers.	8	BT4	CO3	CLO3	PI2.2
	3	Explain the importance of organic farming for sustainable agriculture.	8	BT2	CO3	CLO3	PI1.2
	4	Demonstrate the production process of biofertilizers using <i>Rhizobium</i> , <i>Azospirillum</i> and <i>Azotobacter</i> species.	8	BT3	CO3	CLO3	PI2.1
IV	1	Explain the process of brewing and its industrial significance.	8	BT2	CO4	CLO4	PI1.2
	2	Describe the steps of bread making with emphasis on yeast activation.	8	BT2	CO4	CLO4	PI1.2
V	1	Write an essay on patents.	8	BT2	CO5	CLO5	PI1.2
	2	Write an essay on secret processes.	8	BT2	CO5	CLO5	PI1.2
	3	Discuss the role of inventors and analyze the cost of patent filing in India.	8	BT4	CO5	CLO5	PI2.2

SHORT ANSWERS

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	What is entrepreneurship?	2	BT1	CO1	CLO1	PI1.1
	2	What is MSME?	2	BT1	CO1	CLO1	PI1.1
	3	What are incubation centers?	2	BT1	CO1	CLO1	PI1.1
	4	What are the sources of funding for entrepreneurs?	2	BT1	CO1	CLO1	PI1.2
II	1	What are bacterial insecticides?	2	BT1	CO2	CLO2	PI1.1
	2	What are legume inoculants?	2	BT1	CO2	CLO2	PI1.1
	3	What are invertases?	2	BT1	CO2	CLO2	PI1.1
	4	What factors affect fermentation economics?	2	BT2	CO2	CLO2	PI1.2
III	1	What is <i>Agaricus bisporus</i> ?	2	BT1	CO3	CLO3	PI1.1
	2	What are the characteristics of <i>Agaricus bisporus</i> ?	2	BT2	CO3	CLO3	PI1.2
	3	What is <i>Volvariella volvacea</i> ?	2	BT1	CO3	CLO3	PI1.1
	4	What are microbial consortia?	2	BT2	CO3	CLO3	PI1.2
IV	1	What is bread making?	2	BT1	CO4	CLO4	PI1.1
	2	What is yeast activation?	2	BT1	CO4	CLO4	PI1.1
	3	What is the ideal temperature for yeast activation?	2	BT1	CO4	CLO4	PI1.1
	4	What are the stages of bread making?	2	BT2	CO4	CLO4	PI1.2
V	1	What is a Detailed Project Report (DPR)?	2	BT1	CO5	CLO5	PI1.1
	2	Why is DPR important?	2	BT2	CO5	CLO5	PI1.2
	3	What is market analysis in DPR?	2	BT2	CO5	CLO5	PI1.2
	4	What is financial analysis in DPR?	2	BT2	CO5	CLO5	PI1.2

SEMESTER-IV
COURSE 13 A: APPLIED MICROBIOLOGY
MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

Answer all the following questions . Draw labelled diagrams wherever necessary

S.No	Question	Marks	(BT)	CO	CLO	PI
1.a.	Explain the scope of small, medium and large industries in Microbiology.	8	BT2	CO1	CLO1	PI1.2
	(OR)					
b.	Describe the importance of Mudra loans.	8	BT2	CO1	CLO1	PI1.2
2.a.	Define microbial cells as fermentation products with suitable examples.	8	BT2	CO2	CLO2	PI1.2
	(OR)					
b.	Illustrate the role of bacterial and fungal amylases as fermentation products.	8	BT3	CO2	CLO2	PI2.1
3.a.	Describe the steps involved in mushroom cultivation of <i>Calocyba indica</i> .	8	BT2	CO3	CLO3	PI1.2
	(OR)					
b..	Demonstrate the production process of biofertilizers using <i>Rhizobium</i> , <i>Azospirillum</i> and <i>Azotobacter</i> species.	8	BT3	CO3	CLO3	PI2.1
4.a.	Explain the process of brewing and its industrial significance.	8	BT2	CO4	CLO4	PI1.2
	(OR)					
b.	Describe the steps of bread making with emphasis on yeast activation.	8	BT2	CO4	CLO4	PI1.2
5.a.	Write an essay on patents.	8	BT2	CO5	CLO5	PI1.2
	(OR)					
b.	Write an essay on secret processes.	8	BT2	CO5	CLO5	PI1.2

SECTION-B

5 × 2 = 10 Marks

Answer any 5 of the following questions.

