UNIVERSITY DEPARTMENT OF BIOTECHNOLOGY
VINOBA BHAVE UNIVERSITY, HAZARIBAG

4 YEARS (FYUGP) SYLLABUS AND REGULATIONS

FOR THE DEGREE OF BIOTECHNOLOGY

[UNDER NEW EDUCATION POLICY-2020, SEMESTER EXAMINATION AT U.G. LEVEL]

(Academic Session 2026-2027 onwards)

(Under Self Financed Scheme)

The brochure of the programme of study in Biotechnology is broadly divided into three parts.

(A) General Information (B) Scheme of Examination and (C) Course details.

REGULATION & SYLLABUS

UG Programme in B.Sc. (Honours) in Biotechnology Degree Course

The revised syllabus shall be effective from the academic year 2026 -2027 onwards.

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 3 and 4 years leading to the award of UG Degree.

All UG courses shall focus on conceptual understanding and development of critical thinking in a given field of study, 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 Vinoba Bhave University.

ELIGIBILITY FOR ADMISSION

Candidates for admission to the first year of the B.Sc. or **B.Sc. Honours in Biotechnology** degree shall require to have **passed Higher Secondary course with Biology/Botany/Zoology** as one of the subject or any other equivalent system recognized by the Government based on the admission criteria laid down by Vinoba Bhave University are eligible to apply.

SELECTION PROCEDURE

The admission to first semester of the Biotechnology course shall be made on the basis of performance in **counseling and interview**. For admission against NRI/NRI sponsored seats, Entrance Aptitude Test is not required but the sponsored candidates shall be required to appear at counseling and interview on a date to be decided by the department.

The total number of seats allotted to the University Department/Colleges shall be fixed by the Syndicate on the recommendation of the Academic Council.

Provided that if the Academic Council does not ratify the increase in the number of seats, the increase will be reverted back only in next academic session.

COURSE FEE PER SEMESTER

Since the course is running under SELF FINANCED SCHEME (Vocational Course) of the University, candidates admitted to this course will pay the fee as mentioned below.

The candidate has to pay **Rs 25,000 in each semester irrespective of the category.** Also, they have to pay the examination fee in every semester separately**.**

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 subject to availability of the seats. The guidelines for lateral Entry are as follows:

1. Lateral Entry for II Year B.Sc. / B.Sc. Honours in Biotechnology:
   Student should complete **UG certificate course with major subject as Biotechnology or equivalent** from any University.

2. Lateral Entry for III Year B.Sc. / B.Sc. Honours in Biotechnology:
   Student should complete **UG Diploma course in Biotechnology or equivalent** from any University.

3. Lateral Entry for IV Year B.Sc. Honours in Biotechnology:
   Student should complete **B.Sc. Biotechnology or equivalent from any University.**

COURSE STRUCTURE

All Academic Programmes offered under NEP shall be offered in terms of credits. Each zcourse/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 Biotechnology** provided they have earned a minimum of 40 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 Biotechnology** provided they have earned a minimum of 80 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 they will be awarded **UG degree in B.Sc. Biotechnology** after successful completion of three years, provided they have earned a minimum of 120 credits.

4. After completing the requirements of a three year Bachelor's degree, candidates who meet a minimum C.G.P.A. of 7.5 shall be allowed to continue studies in the fourth year of undergraduate programme (7^{th} and 8^{th} Semester) to pursue and complete the **Bachelor's degree with Honours** in the discipline.

Students admitted in 8th Semester of the course will have to complete their Project Work duly recommended by a committee comprising of the Director/H.O.D./Faculty members of the Biotechnology department, preferably in a National Laboratory/ Institute or any institution duly recognized by a statutory body only **at their own expense only.**

There is also option to complete the Project Work/Dissertation from some of the Private and renowned Institutions/Laboratories/ Pharma Companies based on R & D**.**

The project work evaluation will be evaluated by two external examiners. For the purpose of holding viva-voce 2 external examiners will be appointed as per recommendation of the H.O.D./Director. The scheme of marks for evaluating the various components of dissertation will be followed as given in the syllabus.

GRACE RULE: - Grace rule shall be awarded as per the following guidelines. A maximum of **5 marks** can be given to the student overall in different semesters if there is any shortfall in minimum SGPA/CGPA or improving the grade. (Can avail only once)

SEMINARS: - Students admitted in the course in I, II, III, IV, V, VI, VII and VIII semester will be required to deliver one seminar of 15 minute duration followed by discussion. The performance of the student will be judged by the teachers of the department. The credit for seminar in each semester shall be included along with internal assessment exam marks.

