PONDICHERRY UNIVERSITY
PUDUCHERRY 605 014

CURRICULUM and SYLLABUS of
B.Sc./B.Sc. (Hons.) in Microbiology
for affiliated colleges of Pondicherry University
(2023 onwards)

Department of Microbiology

PONDICHERRY UNIVERSITY

B.Sc. /B.Sc. (Hons.) MICROBIOLOGY

NEP - REGULATIONS

(Effective from the academic year 2023-24)

PROGRAMME OBJECTIVES

- To provide students with a strong foundation in the principles and concepts of microbiology, including the study of microorganisms, their structure, function, and interactions.
- To develop practical laboratory skills, ensuring students can proficiently use modern techniques and equipment for microbial analysis, cultivation, and identification.
- To foster an understanding of the diversity of microorganisms, including bacteria, viruses, fungi, and parasites, and their roles in various ecosystems, industries, and human health.
- To enable students to apply microbiological knowledge in various fields, such as medicine, agriculture, environmental science, and biotechnology.
- To instil a sense of ethics and professionalism in the practice of microbiology, emphasizing responsible conduct in research, safety protocols, and ethical considerations in the field.
- To foster an interdisciplinary approach by integrating microbiology with other scientific disciplines, recognizing its interconnectedness with fields such as genetics, biochemistry, and immunology.
- To provide opportunities for specialization in specific areas of microbiology, allowing students to develop a deeper understanding of particular aspects of the field.
- To encourage students to critically analyze scientific literature, synthesize information, and contribute to the development of new knowledge in microbiology.
- To prepare students for advanced studies, such as postgraduate research or professional degrees, by offering a rigorous academic curriculum and research-focused experiences.

These objectives collectively aim to produce well-rounded graduates with a comprehensive understanding of microbiology, equipped with the skills and knowledge needed for successful careers or advanced studies in the field.

PROGRAMME OUTCOMES

- Demonstrate a solid understanding of the fundamental principles and concepts of microbiology, including the morphology, physiology, and genetics of microorganisms.
- Exhibit competence in performing standard microbiological laboratory techniques, including the cultivation, isolation, and identification of microorganisms.
- Demonstrate awareness of ethical considerations in microbiological research and adhere to professional standards in laboratory practices and scientific inquiry.
- Apply microbiological knowledge to address real-world issues in areas such as healthcare, agriculture, industry, and environmental science.
- Recognize the interdisciplinary nature of microbiology and integrate knowledge from related fields such as genetics, biochemistry, and immunology.
- Develop expertise in a specific area of microbiology through coursework and research, showcasing a deep understanding of specialized topics.
- Engage in critical analysis of scientific literature, synthesizing information from various sources to contribute to the advancement of microbiological knowledge.
- Demonstrate readiness for advanced studies or professional careers through a comprehensive academic background, research experiences, and exposure to advanced topics in microbiology.

These outcomes collectively aim to produce graduates who are well-equipped with the knowledge, skills, and ethical grounding necessary to excel in diverse microbiological careers or pursue advanced studies in the field.

DURATION OF THE COURSE

The Curriculum Framework designed by UGC for implementing NEP 2020 specifies that all Undergraduate(UG) degree programmes are to be for a period of either 3 years or 4 years leading to the award of UG Degree or UG(Hons)Degrees.

All UG courses shall focus on conceptual understanding and development of critical thinking in a given field of Study, incidentally the skills such as communication, teamwork, and leadership shall be embodied in Teaching-learning process to facilitate for career option in the given field of specialization.

AGE LIMIT

The rules as applicable to other Under Graduate courses as prevailing in Pondicherry University.

ELIGIBILITY FOR ADMISSION

Candidates for admission to B.Sc./B.Sc. (Hons.) Microbiology shall require to have passed H.Sc.(or +2) or its equivalent with Botany/Zoology/Biology as one of the subjects of study, conducted by the Government of Tamil Nadu or any other equivalent system recognized by the Government of Puducherry based on the admission criteria laid down by Pondicherry University are eligible to apply.

LATERAL ENTRY

As per NEP, students have a choice of entry into the Programme of study. UGC specifies that about 10% of seats over and above the sanctioned strength shall be allocated to accommodate the Lateral Entry students. The guidelines for lateral Entry are as follows:

1. Lateral Entry for II Year B.Sc. /B.Sc. (Hons.) Microbiology:

Student should complete **UG certificate in Microbiology from** any University.

2. Lateral Entry for III Year B.Sc. /B.Sc. (Hons.) Microbiology:

Student should complete **UG Diploma course in Microbiology** from any University.

3. Lateral Entry for IV Year B.Sc. (Hons.) Microbiology:

Student should complete **B.Sc. Microbiology** from any University

COURSE STRUCTURE

All Academic Programmes offered under NEP shall be offered in terms of credits. Each course/subject in a given Programme of study shall carry certain number of credits which will be awarded on completion of the said course.

EXIT OF THE COURSE:

NEP 2020 introduces the facility to breakdown the Programme of study at Undergraduate (UG) level after completion of every year of study. The students will be awarded the following:

1. Students who opt to exit after completion of first year will be awarded **UG Certificate in Microbiology** provided they have earned a minimum of 42 credits and in addition, they have to complete work based vocational course/internship of 4 credits during the summer vacation of the first year.

2. Students who opt to exit after completion of second year will be awarded **UG Diploma in Microbiology** provided they have earned a minimum of 84 credits and in addition, they have to complete work based vocational course/internship of 4 credits during the summer vacation of the Second year.

3. Students who opt to exit after completion of third year will be awarded **UG degree (B.Sc. in Microbiology)**, provided they have earned a minimum of 124 credits.

4. Students who exit after completion of fourth year will be awarded either **B.Sc. (Hons.) Microbiology**, provided they have earned a minimum of 164 credits or **B.Sc. (Hons. with Research) Microbiology**, provided they have earned a minimum of 164 credits with Research Project.

MEDIUM OF INSTRUCTION

The medium of instruction for B.Sc. Microbiology **shall be in English**.

Break up of Credits and Courses:

NEP Framework has specified the minimum number of credits that a Bachelor student has to earn in ¾ year period. Table I specifies the number of credits and number of courses that a 3year UG student and a four year UG(Hons) Degree student is expected to complete in 3 and 4 year duration respectively.

TABLEI
BREAKUP OF CREDITS AND COURSES

Sl. No.	Component	3 Year Degree	4 Year Hons Degree
1.	Major Disciplinary Courses	60 Credits (15 Courses of 4 credits each)	80 Credits (20 Courses of 4 credits each)
2.	Minor Disciplinary Courses	24 Credits (6 Courses of 4 Credits each)	32 Credits (8 Courses of 4 credits each)
3.	Multi-Disciplinary Courses	9 Credits (3 courses of 3 credits each)	9 Credits (3 courses of 3 credits each)
4.	Ability Enhancement Courses	12 Credits (4 courses of 3credits each)	12 Credits (4 courses of 3credits each)
5.	Skill Enhancement Courses	9 Credits (3 courses of 3 credits each)	9 Credits (3 courses of 3 credits each)
6.	Common Value-added courses	8 Credits (4courseof2creditseach)	8 Credits (4 course of 2 credits each)
7.	Winter Project / Internship Community Engagement	2 Credits (1 field-based course)	2 Credits (1 field-based course)
8.	Research Dissertation Project	-	12 Credits (Project report & background subjects)
9.	Total credits required	124 Credits	164 Credits

Every Undergraduate (UG) programme offered by a College shall confirm to the Structure specified by the UGC's Framework, 2023. A student of 3 year UG programme is mandated to complete a minimum of 124 credits and the student of 4 year Honors degree shall complete 164 credits. An UG student shall complete the following courses under different heads as listed below:

1. Major Disciplinary Courses
2. Minor Disciplinary Courses
3. Multi Disciplinary Courses
4. Ability Enhancement Courses
5. Skill Enhancement Courses
6. Value added/Common Courses
7. Internships and Community Service based projects

NEP Classification of Courses:

i) Major Disciplinary courses (MJD): (60/80 Credits)

Major disciplinary courses are subject specific compulsory subjects that a student has to complete to obtain the UG / UG (Hons) Degree in the given discipline. Major disciplinary courses shall constitute 50% of the total credits.

All discipline specific major courses shall be designed for 4credits each with one/two additional hours or guidance of teaching at Tutorials/Practicals.