S.No	Question	Marks	(BT)	CO	CLO	PI
1	What is entrepreneurship?	2	BT1	CO1	CLO1	PI1.1
2	What are the sources of funding for entrepreneurs?	2	BT1	CO1	CLO1	PI1.2

S.No	Question	Marks	(BT)	CO	CLO	PI
3	What are bacterial insecticides?	2	BT1	CO2	CLO2	PI1.1
4	What are legume inoculants?	2	BT1	CO2	CLO2	PI1.1
5	What is <i>Agaricus bisporus</i> ?	2	BT1	CO3	CLO3	PI1.1
6	What are the characteristics of <i>Agaricus bisporus</i> ?	2	BT2	CO3	CLO3	PI1.2
7	What is bread making?	2	BT1	CO4	CLO4	PI1.1
8	What is a Detailed Project Report (DPR)?	2	BT1	CO5	CLO5	PI1.1

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

**V SEMESTER
COURSE 14 A INDUSTRIAL MICROBIOLOGY
BLUEPRINT FOR QUESTION PAPER**

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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

V SEMESTER
COURSE 14 A: INDUSTRIAL MICROBIOLOGY
QUESTION BANK- ESSAY QUESTIONS (8 MARKS)

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Explain the concept of industrial microbiology with suitable examples.	8	BT2	CO1	CLO1	PI1.2
	2	Describe the industrial importance of yeast.	8	BT2	CO1	CLO1	PI1.2
	3	Explain primary and secondary metabolites and compare their differences.	8	BT4	CO1	CLO1	PI2.2
	4	Describe the industrial importance of <i>Aspergillus niger</i> .	8	BT2	CO1	CLO1	PI1.2
II	1	Describe the preservation and maintenance of industrial strains.	8	BT2	CO2	CLO2	PI1.2
	2	Explain crude and synthetic fermentation media and differentiate between them.	8	BT4	CO2	CLO2	PI2.2
	3	Describe the crude fermentation media used in industries with examples.	8	BT2	CO2	CLO2	PI1.2
	4	Explain the primary screening techniques used for industrial microorganisms.	8	BT3	CO2	CLO2	PI2.1
III	1	Describe the structure and working of a bioreactor (fermentor).	8	BT2	CO3	CLO3	PI1.2
	2	Compare laboratory, pilot-scale and production fermenters.	8	BT4	CO3	CLO3	PI2.2
	3	Explain the different types of industrial fermentation.	8	BT3	CO3	CLO3	PI2.1
	4	Compare solid-state fermentation and submerged (liquid-state) fermentation.	8	BT4	CO3	CLO3	PI2.2
IV	1	Explain the role of pH, temperature, dissolved oxygen, foaming and aeration in fermentation.	8	BT3	CO4	CLO4	PI2.1
	2	Explain the steps involved in downstream processing.	8	BT2	CO4	CLO4	PI1.2
	3	Describe the principle and methods of enzyme immobilization.	8	BT3	CO4	CLO4	PI2.1
	4	Explain the role and applications of immobilized enzymes in large-scale industries.	8	BT5	CO4	CLO4	PI3.1
V	1	Describe the microbial production of citric	8	BT2	CO5	CLO5	PI1.2

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
		acid.					
	2	Explain the microbial production of ethanol.	8	BT3	CO5	CLO5	PI2.1
	3	Describe the microbial production of glutamic acid.	8	BT2	CO5	CLO5	PI1.2
	4	Explain the industrial production and applications of amylase.	8	BT3	CO5	CLO5	PI2.1

SHORT QUESTIONS (2 MARKS)