ASSIGNMENTS: - Regular assignments will be given to each student during 1st, 2nd, 3rd, 4th, 5th, 6th, 7th & 8th semester of the course from each theory paper. Assignments should be relevant to course content. The assignment should be minimum of 2 pages. Credit for assignments in each semester shall be included along with internal assessment marks.

MEDIUM OF INSTRUCTION

The medium of instruction for B.Sc. Biotechnology course shall be in English.

BREAKUP OF CREDITS AND COURSES

NEP Framework has specified the minimum number of credits that a Bachelor student has to earn in ¾th year period.

Minimum requirement of credits for the students to complete the respective course.

Every Undergraduate (UG) programme offered by a University/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. A student of 4-year B.Sc. Honours in Biotechnology programme is mandated to complete a minimum of 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): (72credits)

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 4 credits 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. (Biotechnology) or with multiple major disciplines like B.Sc. (Biotechnology, Bioinformatics &Genetics).

ii) Minor Disciplinary Course (MID): (32credits)

Minor disciplinary courses refer to those subjects which are Allied/Specialization/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 9 credits worth of courses in such multidisciplinary 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. Eg. 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 – 1 and 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, e.t.c . 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 and Technological solutions
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 (4 Credits)

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

EVALUATION: Total Marks: 100

All 4 credit courses are evaluated for 100 marks. Internal Assessment component is for 30 marks and the End Semester University exam is for 70 marks.

In case of theory paper without practicals, the internal assessment will be of 30 marks and external assessment will be of 70 marks.

However, in case of theory paper with practical component, 75 marks are assigned for 3 credit theory course and 25 marks are assigned to 1 credit practical. Further 75 marks are bifurcated as 60 marks for end term and 15 marks for internal assessment. No internal assessment will be done for practical component.

End-Semester University Exam:

Controller of Examinations (COE) of Vinoba Bhave 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/Department 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) Question from all units of syllabus -60 marks.

b) Practical/Internship Project Work subjects.

(Based on Practical Exams/Presentation/Viva) -25 marks

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 (below). As per NEP Regulations, the passing minimum is 40% marks (IA + End semester put together).

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

Letter Grade	% of Marks	Grade Point	Remarks	Conventional equivalent
O	≥ 90	10	Outstanding	1st Class with distinction
A+	80 - < 90	9	Excellent	
A	70 - < 80	8	Very Good	1st Class
B+	60 - < 70	7	Good	2nd Class
B	55 - < 60	6	Above Average	
C	45 - < 55	5	Average	
P	40 - < 45	4	Pass	Pass
F	< 40	0	Fail	Fail
Ab	----------	0	Absent	

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 carries.

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,

$$\text{i.e. } \mathbf{SGPA}\ (Si) = \Sigma(Ci \times Gi) / \Sigma Ci$$

Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

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 course swill 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.

SCHEME OF EXAMINATION FOR THEORY PAPER, 4 Credits.

Total Marks: 100 (Internal: 30 & External: 70)

INTERNAL ASSESSMENT: Maximum Marks: 30, 1 Hour.

- Internal Examination for 1:00 Hours duration shall be taken: 20 Marks
- Attendance: 5 Marks

Seminar/Assignment: 5 Marks

END SEMESTER EXAMINATION: Maximum Marks: 70.

- Examinations shall be in three sections.
- Section-A (Definition based) for 20 Marks,
- Section –B (Short note based) for 20 Marks
- Section-C (Essay based) for 30 Marks.

Question Paper Pattern

Total Marks: - 70 **Time: - 3 Hours**

SECTION – A: (10 x 2 = 20 Marks)

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

SECTION – B: (5 x 4 = 20 Marks)

- It is of short answer type. Each question carries 4 marks.
- Questions to be given by setting 2 question from each unit.
- Candidate should Answer 5 questions out of 10 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

SCHEME OF EXAMINATION FOR PRACTICAL PAPER, Credit- 3 (T) + 1 (P).

Total Marks: 100: (Internal: 15, External: 60, Practical: 25)

INTERNAL ASSESSMENT: Maximum Marks: 15

- Internal Examination for 1:00 Hours duration shall be taken: 10 Marks
- Attendance & Seminar/Assignment: 5 Marks

END SEMESTER EXAMINATION: Maximum Marks: 60.