UG programmes may be offered in a single major discipline or in Multiple Major disciplines giving equal weightage in credits. For example a B.Sc. course may be in a single discipline like B.Sc. (Maths) or with multiple major disciplines like B.Sc. (Maths, Physics & Chemistry).

ii) Minor Disciplinary Course (MID): (24/32 Credits)

Minor disciplinary courses refer to those subjects which are Allied / Specialisation / Elective subjects to the Major discipline. These allied courses are expected to provide additional understanding of the subject in a specific focused area. For example, a B.A. (Political Science) student shall study allied subjects like Public Administration, Sociology as these subjects have inter linkages with the Major Disciplinary subjects.

iii) Multi-Disciplinary Courses (MLD): (9 Credits)

All undergraduate students are mandated to pursue 9credits worth of courses in such Multi-disciplinary areas/Courses out of 9/10 NEP defined subjects. Colleges may identify any 3 multiple disciplinary streams listed below based on availability of resources and manpower.

a) Natural Sciences
b) Physical Sciences
c) Mathematics & Statistics
d) Computer Science/Applications
e) Data Analysis
f) Social Sciences
g) Humanities
h) Commerce & Management
i) Library Science
j) Media Sciences, etc.

Students are expected to learn basic/introductory courses designed by other departments for this purpose. Colleges may list any 3 introductory courses (one each in Natural Sciences, Physical Sciences, Humanities) for uniform adoption of all UG students.

iv) Ability Enhancement (AEC) courses: (8 Credits)

All Undergraduate (UG)students are mandated to complete at least 8 Credits worth of Courses which focus on Communication and Linguistic skills, Critical reading, and writing skills. These courses are expected to enhance the ability in articulation and presentation of their thoughts at workplace. Colleges may design these ability enhancement courses tuned to the requirements of given major discipline. E.g. A course in Business Communication is more appropriate in place of literature/prose/poetry.

a) English Language

Ability Enhancement Course	
I. English Language a) English Language & Literature – 1and 2 b) Functional English–1 and 2 c) Communicative English–1 and 2	II. Indian Language(two courses) a) Indian language & Literature –1 and 2 b) Functional language–2 c) Communicative language –1 and 2

v) Skill Enhancement Course: (9 Credits)

These courses focus at imparting practical skills with hands-on Training. In order to enhance the employability of students, Colleges are expected to design such courses that they deem fit for their students for better employment/entrepreneurship/career development, etc. Colleges may also outsource the Skill Enhancement Courses to AICTE approved agencies for conducting short term Training Workshops, Skill India initiatives of GOI and approved Trades by Skill development of corporation are to be considered. Short term courses.

vi) Value Added Common courses (VAC): (8 Credits)

Under NEP, the UGC has proposed for 6 to 8 credits worth of common courses which are likely to add value to overall knowledge base of the students. These courses include:

a) Understanding India
b) Environmental Sciences/Education
c) Digital Technologies
d) Health, Wellness, Yoga Education, Sports & Fitness

The course structure and coverage of topics are suggested by UGC in its draft documents, colleges/UG Boards of Studies may design the methodology for conducting these value-added courses.

vii) Summer Internship (2 to 4 Credits)

As per the UGC guidelines all UG students should be exposed to 4 to 6-week Summer Internship in an industrial organizations / Training Centres / Research Institution, etc. Such Summer Internship is to be conducted in between 4^{th} Semester and 5^{th} semester. A review of report and award of grade based on Work based learning by students is to be recorded during the 5^{th}Semester.

a) Community Engagement and Service (CES) (2 Credits)

All UG students are also mandated to participate in a 15 days community engagement activity during their winter vacation between 5^{th} and 6^{th} Semesters. This Community engagement activity is expected to expose the students to social problems of neighbourhood village students may prepare a report on the activities carried out for a award of 2 credits.

EVALUATION:

Total Marks: 100

All Credit courses are evaluated for 100 marks. Internal Assessment component is for 25 marks and the End Semester University exam is for 75 marks. In case of Practicals, Project work, etc., it is 50:50 marks for Internal and End-Semester Exams.

Breakup of Internal Assessment Marks:

Total Internal Assessment mark for a theory subject is 25marks. The breakup is:

a)	Mid Semester Exam (one) -20 Marks
b)	Percentage of Attendance-5 Marks
Total - 25Marks	

Marks for Attendance are as follows:

Below75%	0
75%-80%	1
80%-85%	2
85%-90%	3
90%-95%	4
95%-100%	5

Internal Test Scheme:

Principal of the College schedules the Mid-Semester Exam for all courses during 8/9th week of start of classes. All faculty members are expected to conduct this Mid-Semester exam for 1.30 hr duration and evaluate, upload the marks to Controller of Examinations of University. Colleges are also requested to preserve the answer books of Mid-Semester exams until declaration of results by the University.

Internal Assessment marks for Practicals / Project work / Internships subjects:

Faculty member in-charge of Lab practicals shall evaluate the practical subjects for 50 marks. The breakup is as follows:

a) Observation note / Demo note/ Work dairy / etc.	20
b) Practical Record/ Internship Report / etc.	30
Total	**50**

End-Semester University Exam:

Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical subjects based on University calendar.

A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams mostly during 15/16th week of the Semester. Question Papers shall be set externally based on BOS approved syllabus. All students who have a minimum of 70% attendance are eligible to attend the end-semester exams. The breakup of end semester marks:

a) Theory subjects: (Sec A, Sec B and Sec C) Questions from all units of syllabus	75marks
b) Practical/Internship Project Work subjects (Based on Practical Exams/Presentation/Viva)	50marks

Consolidation of Marks and passing Minimum:

Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in end-semester examination. The total marks will be converted into letter grades as shown in the following Table 2. As per NEP Regulations, the passing minimum is 50% marks (IA + End semester put together) However, Pondicherry University considers 40% marks as pass during first 3 years of study and students who secured less than 50 will be awarded 'P' (Pass Grade)

Arrear Exam:

A student who failed to secure 40% marks in aggregate is declared as Failed and he is eligible to take up supplementary examination by registering to the said course in the following Semester. All other candidates who failed due to shortage of attendance, those who are seeking to improve the grade shall repeat the course.

Letter Grades and Calculation of CGPA:

Total Marks Secured by a student in each subject shall be converted into a letter grade. UGC Framework has suggested a Country wide uniform letter grades for all UG courses. The following Table shows the seven letter grades and corresponding meaning and the grade points for calculation of CGPA.

TABLE–2

Equivalent Letter Grade	Meaning	Grade Points for Calculation of CGPA
O	Outstanding	10
A+	Excellent	9
A	Very Good	8
B+	Good	7
B	Above Average	6
C	Average	5
P	Pass	4
F	Fail	0
Ab	Absent	0

In order to work out the above letter grades, the marks secured by a student (Total of IA and Semester End) would be categorized for relative grading. The ranges of marks for each grade would be worked as follows:

Highest marks in the given subject = X

Cut of marks for grading purpose =50marks

Passing mark (for 3 year of UG) =40

Number of grades (excepting P grade) (O, A+, A, B+,B, C) =6

Range of marks =K

$$K = \frac{x - 50}{G}$$

The following table given the range of marks and letter grades. According to K value, one of the following grading schemes will be followed.

(i) If $K \geq 5$, then the grades shall be awarded as given in Table II.

Table II		
Range of Marks in%	**Letter Grade Points for**	**Letter Grade Points for**
X to (X-K) +1	O	10
(X-K) to(X-2K) +1	A+	9
(X-2K) to (X-3K) +1	A	8
(X-3K) to (X-4K) +1	B+	7
(X-4K) to (X-5K) +1	B	6
(X-5K) to 50	C	5
40 –49	P	4
Below 40	F	0
Absent (Lack of Attendance)	Ab	0

(ii) If K < 5, then the grades shall be awarded as given in Table III.

Table III		
Range of Marks in%	**Letter Grade Points for**	**Letter Grade Points for**
80-100	O	10
71-79	A+	9
66-70	A	8
61-65	B+	7
56-60	B	6
50-55	C	5
40-49	P	4
Below40	F	0
Absent (lack of attendance)	Ab	0

Calculation of Semester Grade Point average and CGPA:

Semester Grade Point Average (SGPA) is calculated by taking a weighted average of all grade points secured by a candidate from all subjects registered by him/her in the given Semester. The weights being the number of credits that each subject carry.

Cumulative Grade Point Average (CGPA) CGPA shall be calculated as the weighted average of credits that course carries and the value of Grade points averaged for all subjects.

Computation of SGPA and CGPA

The following procedure shall be followed to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student,

i.e. **SGPA**(Si)=Σ(CixGi)/ΣCi

Where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th}course.

(i) **Example for Computation of SGPA where candidate has not failed in any course.**

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course1	3	A	8	3X8=24
I	Course2	4	B+	7	4X7=28
I	Course3	3	B	6	3X6=18
I	Course4	3	O	10	3X10=30
I	Course5	3	C	5	3X5=15
I	Course6	4	B	6	4X6=24
		20			139
	SGPA				139/20=6.95

(ii)Example for Computation of SGPA where candidate has failed in one course.