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Industrial importance of <i>Streptomyces</i> .	2	BT1	CO1	CLO1	PI1.1
	2	Industrial importance of <i>Aspergillus niger</i> .	2	BT1	CO1	CLO1	PI1.1
	3	Industrial importance of <i>Escherichia coli</i> (<i>E. coli</i>).	2	BT1	CO1	CLO1	PI1.1
	4	List some important microbial products.	2	BT1	CO1	CLO1	PI1.1
II	5	What is primary screening?	2	BT1	CO2	CLO2	PI1.1
	6	What is secondary screening?	2	BT1	CO2	CLO2	PI1.1
	7	What is strain improvement?	2	BT1	CO2	CLO2	PI1.1
	8	What is fermentation medium?	2	BT1	CO2	CLO2	PI1.1
III	9	What is aerobic fermentation?	2	BT1	CO3	CLO3	PI1.1
	10	What is anaerobic fermentation?	2	BT1	CO3	CLO3	PI1.1
	11	What is liquid-state fermentation?	2	BT1	CO3	CLO3	PI1.1
	12	What is batch fermentation?	2	BT1	CO3	CLO3	PI1.1
IV	13	What is pH control during fermentation?	2	BT1	CO4	CLO4	PI1.1
	14	Why is temperature control important during fermentation?	2	BT2	CO4	CLO4	PI1.2
	15	What is foaming in industrial microbiology?	2	BT1	CO4	CLO4	PI1.1
	16	What is aeration in industrial microbiology?	2	BT1	CO4	CLO4	PI1.1
V	17	How is penicillin produced?	2	BT1	CO5	CLO5	PI1.2
	18	What are proteases?	2	BT1	CO5	CLO5	PI1.1
	19	What are lipases?	2	BT1	CO5	CLO5	PI1.1
	20	What are cellulases?	2	BT1	CO5	CLO5	PI1.1

SEMESTER-V
COURSE 14 A: INDUSTRIAL MICROBIOLOGY
MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

Answer all the following questions . Draw labelled diagrams wherever necessary

S.No	Question	Marks	(BT)	CO	CLO	PI
1.a.	Explain the concept of industrial microbiology with suitable examples.	8	BT2	CO1	CLO1	PI1.2
	(OR)					
b.	Describe the industrial importance of <i>Aspergillus niger</i> .	8	BT2	CO1	CLO1	PI1.2
2.a.	Describe the preservation and maintenance of industrial strains.	8	BT2	CO2	CLO2	PI1.2
	(OR)					
b.	Explain the primary screening techniques used for industrial microorganisms.	8	BT3	CO2	CLO2	PI2.1
3.a.	Describe the structure and working of a bioreactor (fermentor).	8	BT2	CO3	CLO3	PI1.2
	(OR)					
b.	Compare laboratory, pilot-scale and production fermenters.	8	BT4	CO3	CLO3	PI2.2
4.a.	Explain the role of pH, temperature, dissolved oxygen, foaming and aeration in fermentation.	8	BT3	CO4	CLO4	PI2.1
	(OR)					
b.	Explain the steps involved in downstream processing.	8	BT2	CO4	CLO4	PI1.2
5.a.	Describe the microbial production of citric acid.	8	BT2	CO5	CLO5	PI1.2
	(OR)					
b.	Explain the industrial production and applications of amylase.	8	BT3	CO5	CLO5	PI2.1

SECTION-B**5 × 2 = 10 Marks****Answer any 5 of the following questions.**

S.No	Question	Marks	(BT)	CO	CLO	PI
1	Industrial importance of <i>Streptomyces</i> .	2	BT1	CO1	CLO1	PI1.1
2	Industrial importance of <i>Aspergillus niger</i> .	2	BT1	CO1	CLO1	PI1.1
3	What is primary screening?	2	BT1	CO2	CLO2	PI1.1
4	What is secondary screening?	2	BT1	CO2	CLO2	PI1.1
5	What is aerobic fermentation?	2	BT1	CO3	CLO3	PI1.1
6	What is batch fermentation?	2	BT1	CO3	CLO3	PI1.1
7	What is pH control during fermentation?	2	BT1	CO4	CLO4	PI1.1
8	What are cellulases?	2	BT1	CO5	CLO5	PI1.1

V SEMESTER
COURSE 15 A: FOOD AND DAIRY MICROBIOLOGY
SYLLABUS

credits -3

Course Outcomes:

By the Completion of the course the learner should be 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.