- Examinations shall be in three sections.
- Section-A (Definition based) for 15 Marks,
- Section –B (Short note based) for 15 Marks
- Section-C (Essay based) for 30 Marks.

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit.
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

- It is of essay answer type. Each question carries 10 Marks.
- 5 questions will be given by setting one question from each unit.
- Candidate should answer 3 questions out of 5 questions.
- Equal weightage will be given to all the units while setting the question paper

PRACTICAL EXAMINATION: Maximum Marks: 25

Major Question: 10 Marks

Practical Performance: 15 Marks

SCHEME OF EXAMINATION FOR SKILL ENHANCEMENT COURSE (SEC) PAPER, Credit- 2 (T) + 1 (P).

Total Marks: 75: (Internal: 10, External: 40, Practical: 25)

Question Paper Pattern (Theory)

Total Marks: - 40 **Time: - 2 Hours**

SECTION – A: (10 x 1 = 10 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (4 x 2.5 = 10 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit.
- Candidate should Answer 4 questions out of 5 questions.

SECTION – C: (2 x 10 = 20 Marks)

- It is of essay answer type. Each question carries 10 Marks.
- 5 questions will be given by setting one question from each unit.
- Candidate should answer 2 questions out of 5 questions.
- Equal weightage will be given to all the units while setting the question paper

PRACTICAL EXAMINATION: Maximum Marks: 25

Major Question: 10 Marks

Practical Performance: 15 Marks

Syllabus & Examinations rule of Minor Disciplinary Course, Multi Disciplinary Course, Ability Enhancement Course, NEP Value Added common course- I & II will be followed as per university guidelines.

SCHEME OF EXAMINATION FOR PROJECT / INTERNSHIP / FIELD WORK

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

INTERNAL EXAMINATION: Maximum Marks: 50 marks

a) Attendance 10 marks
b) Project Report 20 marks
c) Oral Presentation cum viva etc. 20 marks

EXTERNAL EXAMINATION: Maximum Marks: 50 marks.

a) Project Report 20 Marks
b) Oral Presentation cum viva 30 Marks

Course Structure Credits and Work Hours on a Semester Basis. In Accordance With the National Education Policy (NEP) For Academic Year 2026-2027 onwards.

Separate Sheets Attached

SEMESTER I

CELL BIOLOGY	
Paper: - **Theory**	Course code: - **MJ 1**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to understand cell structures and functions, including organelles in plant, animal, bacterial cells, and viruses. Study cell interactions with their environment, focusing on membrane dynamics, transport mechanisms, and surface differentiation. Learn the organization of the nucleus and chromosomes, understanding cellular inheritance and specialized structures. Understand the cell cycle, mitosis, meiosis, and regulation mechanisms. Explore cell signaling pathways, receptor mechanisms, apoptosis, and necrosis; Understanding cellular communication and death.

UNIT: - I History of cell biology; Cell as the fundamental building block of life; Theories of cells, protoplasm, organisms, and endosymbionts; Categorization and description of cell types; Arrangement and structure of bacterial, viral, animal, and plant cells.

UNIT: - II Structure and function of bacterial and plant cell wall; Plasma membrane – fluid mosaic model, other models; Membrane fluidity; Transport across membranes - Uniport, Symport, Antiport, active and passive transport; Cytoskeletal structures – microtubules, microfilaments (actin, myosin), intermediate filament; Cell motility. Differentiation of cell surface: cell junctions, tight junction, gap junctions, desmosomes, hemidesmosomes.

UNIT: - III Structure and functions of cell organelles: golgi apparatus, endoplasmic reticulum (SER & RER), lysosomes, microbodies (peroxisomes and glyoxysomes), ribosomes, vacuoles and its types, centrioles, basal bodies; Role of chloroplast and mitochondria as an energy transducing organelle.

UNIT: - IV Structure and organization of nucleus, nuclear membrane; Organization of chromosomes - structural organization of chromatids, centromere, chromatin, telomere, nucleosomes, euchromatin and heterochromatin; Specialized structures- polytene and lampbrush chromosome; Chromatin remodelling.