Semester	**Course**	**Credits**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course1	3	A	8	3X8=24
I	Course2	4	B+	7	4X7=28
I	Course3	3	B	6	3X6=18
I	Course4	3	O	10	3X10=30

I	Course5	3	C	5	3X5=15
I	Course6	4	F	0	4X0=00
		20			115
	SGPA				115/20=5.75

Example for Computation of SGPA where candidate has failed in two courses.

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course1	3	A	8	3X8=24
I	Course2	4	B+	7	4X7=28
I	Course3	3	F	0	3X0=00
I	Course4	3	B	6	3X6=18
I	Course5	3	C	5	3X5=15
I	Course6	4	F	0	4X0=00
		20			85
	SGPA				85/20=4.25

The CGPA shall also be calculated in similar way as shown in examples (i), (ii) and (iii) of SGPA for all subjects taken by the students in all the semesters. However, if any student fails more than once in the same subject, then while calculating CGPA, the credit and grade point related to the subject in which the student fails in multiple attempts will be restricted to one time only. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

In case of audit courses offered, the students may be given (P) or (F) grade without any credits. This may be indicated in the mark sheet. Audit courses will not be considered towards the calculation of CGPA.

Declaration of Results:

Controller of Examinations (COE) of the University shall declare the results of given UG programme following the CGPA secured by students by the end of 6th Semester.

PASS CLASSES

Range of CGPA	Result
9.0 above	First Class with distinction
6.0 above	First Class
5.0 Below5.99	Second Class
4.0 4.99	Pass Class

SCHEME OF EXAMINATION (Practical Paper)

Total Marks: 100: (Internal: 50 & External: 50)

INTERNAL EXAMINATION: Maximum Marks: 50

- Components of Internal Evaluation (50 Marks)

1. Attendance - 5 marks
2. Observation Notebook/Demonstration – 5 marks
3. Model Practical Exam -10 marks
4. Record – 30 marks

END-SEMESTER PRACTICAL EXAMINATION: Maximum marks: 50

Question Paper Pattern for End Semester Practical Examination (50 Marks)

1. Question I – 20 marks
2. Question II - Spotters -10 marks
3. Record – 20 marks

(Submission of practical record for the End Semester Practical Examination is mandatory])

SCHEME OF EXAMINATION (Theory Paper)

Total Marks: 100 (Internal: 25 & External: 75)

INTERNAL EXAMINATION: Maximum Marks: 25.

- Mid-Semester Examination for 1.30 Hours duration shall be taken: 20 Marks
- Attendance: 5 Marks

EXTERNAL EXAMINATION : Maximum Marks: 75.

- Examinations shall be in three sections.
- Section-A for 20 Marks, Section –B for 25 Marks and Section-C for 30 Marks.

Question Paper Pattern for End Semester Theory Examination

SECTION – A: (10 x 2 = 20 Marks)

- It is of short answer type. Each question carries 2 marks.
- 10 questions to be given by selecting 2 questions from each unit.
- Candidate should Answer all the questions.

SECTION – B: (5 x 5 = 25 Marks)

- It is of short answer type. Each question carries 5 marks.
- 5 questions to be given with either or choice, 1 question from each unit.
- Candidate should answer all 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

- It is of essay answer type. Each question carries 10 Marks.
- 5 questions to be given. One question from each unit.
- Candidate should answer 3 out of 5 questions.

B.Sc./B.Sc. (Honors) in Microbiology

The Semester-wise and Broad Course Category-wise Distribution of credits of the Undergraduate Programme:

Semester	Major	Minor	Multi-disciplinary	Language	Skill Enhancement Course	Value Added	Community Engagement	Summer Internship	Research Project	Total Credits
I	1. Fundamentals of Microbiology	1. Cell Biology	1. Biomolecules	English /MIL	1. Mushroom and *Spirulina* Cultivation/ 2. Management of Microbiology Laboratory/ 3. Haematology and Blood Banking **(Any one)**	Two courses		Nil	Nil	
Credits	**4**	**4**	**3**	**3**	**3**	**4**				**21**
II	2. Immunology	2. Clinical Biochemistry	2. Fermented Foods and Dairy Products	English /MIL	4. Quality Control and Assurance in Microbiology/ 5. Bioremediation/ 6. Vermitechnology **(Any one)**	Two courses		Nil	Nil	
Credits	**4**	**4**	**3**	**3**	**3**	**4**				**21**
III	3. Molecular Biology 4. Food Microbiology	3. Economic and Medical Entomology	3.Public Health Microbiology	English /MIL	7. Bioinoculants production/ 8. Diagnostic Microbiology/ 9. Microbial Food Safety **(Any one)**	Nil		Nil	Nil	
Credits	**8**	**4**	**3**	**3**	**3**					**21**

IV	5. Bacterial Physiology and Metabolism 6. Virology 7. Recombinant DNA Technology	4. Plant Pathology	Nil	English /MIL	Nil	Nil	Community Engagement	Nil	Nil
Credits	**12**	**4**		**3**			**2**		**21**
V	8. Pharmaceutical Microbiology 9. Microbial Diversity and Bacterial Phylogeny 10. Medical Mycology and Parasitology	5. Microbes in Human Welfare	Nil	Nil	Nil	Nil		Summer Internship	Nil
Credits	**12**	**4**						**4**	**20**
VI	11. Microbial Process and Products Technology 12. Agricultural Microbiology 13. Environmental Microbiology 14. Medical Bacteriology	6. Microbial Culture and Control	Nil	Nil	Nil	Nil		Nil	Nil
Credits	**16**	**4**							**20**
VII	15. Microbial Ecology 16. Dairy Microbiology 17. Research Methodology	7. Introduction to Bioinformatics 8. Advances in Bioinformatics	Nil	Nil	Nil	Nil		Nil	Nil

Credits	**12**	**8**								**20**
VIII	18. Microbes and their applications (Credit Seminar) 19. Industrial Microbiology 20. Research Project **or** 21. Soil Microbiology 22. Techniques in Microbiology 23. Entrepreneurial Microbiology	Nil	Nil	Nil	Nil	Nil		Nil	Project	
Credits	**8** (With project) **or** **20** (Without Project)								**12**	**20**
Total Credits	**76** (With project) **or** **88** (Without project)	**32**	**9**	**12**	**9**	**8**	**2**	**4**	**12** (With project) **or** **0** (Without project)	**164**

UG Certificate in Microbiology: Students exiting the programme after two semesters and securing **42 credits** will be awarded UG Certificate provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.

UG Diploma in Microbiology: Students exiting the programme after four semesters and securing **84 credits** will be awarded UG Diploma provided they secure additional 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 9 credits from skill-based courses earned during first year and second year.

B.Sc. Microbiology: Students who want to undertake 3-year UG programme will be awarded UG Degree (B.Sc. Microbiology) after six semesters upon securing **124 credits**.

B.Sc. (Honors) in Microbiology: Students will be awarded B.Sc. (Honors) in Microbiology after eight semesters and securing minimum **164 credits.**

B.Sc. (Honors with Research) in Microbiology: Students will be awarded B.Sc., (Honors with Research) in Microbiology after eight semesters and securing minimum **164 credits** with Research Project.

ANNEXURE II

SEMESTER WISE CREDITS AND HOURS OF WORK AS PER NEP

SEMESTER I

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD 1	Major Disciplinary course (compulsory)	MJD-1:**Fundamentals of Microbiology**	3+1	3+2 P
MID1	Minor Disciplinary Courses	MID-1: **Cell Biology**	3+1	3+2 P
MLD 1	Multi-Disciplinary courses	MLD-1:**Biomolecules**	2+1	2+2 P
AEC I & II	Ability Enhancement courses I & II English or Indian Language	AEC-1(A):Basic Language and Literature	2+1	4
		AEC-1(B):Functional Language		
		AEC-1(C):Spoken communication		
		AEC-2(A):Basic Language and Literature		
		AEC-2(B).Functional Language		
		AEC-2(C).Spoken communication		
SEC	Skill Enhancement Course (Anyone)	SEC-1(A): **Mushroom and *Spirulina* Cultivation**	3	4
		SEC-1(B): **Management of Microbiology Laboratory**		
		SEC-1(C): **Haematology and Blood Banking**		
VAC	NEP Value Added common courses I & II (compulsory)	VAC-1.Environmental Strudies	2	4
		VAC-2.Understanding India (Theory/Field based)	2	4
		Total Credits / Total Hours of Work	**21 Credits**	**30 Hours**

P denotes Practical hours and conducted in batches if student strength exceeds 25.