References

1. Stanbury, PF., Principles of Fermentation Technology. Whittaker, A and Hall,
2. S.J 2nd Edition. Pergamon Press (1995).
3. Banwart, GJ. Basic Food Microbiology. CBS Publishers and Distributors, Delhi. (1989).
4. Hobbs BC and Roberts D. Food poisoning and Food Hygiene. Edward Arnold (A division of Hodder and Stoughton) London.
5. Joshi. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2.
6. John Garbult. Essentials of Food Microbiology. Arnold International.
7. John C. Ayres. J. Orwin Mundt. William E. Sandinee. Microbiology of Foods.
8. W.H. Freeman and Co.
9. D. J. Bagyaraj and G. Rangaswami. AGRICULTURAL MICROBIOLOGY.
10. Prentice Hall of India Pvt Ltd. 2005
11. N S Subba Rao. Soil Microbiology. Oxford and IBH publishing Company 2009
12. Photis Papademas. Dairy Microbiology: A Practical Approach. CRC Press
13. Rao M.K.. Food and Dairy Microbiology. Manglam Publishers
14. William Frazier. Food Microbiology. McGraw Hill Education
15. Jay, James M., Loessner, Martin J., Golden, David A. Modern Food Microbiology. Springer .

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.

V SEMESTER
COURSE 15 A: FOOD AND DAIRY MICROBIOLOGY

Unit	Section A – Essay Questions	Section B – Short Answers
Unit I	Q1 (a) OR (b) – 8 Marks	2 questions offered
Unit II	Q2 (a) OR (b) – 8 Marks	2 questions offered
Unit III	Q3 (a) OR (b) – 8 Marks	2 questions offered
Unit IV	Q4 (a) OR (b) – 8 Marks	1 question offered
Unit V	Q5 (a) OR (b) – 8 Marks	1 question offered
Pattern	Answer one from each unit	Answer any 5 of 8
Marks	$5 \times 8 = 40$	$5 \times 2 = 10$
Total	50 Marks	

SECTION-A

$5 \times 8 = 40$ Marks

Essay 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.

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

V SEMESTER
COURSE 15 A: FOOD AND DAIRY MICROBIOLOGY
QUESTION BANK- 8 Marks Essays

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Explain intrinsic and extrinsic factors that affect growth and survival of microbes in foods.	8	BT2	CO1	CLO1	PI1.2
	2	Describe natural flora and sources of contamination of foods in general.	8	BT2	CO1	CLO1	PI1.2
	3	Essay on sources of contamination in raw milk.	8	BT2	CO1	CLO1	PI1.2
	4	Compare sources of microbial contamination and spoilage of fruits, meat, eggs and bread.	8	BT4	CO1	CLO1	PI2.2
II	1	List the physical methods of food preservation.	8	BT1	CO2	CLO2	PI1.1
	2	Explain chemical methods of food preservation with examples.	8	BT2	CO2	CLO2	PI1.2
	3	Explain microbial and chemical changes in raw milk during chilling and refrigeration.	8	BT3	CO2	CLO2	PI2.1
	4	Evaluate the use of food-grade biopreservatives (GRAS).	8	BT5	CO2	CLO2	PI3.1
III	1	Describe fermented dairy products like yogurt and cheese.	8	BT2	CO3	CLO3	PI1.2
	2	Explain the preparation of fermented foods such as dosa and sauerkraut.	8	BT2	CO3	CLO3	PI1.2
	3	Assess the health benefits and types of microorganisms used as probiotics.	8	BT5	CO3	CLO3	PI3.1
	4	Discuss utilization and disposal methods of dairy by-products such as whey.	8	BT4	CO3	CLO3	PI2.2
IV	1	Describe major food-borne diseases—causative agents, foods involved, symptoms and preventive measures.	8	BT2	CO4	CLO4	PI1.2
	2	Explain food intoxication caused by <i>Clostridium botulinum</i> .	8	BT2	CO4	CLO4	PI1.2
	3	Analyze the role and effects of	8	BT4	CO4	CLO4	PI2.2

		mycotoxins in food safety.					
	4	Differentiate food infections caused by <i>Escherichia coli</i> , <i>Salmonella</i> and <i>Shigella</i> .	8	BT4	CO4	CLO4	PI2.2
V	1	Explain food sanitation and control measures, including HACCP.	8	BT2	CO5	CLO5	PI1.2
	2	Essay on cultural detection methods and difference between cultural and rapid detection methods of food-borne pathogens in microbiology.	8	BT4	CO5	CLO5	PI2.2
	3	Evaluate the impact of genetically modified foods on health and safety.	8	BT5	CO5	CLO5	PI3.1
	4	Discuss the role of nutraceuticals in human health.	8	BT4	CO5	CLO5	PI2.2
	5	Write a note on applications of protease and lipase in the dairy industry.	8	BT2	CO5	CLO5	PI1.2