UNIT: - V Cell division - mitosis and meiosis; Cell cycle- regulations of cell cycle and check points and proteins involved in cell cycle check points; Basics in cell signaling- ligand molecules and receptors, G protein coupled receptors, tyrosine kinase receptor; Apoptosis and necrosis; Development in *Drosophila melanogester, Arabidopsis thaliana* and *Caenorhabditis elegans.*

Reference Books: -

1. E.D. P. De Robertis and E.M.F. De Robertis, Jr. (2012). Cell and Molecular Biology (8th edition). B.I. Waverly Pvt. Ltd., New Delhi.
2. Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Dernell (2009). Molecular Cell Biology (4th edition). W.H. Freeman and Company.
3. P.S. Verma and V.K. Agarwal (2012). Concepts of Cell Biology. S. Chand & Company Ltd., New Delhi.
4. Bruce Alberts (2009). Essential Cell Biology (3rd edition). Garland Science.
5. Gerald Karp (2013). Cell and Molecular Biology: Concepts and Experiments (7th edition). John Wiley & Sons.
6. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick (2014). Molecular Biology of the Gene (7th edition). Cold Spring Harbor Laboratory Press.
7. David Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter (2015). Molecular Biology of the Cell (6th edition). Garland Science.
8. Thomas D. Pollard and William C. Earnshaw (2017). Cell Biology (3rd edition). Elsevier.
9. Geoffrey M. Cooper and Robert E. Hausman (2013). The Cell: A Molecular Approach (6th edition). Sinauer Associates.
10. Lehninger, Albert L., Michael M. Cox, and David L. Nelson (2017). Lehninger Principles of Biochemistry (7th edition). W.H. Freeman and Company.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 1**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals

1. Microscopic techniques- light microscopy
2. Observation of permanent slides.
3. Measurement of cell using ocular micrometer and stage micrometer.
4. Cell types- Microbial, Animal and Plant cells.
5. Cell counting method: animal cell-Haemocytometer, Plant cells- stomatal density
6. Mitosis in onion root tip
7. Meiosis in Pollen mother cells of plants
8. Subcellular fractionation
9. Plasmolysis in onion

SEMESTER II

MICROBIOLOGY	
Paper: - **Theory**	Course code: - **MJ 2**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to define microbiology, its development, and its significance in fields like healthcare and biotechnology. Describe microbial diversity, including classification and features of Archaea, Bacteria, Fungi, Algae, Protozoa, Viruses, and Prions. Explain the ultrastructure of bacteria, including cell wall biosynthesis, cellular appendages, and genetic mechanisms. Demonstrate microscopy techniques, including principles and applications of various types of microscopes. Understand microbial nutrition, growth, and control methods, including sterilization, disinfection, and physical and chemical control methods.

UNIT: - I **Microbial Diversity:** History and Scope of microbiology; Basics of microbiology; General features and Classification of Archaea; Bacteria; Fungi; Algae; Protozoa; Viruses and Prions. Differences between prokaryotes and eukaryotes.

UNIT: - II **Ultrastructure of Bacteria:** Sub-cellular structures **-** cell wall of bacteria and its biosynthesis; Cell envelope - capsule and slime layer; Cellular appendages - pili, flagella and fimbriae; Cell membrane; Inclusion bodies; Plasmid DNA and chromosomal DNA. Bacterial genetics - transfromation, transduction (generalized and specialized), and conjugation.

UNIT: - III **Microscopy and Staining:** Microscopy - Instrumentation, principles and applications of light microscopes (bright field, dark field, phase contrast, fluorescent microscopes) and electron microscopes (transmission and scanning electron microscopes); Freeze etching and image processing. Principles and types of staining (simple and differential).

UNIT: - IV **Microbial Nutrition:** Classification of microorganisms based on their nutritional types; Preparation of media, types of media, culturing of microbes. Microbial growth curve, viral replication: lytic and lysogenic cycles; Isolation, preservation and maintenance of microorganisms; Aerobic and Anaerobic culturing of bacteria; Effect of biotic and abiotic factors on the growth of organisms.

UNIT: - V **Microbial Control:** Sterilization, disinfection, antisepsis, fumigation; Physical control: temperature (moist heat, autoclave, dry heat, hot air oven and incinerators), desiccation, osmotic pressure, radiation, UV-light, electricity, ultrasonic sound waves, filtration; Chemical control: antiseptics and disinfectants (halogens, alcohol, gaseous sterilization).