SEMESTER II

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD 2	Major Disciplinary courses (compulsory)	MJD-2:**Immunology**	3+1	3+2 P
MID2	Minor Disciplinary courses	MID-2: **Clinical Biochemistry**	3+1	3+2 P
MLD2	Multi-Disciplinary courses (compulsory)	MLD-2: **Fermented Foods and Dairy Products**	3	4
AEC III &IV	Ability Enhancement courses III & IV English or Indian Language	AEC-3(A):Basic Language and Literature	2+1	4
		AEC-3(B):Functional Language		
		AEC-3(C):Spoken communication		
		AEC-4(A):Basic Language and Literature		
		AEC-4(B):Functional Language		
		AEC-4(C):Spoken communication		
SEC	Skill Enhancement Course (Any one)	SEC-2(A):**Quality Control and Assurance in Microbiology**	3	4
		SEC-2(B): **Bioremediation**		
		SEC-2(C): **Vermitechnology**		
VAC	NEP Value added common courses I & II (compulsory)	VAC-3:Health & Wellness/ Yoga Education	2	4
		VAC-4:Digital Technologies (Theory/Field based)	2	4
		Total Credits / Total Hours of Work	**21 Credits**	**30 Hours**

P denotes Practical hours and conducted in batches if student strength exceeds 25.

UG Certificate in Microbiology: Students exiting the programme after two semesters and securing **42 credits** will be awarded UG Certificate provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.

SEMESTER III

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD3 MJD4	Major Disciplinary courses (compulsory)	MJD3: **Molecular Biology** MJD4: **Food Microbiology**	3+1 3+1	4+2 P 4+2 P
MID3	Minor Disciplinary courses	MID-3: **Economic and Medical Entomology**	3+1	4+2 P
MLD3	Multi-Disciplinary Course (compulsory)	MLD-3:**Public Health Microbiology**	3	4
AEC V &VI	Ability Enhancement courses V&VI English or Indian Language	AEC-5(A):Basic Language and Literature AEC-5(B):Functional Language AEC-5(C):Spoken communication AEC-6(A):Basic Language and Literature AEC-6(B):Functional Language AEC-6(C):Spoken communication	2+1	4
SEC	Skill Enhancement Course (Anyone)	SEC-3(A):**Bioinoculants production** SEC-3(B): **Diagnostic Microbiology** SEC-3(C): **Microbial Food Safety**	3	4
		Total Credits / Total Hours of Work	**21 Credits**	**30 Hours**

P denotes Practical hours and conducted in batches if student strength exceeds 25.

SEMESTER IV

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD5	Major Disciplinary courses (compulsory)	MJD5:**Bacterial Physiology and Metabolism**	3+1	3+2 P
MJD6		MJD6: **Virology**	3+1	3+2 P
MJD7		MJD7:**Recombinant DNA Technology**	3+1	3+2 P
MID4	Minor Disciplinary courses	MID-4: **Plant Pathology**	3+1	3+2 P
AEC VII &VII I	Ability Enhancement courses VII & VIII English or Indian Language	AEC-7(A):Basic Language and Literature	2+1	4
		AEC-7(B):Functional Language		
		AEC-7(C):Spoken communication		
		AEC-8(A):Basic Language and Literature		
		AEC-8(B):Functional Language		
		AEC-8(C):Spoken communication		
Project	WP/Internship	Community Engagement	2	6
		Total Credits / Total Hours of Work	**21 Credits**	**30 Hours**

P denotes Practical hours and conducted in batches if student strength exceeds 25.

UG Diploma in Microbiology: Students exiting the programme after four semesters and securing **84 credits** will be awarded UG Diploma provided they secure additional 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 9 credits from skill-based courses earned during first year and second year.

SEMESTER V

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD 8	Major Disciplinary courses (compulsory)	MJD8:**Pharmaceutical Microbiology**	3+1	4+2 P
MJD 9		MJD9: **Microbial Diversity and Bacterial Phylogeny**	3+1	4+2 P
MJD10		MJD10:**Medical Mycology and Parasitology**	3+1	4+2 P
MID5	Minor Disciplinary courses	MID-5: **Microbes in Human Welfare**	3+1	4+2 P
SKD	Skill Developmen tCourse	MJD15–Summer Internship	4	6
		Total Credits / Total Hours of Work	**20 Credits**	**30 Hours**

P denotes Practical hours and conducted in batches if student strength exceeds 25.

SEMESTER VI

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher
MJD11	Major Disciplinary courses (compulsory)	MJD11: **Microbial Process and Products Technology**	3+1	4+2 P
MJD12		MJD12:**Agricultural Microbiology**	3+1	4+2 P
MJD13		MJD13:**Environmental Microbiology**	3+1	4+2 P
MJD14		MJD14: **Medical Bacteriology**	3+1	4+2 P
MID6	Minor Disciplinary courses	MID-6: **Microbial Culture and Control**	3+1	4+2 P
		Total Credits / Total Hours of Work	**20 Credits**	**30 Hours**

P denotes Practical hours and conducted in batches if student strength exceeds 25.

B.Sc.Microbiology: Students who want to undertake 3-year UG programme will be awarded UG Degree (B.Sc. in Microbiology) after six semesters upon securing **124 credits**.

SEMESTER VII

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher	
MJD15	Major Disciplinary courses (compulsory)	MJD15: **Microbial Ecology**	3+1	4+2 P	
MJD16		MJD16: **Dairy Microbiology**	3+1	4+2 P	
MJD17		MJD17: **Research Methodology**	3+1	4+2 P	
MID7	Minor Disciplinary courses	MID-7: **Introduction to Bioinformatics**	3+1	4+2 P	
MID8		MID-8: **Advances in Bioinformatics**	3+1	4+2 P	
		Total Credits / Total Hours of Work	**20 Credits**	**30 Hours**	

P denotes Practical hours and conducted in batches if student strength exceeds 25.

SEMESTER VIII

Code No	Nature of Course	Title of the Course	Credits	Hours of Teacher	
MJD18 MJD19	Major Disciplinary courses (compulsory)	MJD18: **Microbes and their applications (Credit Seminar)** MJD19:**Industrial Microbiology**	2+2 3+1	2+4 P 4+2 P	
MJD 20	Research Project or Major Disciplinary Course (Choose one) **or**	MJD 20: R**esearch Project** (Alternatively) **or**	12 **or**	18 **or**	
MJD 21	**3** Major Disciplinary Courses	MJD 21:**Soil Microbiology**	3+1	4+2 P	
MJD 22		MJD 22:**Techniques in Microbiology**	3+1	4+2 P	
MJD 23		MJD 23:**Entrepreneurial Microbiology**	3+1	4+2 P	
		Total Credits / Total Hours of Work	**20 Credits**	**30 Hours**	

P denotes Practical hours and conducted in batches if student strength exceeds 25.
B.Sc. (Honors) in Microbiology: Students will be awarded B.Sc. (Honors) in Microbiology after eight semesters and securing minimum **164 credits.**

B.Sc. (Honors with Research) in Microbiology: Students will be awarded B.Sc. (Honors with Research) in Microbiology after eight semesters and securing minimum **164 credits** with Research Project.

Major courses for B.Sc. / B.Sc.(Honors) in Microbiology- semester wise distribution.

SEMESTER	COURSE	TOTAL CREDIT
I	Fundamentals of Microbiology	3+1 (P)
II	Immunology	3+1 (P)
III	Molecular Biology	3+1 (P)
	Food Microbiology	3+1 (P)
IV	Bacterial Physiology and Metabolism	3+1 (P)
	Virology	3+1 (P)
	Recombinant DNA Technology	3+1 (P)
V	Pharmaceutical Microbiology	3+1 (P)
	Microbial Diversity and Bacterial Phylogeny	3+1 (P)
	Medical Mycology and Parasitology	3+1 (P)
VI	Microbial Process and Products Technology	3+1 (P)
	Agricultural Microbiology	3+1 (P)
	Environmental Microbiology	3+1 (P)
	Medical Bacteriology	3+1 (P)
VII	Microbial Ecology	3+1 (P)
	Dairy Microbiology	3+1 (P)
	Research Methodology	3+1 (P)
VIII	Microbes and their applications (Credit Seminar)	2+2 (P)
	Industrial Microbiology	3+1 (P)
	Soil Microbiology	3+1 (P)
	Techniques in Microbiology	3+1 (P)
	Entrepreneurial Microbiology	3+1 (P)
	Total Credits	**88**

Courses offered under Minor stream in Microbiology.