SHORT ANSWERS

Unit	S.No	Question	Marks	(BT)	CO	CLO	PI
I	1	Natural flora	2	BT1	CO1	CLO1	PI1.1
	2	Sources of contamination	2	BT1	CO1	CLO1	PI1.1
	3	Sources of raw milk contamination	2	BT1	CO1	CLO1	PI1.1
	4	Spoilage of eggs and food	2	BT2	CO1	CLO1	PI1.2
II	1	Food-grade biopreservatives	2	BT1	CO2	CLO2	PI1.1
	2	Bacteriocins of Lactic Acid Bacteria (LAB)	2	BT1	CO2	CLO2	PI1.1
	3	Nisin and other antimicrobials produced by LAB	2	BT1	CO2	CLO2	PI1.1
	4	Lipase	2	BT1	CO2	CLO2	PI1.1
III	1	Kefir	2	BT1	CO3	CLO3	PI1.1
	2	Soy Sauce	2	BT1	CO3	CLO3	PI1.1
	3	Tempeh	2	BT1	CO3	CLO3	PI1.1
	4	Utilization and Disposal of Whey	2	BT2	CO3	CLO3	PI1.2
IV	1	Food-borne Diseases	2	BT1	CO4	CLO4	PI1.1
	2	Food Intoxication	2	BT1	CO4	CLO4	PI1.1
	3	Mycotoxins	2	BT1	CO4	CLO4	PI1.1
	4	<i>Escherichia coli</i> (<i>E. coli</i>) Infection	2	BT2	CO4	CLO4	PI1.2
V	1	Food Sanitation and Control	2	BT1	CO5	CLO5	PI1.1
	2	Predictive Microbiology	2	BT2	CO5	CLO5	PI1.2
	3	Protease	2	BT1	CO5	CLO5	PI1.1
	4	Lipase	2	BT1	CO5	CLO5	PI1.1

SEMESTER-V
COURSE 15 A: FOOD AND DAIRY MICROBIOLOGY
MODEL QUESTION PAPER

Time : 2hr.30min

Marks : 50M

SECTION-A

5 × 8 = 40 Marks

Answer all the following questions . Draw labelled diagrams wherever necessary

S.No	Question	Marks	(BT)	CO	CLO	PI
1.a.	Explain intrinsic and extrinsic factors that affect growth and survival of microbes in foods.	8	BT2	CO1	CLO1	PI1.2
	(OR)					
b.	Compare sources of microbial contamination and spoilage of fruits, meat, eggs and bread.	8	BT4	CO1	CLO1	PI2.2
2.a.	List the physical methods of food preservation.	8	BT1	CO2	CLO2	PI1.1
	(OR)					
b.	Evaluate the use of food-grade biopreservatives (GRAS).	8	BT5	CO2	CLO2	PI3.1
3.a.	Describe fermented dairy products like yogurt and cheese.	8	BT2	CO3	CLO3	PI1.2
	(OR)					
b.	Discuss utilization and disposal methods of dairy by-products such as whey.	8	BT4	CO3	CLO3	PI2.2
4.a.	Describe major food-borne diseases—causative agents, foods involved, symptoms and preventive measures.	8	BT2	CO4	CLO4	PI1.2
	(OR)					
b.	Differentiate food infections caused by <i>Escherichia coli</i> , <i>Salmonella</i> and <i>Shigella</i> .	8	BT4	CO4	CLO4	PI2.2
5.a.	Explain food sanitation and control measures, including HACCP.	8	BT2	CO5	CLO5	PI1.2
	(OR)					
b.	Discuss the role of nutraceuticals in human health.	8	BT4	CO5	CLO5	PI2.2

SECTION-B**5 × 2 = 10 Marks****Answer any 5 of the following questions.**

S.No	Question	Marks	(BT)	CO	CLO	PI
1	Natural flora	2	BT1	CO1	CLO1	PI1.1
2	Spoilage of eggs and food	2	BT2	CO1	CLO1	PI1.2
3	Food-grade biopreservatives	2	BT1	CO2	CLO2	PI1.1
4	Bacteriocins of Lactic Acid Bacteria (LAB)	2	BT1	CO2	CLO2	PI1.1
5	Kefir	2	BT1	CO3	CLO3	PI1.1
6	Soy Sauce	2	BT1	CO3	CLO3	PI1.1
7	Food-borne Diseases	2	BT1	CO4	CLO4	PI1.1
8	Lipase	2	BT1	CO5	CLO5	PI1.1