Reference Books: -

1. M.J. Pelczar Jr., E.C.S. Chan, and N.R. Krieg, Microbiology, 5th edition (2001), Tata McGraw-Hill, New Delhi.
2. R. Ananthanarayanan and C.K. Jayaram Paniker, Textbook of Microbiology, 12th edition (2022), Universities Press, Hyderabad.
3. Lansing M. Prescott, John P. Harley, and Donald A. Klein, Microbiology, 10th edition (2017), McGraw-Hill Education, New York.
4. R.C. Dubey and D.K. Maheswari, A Textbook of Microbiology, 4th edition (2014), S. Chand & Company Ltd., New Delhi.
5. Gerard J. Tortora, Berdell R. Funke, and Christine L. Case, Microbiology: An Introduction, 13th edition (2018), Pearson, New York.
6. Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, and David A. Stahl, Brock Biology of Microorganisms, 15th edition (2017), Pearson, Boston.
7. Joanne M. Willey, Linda M. Sherwood, and Christopher J. Woolverton, Prescott's Microbiology, 10th edition (2017), McGraw-Hill Education, New York.
8. James G. Cappuccino and Natalie Sherman, Microbiology: A Laboratory Manual, 11th edition (2019), Pearson, Boston.
9. Robert W. Bauman, Microbiology with Diseases by Taxonomy, 5th edition (2017), Pearson, Boston.
10. David Greenwood, Richard Slack, John Peutherer, and Mike Barer, Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control, 18th edition (2012), Churchill Livingstone, London.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 2**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals: -

1. Microscopic Examination of Bacteria; Yeast and Fungi.
2. Bacterial Motility Assay.
3. Gram Staining Procedure.
4. Preparation of Solid; Semi-Solid and Liquid media.
5. Techniques for Inoculation.
6. Isolation and Maintenance of Pure Bacterial Cultures (pouring, spreading, streaking).
7. Microbial Growth Curve Analysis.
8. Antibiotic Sensitivity Test.

SEMESTER III

MOLECULAR BIOLOGY	
Paper: - **Theory**	Course code: - **MJ 3**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to understand molecular biology fundamentals, including key experiments and genetic material types. Explain DNA replication mechanisms in prokaryotes, involving enzymes and replication machinery. Describe transcription processes, post-transcriptional modifications, and transcriptional inhibitors. Analyze genetic code characteristics, protein biosynthesis, mutations, mutagens, and DNA repair mechanisms. Comprehend the regulation of gene expression and the significance of operons in genetic control.

UNIT: - I Introduction to Molecular Biology; Types of genetic materials; Experiments of Griffith; Avery; MacLeod and McCarty; Hershey and chase; John Cairns experiment; Meselson & Stahl experiment; Central dogma of life.

UNIT: - II Replication of DNA; Models of DNA replication; Mechanism of DNA replication in prokaryotes and eukaryotes (initiation, elongation, replication fork, replication machinery, termination); Enzymes and proteins involved in DNA replication (nucleases, DNA polymerases, DNA helicases, gyrases, SSB Proteins, topoisomerase, primase).

UNIT: - III Mechanism of transcription in prokaryotes and eukaryotes; Enzymes and proteins involved in transcription, post transcriptional modifications; Inhibitors of transcription.

UNIT: - IV Genetic code - characteristics and properties; Wobble hypothesis; Protein biosynthesis in prokaryotes and eukaryotes; post translational modifications; protein degradation; Inhibitors of protein synthesis; Regulation of gene expression (lac, trp and gal operons).

UNIT: - V Mutation and its types- spontaneous, induced, reverse, suppressor mutations; chemical mutagens- alkylating agent, nitrous acid, hydroxylamine, physical mutagen- radiation; DNA repair- mismatch repair, base excision repair, nucleotide excision, direct repair and SOS repair; DNA recombination.

Reference Books: -

1. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D., & Darnell,
2. J. (2012). Molecular Cell Biology (7th ed.). W. H. Freeman.
3. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014).
4. Molecular Biology of the Cell (6th ed.). Garland Science.
5. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., & Losick, R. (2013). Molecular Biology of the Gene (7th ed.). Cold Spring Harbor Laboratory Press.
6. Voet, D., & Voet, J.G. (2010). Biochemistry (4th ed.). John Wiley & Sons.
7. Lehninger, A.L., Nelson, D.L., & Cox, M.M. (2021). Lehninger Principles of Biochemistry (8 th ed.). W. H. Freeman.
8. Krebs, J.E., Goldstein, E.S., & Kilpatrick, S.T. (2017). Lewin's GENES XII (12th ed.). Jones & Bartlett Learning.
9. Strachan, T., & Read, A.P. (2010). Human Molecular Genetics (4th ed.). Garland Science.
10. Brown, T.A. (2010). Gene Cloning and DNAAnalysis: An Introduction (6th ed.). Wiley-Blackwell.
11. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., & Doebley, J. (2015). Introduction to Genetic Analysis (11th ed.). W. H. Freeman.
12. Berg, J.M., Tymoczko, J.L., Gatto Jr, G.J., & Stryer, L. (2015). Biochemistry (8th ed.). W. H. Freeman.B.Sc. Biotechnology / B.S Honors in Biotechnology 24-25 onwards