SEMESTER	COURSE	TOTAL CREDIT
I	Cell Biology	3+1 (P)
II	Clinical Biochemistry	3+1 (P)
III	Economic and Medical Entomology	3+1 (P)
IV	Plant Pathology	3+1 (P)
V	Microbes in Human Welfare	3+1 (P)
VI	Microbial Culture and Control	3+1 (P)
VII	Introduction to Bioinformatics	3+1 (P)
VIII	Advances in Bioinformatics	3+1 (P)
	Total Credits	**32**

Multidisciplinary course offered in Department of Microbiology

SEMESTER	COURSE	TOTAL CREDIT
I	Biomolecules	2+1 (P)
II	Fermented Foods and Dairy Products	3
III	Public Health Microbiology	3
	Total Credits	**9**

Skill Enhancement Course offered in Department of Microbiology

SEMESTER	COURSE	TOTAL CREDIT
I (Any one)	1.Mushroom and *Spirulina* Cultivation	**3**
	2.Management of Microbiology Laboratory	
	3. Haematology and Blood Banking	
II (Any one)	4.Quality Control and Assurance in Microbiology	**3**
	5.Bioremediation	
	6.Vermitechnology	
III (Any one)	7. Bioinoculants Production	**3**
	8. Diagnostic Microbiology	
	9. Microbial Food Safety	
	Total Credits	**9**

SEMESTER – I

Major Disciplinary Course
MJD1

FUNDAMENTALS OF MICROBIOLOGY

Credits: 3+1(P)

Total hours: 75

Course Objectives:

The objectives of the course include (i) to learn the basics of microbiology including, historical events (ii) to understand about the types of microscopy and intricate details of the bacterial cell. (iii) to appreciate various methods of sterilization employed to ensure aseptic conditions in microbiology works and (iv) lastly to know about the types of culture media employed to isolate the microorganisms.

Unit - I **5 hours**

History and scope of microbiology, spontaneous generation – biogenesis theory – contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Paul Ehrlich and Fleming.

Unit – II **10 hours**

Microscope– principles and application – simple and compound microscope – dark field – phase contrast, fluorescent microscope, SEM and TEM. Types of staining – simple, differential (Gram's, AFB), special – capsular staining (negative), spore, LPCB, KOH mount.

Unit - III **10 hours**

Ultra structure of bacteria, cell envelope, cell wall– Gram positive and Gram negative bacterial cell wall, slime, flagella, capsule, pili.

Unit – IV **10 hours**

Sterilization and disinfection – principles – methods of sterilization – physical methods – dry heat –moist heat – radiation– filtration (membrane and HEPA)– chemical sterilization – chemical agents – mode of action. Preservation and maintenance of culture.

Unit - V **10 hours**

Culture and media preparation – solid and liquid. Types of media –semi synthetic, synthetic, enriched, enrichment, selective and differential media. Pure culture techniques – tube dilution, pour, spread, streak plate. Anaerobic cultivation of bacteria.

Unit – VI **30 hours**

Practical- Microbiology Good Laboratory Practices and Bio safety- Preparation of culture media and cultivation of bacteria & fungi- microscopic observation of bacteria and fungi - Microbial preservation techniques - Isolation and Identification of bacteria and fungi.

Text Books

1. Willey J.M., Sandman K.M. and Wood D.H. (2023) Prescott's Microbiology, 12thEdn., Mc Graw Hill, p. 1024.
2. Madigan, M.T., Bender K.S. Buckley D.H., Sattley W.M. and Stahl D.A (2021) Brock Biology of Microorganisms, 16th Global Edn., Pearson Education Ltd., p.1129.

Reference Books

1. Chess B. (2024) Talaro's Foundations in Microbiology, 12th Edn., Mc Graw Hill, p.993.
2. Tortora G.J., Funke B.R., Chase C.L., Bair W.B. and Weber D. (2024) Microbiology: An Introduction, 14th Edn. Pearson-Benjamin Cummings.
3. Brown A. and Smith H. (2016) Benson's Microbiological Applications: Laboratory Manual concise version, 14th Edn. McGraw-Hill Companies.

Course Outcome:

Upon successful completion of the course the candidate will

- *be familiar with the history and development of Microbiology with the broad perspective of the scope of Microbiology.*
- *understand the principles and applications of the different microscopes and staining methods.*
- *have gained knowledge on the ultrastructure of bacteria.*
- *be acquainted with different methods of sterilization and preservation of cultures.*
- *understand the different types of media used for the cultivation of microbes.*

SEMESTER – I

Minor Disciplinary Course
MID1

CELL BIOLOGY

Credits: 3+1(P)

Total hours: 75

Course Objectives:

The objectives of this course is to understand the basics of cell biology which is an essential part of any life science programme, it includes (i) to know about the history and broad classification of the cells types (ii) to appreciate the structural and functional roles of the cells in the daily life such as appreciating the role of the organelles and to value the life processes such as respiration and photosynthesis (iii) finally to comprehend the role of cell communication in life systems.

Unit – I **5 hours**

History of cell biology, cell as basic unit of life, cell theory, protoplasm theory and organismal theory, broad classification of cell types, Bacteria, Archaea (prokaryotic) and Eukaryotic cells and their similarities and differences.

Unit – II **10 hours**

Structure and functions of cell wall: bacterial cell wall – plant cell wall and fungal cell wall, plasma membrane – exocytosis, endocytosis, phagocytosis – vesicles and their importance in transport. Cytoskeleton structure – microtubules, microfilaments, intermediate filament.

Unit – III **10 hours**

Structure and functions of cell organelles– endoplasmic reticulum (rough endoplasmic reticulum and smooth endoplasmic reticulum), golgi apparatus, lysosomes, microbodies (peroxysomes and glyoxysomes), vacuoles, ribosomes, centriole and basal bodies.

Unit - IV **10 hours**

Mitochondria – organization of respiratory chain, chloroplasts– photophosphorylation, nucleus, nucleolus, nuclear membrane and organization of chromosomes, cell cycle and its check points, cell division (mitosis and meiosis).

Unit – V **10 hours**

Cell communication – overview – types of cell signalling – signal molecules – signal amplification – receptor types – quorum sensing.

Unit – VI **30 hours**

Practical: Understand about the cell types of prokaryotes and eukaryotes, by observing their structure, the cell division and function. Observing the internal structures of the cells, their importance and functioning.

Text Books

1. Verma P.S. and Agarwal V.K. (2016) Cell Biology (Cytology, Biomolecules, Molecular Biology),Paperback, S. Chand and Company Ltd**.**
2. Hardin J., Bertoni G. and Kleinsmith (2022) Becker's World of the Cell. 10th Edn (Global Edition). Pearson Education Ltd., p. 929.

Reference Books

1. Cooper G.M. (2019) The cell A molecular approach. 8th Edn., Sinauer Associates. p. 813.
2. Bergtrom G. (2022) Cell and Molecular Biology, 5th Edn., OER, p.628.
3. Iwasa J. and Marshall W. (2020) Karp's Cell and Molecular Biology. John Wiley& Sons. p. 2105.

Course Outcome:

Upon successful completion of the course the candidate will

- *be able to understand the history of cell biology and broad classification of cell types.*
- *have gained knowledge on the structure and functions of cell wall, plasma membrane, vesicles and cytoskeleton.*
- *understand the structure and functions of the nucleus and different cell organelles.*
- *understand cell division and the significance of cell cycle and its check points.*
- *have gained insight on types of cell signaling, signal amplification and quorum sensing.*

SEMESTER – I

Multi - Disciplinary Course
MLD1

BIOMOLECULES

Credits: 2+1(P)

Total hours: 60

Course Objectives:

The objectives of including the biomolecules paper are (i) to learn about the structural and functional role of vital biomolecules like carbohydrates, proteins, fats, and nucleic acids in biological systems) (ii) to appreciate the role of biochemical processes in living organisms.

Unit-I **6 hours**

Chemistry of carbohydrates: definition and classification of carbohydrates, linear and ring forms (Haworth formula) for monosaccharides–disaccharides and glycosidic bond. Physical properties – mutarotation and kiliani cyanohydrin synthesis. Chemical properties – oxidation, reduction, osazone formation. Polysaccharides (homo and hetero): starch and cellulose – occurrence, structure, physical and chemical properties – reducing and non reducing sugar.

Unit-II **6 hours**

Chemistry of aminoacids and proteins: standard and non-standard amino acids and their properties, amphoteric nature, isoelectric point, isoelectric pH and Zwitter ion – Ramachandran plot for amino acids. Proteins: classification – shape and size, solubility, physical properties and functional properties. Primary, secondary, tertiary and quaternary structure of protein –protein folding – molecular chaperones.

Unit-III **6 hours**

Chemistry of lipids: definition, classification and functions. Occurrence, chemistry and biological functions – simple lipids: tertiary compound lipids (e.g. phospholipids), derived lipids: steroids (e.g. cholesterol). Saturated and unsaturated fatty acids physical property–emulsification. Chemical properties – saponification, rancidity, definition of acid number, saponification number, iodine number and Reichert-Meissl number. Bile acid and bile salt functions.

Unit-IV **6 hours**

Chemistry of nucleic acids: definition, sugar pucker – nucleoside, nucleotide and polynucleotide. Double helical model of DNA – super coil forms and linking numbers of DNA. Structure of RNA's– occurrence, chemistry and biological functions. Differences between DNA and RNA, properties– quantification of nucleic acids – thermal denaturation – cot curve and cot value, T_m, hypo and hyperchromicity.

Unit -V **6 hours**

Metabolic pathways: Glycolysis, TCA cycle and its energetics, electron transport chain and oxidative phosphorylation: Gluconeogenesis, Glyoxylate cycle; Entner-

Doudoroff pathway. Deamination, transamination reaction, β – oxidation of fatty acids, Urea cycle.

Unit –VI **30 hours**

Practical: Preparation of Molar, Normal solutions and buffers – Determination of pH using pH meter - . Qualitative analysis of carbohydrates, protein and fats-. Estimation of glucose by Benedict's test, Estimation of ascorbic acid, Preparation of starch from potatoes, Determination of activity of human salivary α amylase.

Text Books

1. Satynarayana T. (2013) Biochemistry, 4th Edn. Elsevier, India.
2. Moore J.T. and Langley R. (2008) Biochemistry for Dummies, Wiley Publishing Company.

Reference Books

1. Nelson D.L and Cox M.M. (2021) Lehninger Principles of Biochemistry, 8thEdn. Intl. Edition, MacMillan Learning.
2. Voet D., Voet J.G. and Pratt C.W. (2016) Biochemistry, 5thEdn. John Wiley and Sons Ltd.
3. Campbell M.K., Farrell S.O. and McDougal O.M. (2018) Biochemistry, 9thEdn. Brooks /Cole Cenage Learning.

Course Outcome:

Upon successful completion of the course the candidate will

- *understand the chemistry of carbohydrates and its classification.*
- *understand the chemistry of amino acids and hierarchy of protein structure – primary, secondary, tertiary and quaternary structure.*
- *able to comprehend the chemistry of lipids and nucleic acids.*
- *able to understand the metabolic pathways which occurs in living organisms.*

SEMESTER – I

Skill Enhancement Course
SEC-1(A)
MUSHROOM AND SPIRULINA CULTIVATION

Credits: 3

Total hours: 45

Course Objectives:

The course imparts entrepreneurial skills with objectives (i) to learn about the types of edible mushrooms and their uses to human kind (ii) to gain knowledge on cultivation methods for mushroom and the diseases that commonly affect them (iii) to appreciate the importance of Spirulina to human kind, understanding their cultivation methods and processing techniques.

Unit – I **5 hours**

Edible and non-edible mushroom –historical account, most commonly cultivated mushrooms in the world, distribution and production in various countries.

Unit – II **10 hours**

Cultivation of button, oyster and paddy straw mushroom –raising a pure culture – spawn preparation and mass cultivation – harvest pests and diseases in mushroom

Unit – III **10 hours**

Economics of mushroom cultivation – precautions in mushroom cultivation –precaution to be taken while selecting the area, spawn preparation, spawn run, during cropping harvesting etc. Mushroom recipes (western and Indian recipes, pickles, powders, jams etc.

Unit – IV **10 hours**

Introduction to SCP production –historical use and rediscovery of *Spirulina* importance– morphology, taxonomy and habitat of *Spirulina*– biochemical composition including proximate composition – amino acids – unsaturated fatty acids – minerals and vitamins. Human health benefits of *Spirulina*.

Unit – V **10 hours**

Natural production –laboratory cultivation – small scale commercial production – commercial and mass cultivation (tank construction, culture medium, strain selection, scaling up of the process) – importance of light and pH in *Spirulina* cultivation – harvesting, drying and packing.

Text Books

1. Changs T. and Hayanes W.A. (Ed.) (1978) Biology and Cultivation of Edible Mushrooms. Academic Press. N.Y.
2. Habib M.A.B., Parvin M., Huntington T.C. and Hasan M.R. (2008) A review on culture, production and use of *Spirulina* as food for humans and feeds for domestic animals and fish. FAO Fishers and Aquaculture Circular No. 1034, FAO, Rome, Italy.

Reference books

1. Biswas S., Datta M. and Ngachan S.V. (2012) Mushrooms: A Manual for Cultivation, PHI.
2. Selvendran D. (2015) Large Scale Algal Biomass (*Spirulina*) Production in India. In: D. Das (Ed.) Algal Biorefinery: An Integrated Approach, Springer.
3. Zadrazil F. and Grabbe K. (1983) Edible Mushroom, Biotechnology Vol. 3, Weinheim: Verlag Chemie, Berlin.

Course Outcome:

Upon successful completion of the course the candidate will

- *gain understanding on the edible mushrooms, its distribution and production in various countries.*
- *gain insight on the cultivation of various mushrooms.*
- *gain knowledge on economics of mushroom cultivation and preparation of various mushroom recipes.*
- *understand the importance of Spirulina and their cultivation methods.*

SEMESTER – I

Skill Enhancement Course
SEC-1(B)
MANAGEMENT OF MICROBIOLOGY LABORATORY

Credits: 3

Total hours: 45

Course Objectives:

A skill based learning course with objectives (i) to understand the rules and regulations of microbiological laboratory maintenance (ii) to familiarize with the instruments and quality control measures commonly adopted in microbiology laboratory (iii) to know about the procedures involved in strain maintenance and laboratory waste disposal.

Unit – I **5 hours**

Rules and regulations to be followed in a microbiology laboratory – maintenance of records –familiarizing with common chemicals, instruments and equipments of microbiology laboratory.

Unit - II **10 hours**

Laboratory management: human resources – logistics and supply – test performance – data management – resource tapping – instruments– water and sources of light and electricity – room– table and benches and space in the laboratory.

Unit - III **10 hours**

Laboratory quality control assessment: Internal quality control and external quality control.

Unit – IV **10 hours**

Maintenance of type strains or reference strain of microbes: culture collection centres – preservation and maintenance of cultures.

Unit – V **10 hours**

Laboratory waste disposal system: national and international guidelines for the disposal of waste. Basic concepts of bio-safety and its universal precautions.

Text books

1. Cappuccino J.G. and Welsh C. (2020) Microbiology a laboratory manual. 12thEdn. Pearson.
2. Gile, T.J. and Scungio D. (2014) Complete guide to Laboratory safety, 4thEdn. HCPro a division of BLR.

Reference books

1. Emmert E. (2013). Biosafety guidelines for handling microorganisms in the teaching laboratory: development and rationale. Journal of Microbiology & Biology Education14: 78–83.

Course Outcome:

Upon successful completion of the course the candidate will

- *become familiar with the rules and regulations to be followed in Microbiology laboratory.*
- *become acquainted with management of laboratory.*
- *gain knowledge on laboratory quality control assessment.*
- *have an understanding on maintenance of type strains.*
- *have an idea on laboratory waste disposal system and biosafety*

SEMESTER – I

Skill Enhancement Course
SEC-1(C)
HAEMATOLOGY AND BLOOD BANKING

Credits: 3

Total hours: 45

Course Objectives:
A skill based learning course with objectives (i) to appreciate the importance of blood and its examination (ii) to gain knowledge on the methods of counting of blood cells (iii) to know about the coagulation process, stains and staining techniques of examination of blood smear and to gain insight on ABO grouping, Rh typing, donor screening, preservation and storage of blood.

Unit – I **5 hours**

Blood: definition, characters, composition. Collection of blood – capillary blood: from adults and infants, examinations employed. Venous blood: from adults and infants, examinations employed – Anticoagulants: definition – type: Wintrobes, EDTA, heparin, citrate, concentration, examinations, advantages and disadvantages.

Unit – II **10 hours**

Counting of blood cells: Neubauer counting chamber – total RBC count: diluting fluids, normal values – total WBC count: diluting fluids, normal values differential leucocyte count: granulocyte and agranulocytes, morphology and function, staining technique – Platelet count: morphological characters and functions, haemoglobin: composition and normal values, haemoglobin estimation.

Unit – III **10 hours**

Coagulation mechanism: factors, bleeding time, clotting time. Haematological indices: packed cell volume. Erythrocyte sedimentation: principle – determination: introbes, Westergren method – advantages and disadvantages – factors affecting the process.

Unit – IV **10 hours**

Preparation of stains and staining techniques: Wright stain, Leishman's stain, Giemsa's stain, Fields stain, peroxidase stain. Examination of blood smear – peripheral smear report – size, colour and shape. Blood parasites: malarial parasite and microfilaria.

Unit – V **10 hours**

ABO Grouping: History, slide and tube technique, Rh typing: slide and tube technique, Coombs test: direct and indirect method, donor screening – cross matching, collection of blood,preservation and storage.

Text Books

1. Maheswari N. (2008) Clinical Pathology, Haematology and Blood Banking (for DMLT students), 2nd Edn. Jaypee Brothers Medical Publishers.
2. Hoffbrand A.V. and Moss P.A.H. (2015) Hoffbrand's Essential Haematology, 7th Edn. Wiley.

Reference books

1. Greer J.P., Foerster J., Lukens J.N.,Rodgers G.M., Paraskevas F. and Glader B.E. (Ed.) (2013). Wintrobe's Clinical Hematology, 13th Edn. Wolters Kluwer.
2. Hillyer C., Silberstein L., Ness P., Anderson K. and Roback J. (2006) Blood banking and Transfusion medicine, 2nd Edn. Elsevier Press.
3. Godkar P.B. and Godkar D.P. (2013) Textbook Medical Laboratory Technology Vol-I and II, Bhalani Publishing House.

Course Outcome:

Upon successful completion of the course the candidate will

- *understand the composition of blood and collection of blood.*
- *gain an insight on the various methods involved in counting of different blood cells.*
- *have a better understanding on the coagulation mechanism and erythrocyte sedimentation.*
- *become acquainted with the preparation of stains and staining techniques of examination of blood smear.*
- *understand ABO grouping, Rh typing, donor screening, preservation and storage of blood.*

SEMESTER – II

Major Disciplinary Course
MJD2

IMMUNOLOGY

Credits: 3+1(P)

Total hours: 75

Course Objectives:

The objectives of learning immunology are (i) to understand about the nature of infections and the natural immunity systems functioning in our body (ii) to appreciate the different type of immunoglobulin types and their unique role in immunity (iii) to identify the different assays used to quantify immunoglobulin molecules and to understand about hypersensitive reactions of cells.

Unit – I **9 hours**

History of immunology, host parasitic relationships, microbial infections – types – sources of infection – steps involved in infection – transmission of infection , virulence – toxigenicity and invasiveness, host resistance. Innate immunity and acquired immunity.

Unit – II **9 hours**

Structure, functions and properties of immune cells: stem cell, T cell, B cell, NK cell, macrophage, neutrophil, eosinophil, basophil, mast cell, dendritic cell and immune organs – bone marrow, thymus, lymph node, spleen, GALT, MALT, CALT.

Unit – III **9 hours**

Antigens– types, properties, haptens, adjuvants, vaccines – types – toxoids – antitoxins. Immunoglobulins – structure, types and properties. Hybridoma Technology, complement structure, properties, function of complement components and pathways.

Unit – IV **9 hours**

Antigen and antibody reactions: agglutination, precipitation, Complement Fixation Test, Immunofluorescence, Enzyme Linked Immuno Sorbent Assay (ELISA), Radioimmunoassay.

Unit – V **9 hours**

Hypersensitivity reactions: antibody mediated – type I anaphylaxis – type II antibody dependent cell cytotoxicity – type III – immune complex reactions – type IV – delayed type hypersensitivity reactions. Cell mediated immune responses –lymphokines, cytokines.

Unit – VI **30 hours**

Practical: Separation of serum and plasma, Blood grouping- Forward and Reverse Grouping, Differential Leukocyte Count, Total leukocyte count, Precipitation reactions, Radial immunodiffusion, Counter immunoelectrophoresis (CIE), Rocket electrophoresis, Rapid plasma reagin (RPR) test, Agglutination Test – Widal test, Antistreptolysin O (ASLO) test, ELISA (demonstration).

Text Books

1. Punt J., Stranford S., Jones P., Owen J.A. (2018) Kuby Immunology, 8th Edn. W.H. Freeman.
2. Shetti N. (2005) Immunology: Introductory Text book, 2nd Edn. New Age International Limited.

Reference Books

1. Lydyard P., Whelan A. and Fanger M. (2011) Bios Instant notes in Immunology, 3rd Edn. Garland Science publishers.
2. Delves P.J., Martin S.J., Burton D.R. and Roitt I.M. (2017) Roitt's Essential Immunology, 13th Edn. Wiley publishers.
3. Riedel S., Morse S., Mietzner T. and Miller S. (2022) Jawetz Melnick and Adelberg Medical Microbiology, 28th Edn. McGraw Hill Publications.

Course Outcome:

Upon successful completion of the course the candidate will

- *understand the history of immunology and host parasitic relationships.*
- *understand the structure and functions of the cells and organs of immune system.*
- *gain insight on antigens, antibodies and complements.*
- *understand the different antigen-antibody reaction.*
- *gain knowledge on hypersensitivity and cell mediated immune response.*

SEMESTER – II

Minor Disciplinary Course
MID2

CLINICAL BIOCHEMISTRY

Credits: 3+1(P)

Total hours: 75

Course Objectives:

Learning clinical biochemistry is (i) to appreciate the applications of biochemistry in clinical background (ii) to understand about the disorders and their impacts which resulted due to malfunctioning of carbohydrate, protein and lipid metabolism (iii) lastly to enlighten about the diagnostic enzymology under clinical conditions.

Unit-I **9 hours**

Basic concepts of clinical biochemistry: A brief review of units and abbreviations used in expressing concentrations and standard solutions. Biological samples– specimen collection–anticoagulant– preservatives for blood and urine– transport of specimens.

Unit - II **9 hours**

Disorders related to carbohydrate metabolism: diabetes mellitus–definition–WHO criteria– classification of diabetes mellitus– signs, symptoms and complications – GTT– galactosemia, galactosuria, fructosuria.

Unit – III **9 hours**

Disorders related to amino acid and lipid metabolism: Inborn errors of metabolism– phenylketonuria, alkaptonuria, albinism and tyrosinosis. Exogenous and endogenous transport of lipids–chylomicron transport, VLDL transport– reverse cholesterol transport– atherosclerosis–fatty liver– risk and anti-risk factors.

Unit – IV **9 hours**

Liver function test: detoxification and excretory functions– protein changes in liver disease- differential diagnosis of jaundice –hemolytic hepatic and obstructive jaundice– Bilirubin metabolism, bile pigment levels in blood and urine–gastric function test– fractional test meal analysis and its interpretation. GI hormones –gastrin, secretin, CCK and gastric inhibitory peptide.

Unit – V **9 hours**

Diagnostic enzymology: plasma enzymes–functional and non-functional enzymes– isoenzymes–enzyme patterns in acute pancreatitis, liver diseases and myocardial infarction.

Unit – VI **30hours**

Practical : Biochemical Specimens – collection – anticoagulants- calorimetric analysis - Blood sugar analysis-Blood urea analysis - Serum – creatinine estimation -Serum uric acid estimation -Serum cholesterol estimation - Serum –bilirubin estimation - estimation of total protein - Determination of A/G ratio - Urine analysis - Estimation of SGOT and SGPT.

Text Books

1. Ahmed N. (2011) Clinical Biochemistry. Oxford University Press.
2. VasudevanD.M. (2008) Textbook of Biochemistry for Medical Students, 5thEdn, Jaypee publishers.

Reference Books

1. Beckett G., Walker S., Rae P. and Ashby P. (2010) Lecture notes: Clinical Biochemistry, 8th Edn., Wiley-Blackwell.
2. Sathya Narayana U. (1999) Biochemistry, 2ndEdn. Kolkata, Allied Publishers.
3. Mallikarjuna Rao N. (2002) Medical Biochemistry,2ndEdn.New Age Publishers.

Course Outcome:

Upon successful completion of the course the candidate will

- *understand the basic concepts in clinical biochemistry.*
- *comprehend disorders related to carbohydrate metabolism.*
- *understand the disorders related to amino acid and lipid metabolism.*
- *understand the importance of liver functions and gastric functions and diagnosis of their disorders.*
- *understand the role of various enzymes in disease diagnosis, prognosis and assessment of response therapy.*

SEMESTER – II

Multi – Disciplinary Course
MLD2

FERMENTED FOOD AND DAIRY PRODUCTS

Credits: 3

Total hours: 45

Course Objectives:

The objective of the course includes i) to understand the role of microbes in food fermentation, ii) to know the criteria of fermented food products and iii) finally to gain knowledge on dairy based fermented products.

Unit – I **9 hours**

Fermentation: Definition – History of food fermentations, types of fermented foods, benefit of fermentation - nutritive value of fermented foods - microbial changes in fermented foods - microorganism - proteolytic, lipolytic and fermentative bacteria.

Unit - II **9 hours**

Importance of fermented foods: Traditional fermented foods, Organisms used for production of fermented food products, Environmental parameters for fermentation process; Classification of fermentation processes for fermented foods; safety criteria of fermented foods.

Unit - III **9 hours**

Oriental fermented foods, Soya Sauce, Koji, Tempeh, Miso, Natto, Tofu, Minchin, Bread, Indian products like Idly, Dosa, Bada, Bori.

Unit - IV **9 hours**

Fish and meat based fermented products, Different types of pickles like olive, cabbage, cucumber, salt stock and dill pickles, Fish sauce, sausages and Surimi.

Unit - V **9 hours**

Dairy based fermented products like Cheese, Acidophilus milk, Butter, Yoghurt, Kefir, Kumiss, Cultured butter milk.

Text Book

1. Food Microbiology. 5th Edition, 2013. William C. Frazier, Dennis C. Westhoff, N. M. Vanitha. McGraw-Hill Education (India).
2. Food Microbiology, 4th Edition, 2015. Adams, M.R., Moss, M.O and McClure, P. J. RSC Publication, CPI Group (UK) Ltd., Croydon, UK.

Reference Books:

1. Jay J.M., Loessner, M.J. and Golden D.A. (2005) Modern Food Microbiology, 7thEdn. Springer, p.782.
2. Matthews K.R., Kniel K.E. and Montville T.J. (2017) Food microbiology: An Introduction, 4thEdn., ASM Press, Washington, DC
3. The Microbiological Safety and Quality of Food. 2000. Barbara M. Lund, Baird-Parker, Gould G.W. An Aspen publication, Maryland, U.S.A.

***Course Outcome*:**

Upon successful completion of the course, the candidate will

- *Gain knowledge on the history of food fermentation*
- *Understand various types of fermentation process*
- *Acquire knowledge on various fermented food products*
- *Understand the fermentation process behind dairy products*

SEMESTER – II

Skill Enhancement Course
SEC2(A)
QUALITY CONTROL AND ASSURANCE IN MICROBIOLOGY

Credits: 3

Total hours: 45

Course Objectives:

The objective of the course includes i) to learn basics about good laboratory practices ii) to understand the role of quality control and quality assurance in microbiology and iii) finally to learn the various microbial standards for food and water.

Unit I **9 hours**

Good laboratory practices (GLPs) – Management of laboratory hazards and knowledge in First aid procedures. Quality assurance – Introduction and overview – Definition, Designing of microbiology laboratory –Quality Control and its Applications.

Unit II **9 hours**

Quality assessment of Equipment, Chemicals, Glass wares and Laboratory environments–Variance – Quality control calculations – Quality management – Maintenance of records and reports.

UNIT III **9 hours**

Quality assurance in Sterilization and Disinfection - Preservation of stock cultures, media and
diagnostic kits – Quality control of media and stains.

UNIT IV **9 hours**

Quality assessment of Disposal, Decontaminated matters and other biological effluents. Quality management in transportations of cultures. National control of Biological references and standards. Microbial quality control of pharmaceutical products.

UNIT V **9 hours**

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water.

Text Books

1. Philip Kotler, R, 2014, "Quality assurance of pharmaceuticals: A compendium of guidelines and related materials" ,Volume 2. Prentice Hall, Delhi.
2. W.B.Hugo and A.D.Russel, 2007, "Pharmaceutical Microbiology", 4th Edition, Blackwell Scientific Publications, New Jersey.

Reference Books

1. Baird RM, Hodges NA and Denyer SP, 2019,"Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices", CRC Press, USA.
2. Dr Norman Hodges and Professor Geoffrey Hanlon (University of Brighton), 2013, "Industrial Pharmaceutical Microbiology,Vol I &Vol II: standards & controls" Wiley - Blackwell Publication, New Jersey.
3. Madigan M.T. 2017. "Brock Biology of Microorganisms" 14th Edition. Pearson-Prentice Hall, USA.

Course Outcome:

On completion of the course, the student will be able

- *to understand the good laboratory practices (GLPs)*
- *equip themselves with quality control and quality assurance in Microbiology*
- *gain knowledge on handling, storage, preservation, experimentation, analysis and documentation.*
- *Gain understanding on microbial standards for food and water*

-

SEMESTER – II

Skill Enhancement Course
SEC2(B)

BIOREMEDIATION

Credits: 3

Total hours: 45

Course Objectives:
The objective of the course includes i) to learn basics about bioremediation and its types, ii) to understand the role of different microbes in bioremediation, and iii) finally to learn the mechanism behind bioremediation of environmental pollutants.

Unit- I **9 hours**

Introduction to Bioremediation: Types of Bioremediation, Factors affecting Bioremediation, Limitations in Bioremediation, Bioremediation Techniques: *In situ* and *Exsitu* bioremediation techniques.

Unit - II **9 hours**

Microbes for bioremediation – Bacteria, algae and fungi; Role of plasmids in bioremediation; Gene manipulation in creation of new strains; Phytoremediation.

Unit - III **9 hours**

Mechanism of bioremediation - Metabolic pathways for the degradation of xenobiotics; Bioprocess design – Optimization; Problems associated with biotreatment studies; Quantification of biodegradation.

Unit - IV **9 hours**

Bioremediation of pollutants in soil and effluents; Bioreactors - Advantages and disadvantages; Biodegradation of oil spill in marine environment, Biosurfactants; Biosorption of heavy metals.

Unit- V **9 hours**

Anoxic bioremediation; Fermentation; Anaerobic bioremediation of Hydrocarbons, Phenols, Chlorinated phenolic compounds, Polycyclic Aromatic Hydrocarbon (PAH), Dyes and Radioactive wastes.

Text book

1. Microbial Bioremediation. 2011. P. Rajendran and P. Gunasekaran. MJP Publishers, Chennai, India.

Reference books

1. Advances in Biodegradation and Bioremediation of industrial wastes. 2015. Ram Chandra. CRC Press
2. Bioremediation of Pollutants. 2020. V.C. Pandey and V. Singh. Elsevier.
3. Pepper I., Gerba C. and Gentry T. (2015) Environmental Microbiology. 3rdEdn. Academic Press. p.728.

Course Outcome:

- *Upon successful completion of the course, the student will*
- *Understand Bioremediation and its types*
- *List the microbes involved in Bioremediation*
- *Know the mechanisms of Bioremediation*
- *Understand the Bioremediation practices to treat soil and water pollution*
- *Know the anaerobic treatments for different wastes*

SEMESTER – II

Skill Enhancement Course
SEC2(C)

VERMITECHNOLOGY

Credits: 3

Total hours: 45

Course Objectives:

The objective of the course includes i) to gain knowledge on the history of vermitechnology and its economic importance, ii) to understand vermiculture and its culture methods, and iii) finally to gain insight on the applications of vermiculture and its future prospects.

Unit- I **9 hours**

Vermitechnology- Definition, history, growth and development in other countries and in India. Economic importance of Earthworms: In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition and moisture, bait and food.

Unit- II **9 hours**

Vermiculture – definition, scope and importance; common species for culture; Environmental parmeters; culture methods – wormery – breeding techniques; indoor and out door cultures - monoculture and polyculture – merits and demerits.

Unit- III **9 hours**

Vermicomposting of wastes in field pits, ground heaps, tank method, roof shed method, static pile windrows, top fed windrows, wedges & bin method, harvesting the compost, storage, Vermiwash-Preparation and application.

Unit- IV **9 hours**

Applications of vermiculture – Vermiculture bio-technology, vermicomposting, use of vermicastings in organic farming/horticulture, earthworms for management of municipal/selected biomedical solid wastes; as feed/bait for capture/culture fisheries; forest regeneration.

Unit- V **9 hours**

Future perspectives – Predator / pathogen control in wormeries; Potentials and constraints for vermiculture in India. Marketing the products of vermiculture – quality control, market research, marketing techniques – creating the demand by awareness and demonstration, advertisements, packaging and transport, direct marketing.

Text Books

1.Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.

2.Bhatnagar & Patla,2007. Earthworm vermiculture and vermi-composting, Kalyani Publishers, New Delhi

Reference Books

1.Mary Violet Christy,2008. Vermitechnology, MJP Publishers, Chennai.

2.Aravind Kumar, 2005.Verms & Vermitechnology, A.P.H. Publishing Corporation, New Delhi.

3.Edwards, C.A & J.R Lofty Vermicology – The Biology of earthworm, 1997 Chapman & Hall Publications N.Y.U.S.A.

Course Outcome:

Upon successful completion of the course, the student will

- *Gain insight on the history and economic importance of vermitechnology.*
- *understand vermiculture and its culture methods,*
- *gain insight on the applications of vermiculture*
- *gain insight on vermicomposting*
- *gain knowledge on the future perspective of vermitechnology.*