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 3**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals: -

1. Isolating DNA from prokaryotes like E. coli.
2. Isolation of plasmids from E.coli.
3. Isolation of DNA from germinating gram seeds.
4. Quantifying DNA content.
5. Conducting agarose gel electrophoresis for DNA.
6. Determining the molecular weight of DNA.
7. Executing SDS- Poly Acrylamide Gel Electrophoresis and staining for proteins.

BIOCHEMISTRY	
Paper: - **Theory**	Course code: - **MJ 4**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to classify and describe the structures of carbohydrates, amino acids, proteins, lipids, and nucleic acids. Comprehend enzyme kinetics, inhibition mechanisms, and regulation, and their roles in biochemical processes. Identify and explain the structural levels of proteins and their biological functions. Classify different lipids and understand their structures and biological functions. Describe the structure, types, and properties of nucleic acids, understanding their significance in genetics.

UNIT: - I **Carbohydrates:** Classification of carbohydrates; Occurrence and structure of mono, di and polysaccharides (homo and heteropolysaccharides), asymmetry, stereo-isomerism and optical isomerism of sugars, anomeric form and mutarotation.; Biological importance of carbohydrates (starch, cellulose, chitin); Biochemical tests for carbohydrates; Metabolism of carbohydrate (Glycosis, Kreb's cycle; Gluconeogenesis and Glycogenolysis).

UNIT: - II **Amino acids & Proteins:** Classification, structure and Properties of amino acids; Essential and non-essential amino acids, peptide bond and chemical bonds involved in protein structure; Protein classification based on solubility, shape, composition and function; Structure of proteins (Primary, secondary tertiary and quaternary); Biologically important peptides (insulin, vasopressin); Biochemical tests for proteins; Amino acid metabolism (in brief).

UNIT: - III **Enzymes:** Definition, classification & nomenclature of enzymes - Specificity of enzyme action - Lock and Key Hypothesis and Induced Fit Hypothesis; Active site – coenzyme - Enzyme kinetics; Michaelis-Menten equation and Lineweaver-burk plot) - significance of Km and Vmax – enzyme inhibitors (reversible, irreversible and feedback inhibitions); Modes of enzyme inhibition; Regulatory enzymes (allosteric & covalently modulated enzymes); Biological and Industrial importance of enzymes.

UNIT: - IV **Lipids:** Classification, nomenclatures, structure and functions of simple, compound and derived lipids; Structure and functions of fatty acids (Essential Fatty Acids), Tri-acyl glycerol, phospholipids, sphingolipids, glycolipids and gangliosides; Biological importance of lipids (PUFA); Biochemical tests for lipids and FAME analysis. Fatty acid biosynthesis and beta oxidation.

UNIT: - V **Nucleic acid:** Structure; Properties and types of nucleic acid; Composition of DNA and RNA -Watson and Crick model of DNA; Structure of purines and pyrimidines; Structure of Nucleosides and Nucleotides; Structural forms of DNA; Biological importance of Nucleic acids; Biological Interactions.

Reference Books: -

1. Nelson, D.L., Cox, M.M. (2013). Lehninger: Principles of Biochemistry (6th Edition). W.H. Freeman and Company.
2. Devlin, T.M. (2011). Textbook of Biochemistry with Clinical Correlations (7th Edition). John Wiley & Sons, Inc.
3. Berg, J.M., Tymoczko, J.L., Stryer, L. (2012). Biochemistry (7th Edition). W.H. Freeman and Company.
4. Voet, D., Voet, J.G. (2011). Biochemistry (4th Edition). John Wiley & Sons.
5. Garrett, R.H., Grisham, C.M. (2013). Biochemistry (5th Edition). Cengage Learning.
6. Murray, R.K., Granner, D.K., Mayes, P.A., Rodwell, V.W. (2012). Harper's Illustrated Biochemistry (29th Edition). McGraw-Hill Medical.
7. Mathews, C.K., van Holde, K.E., Appling, D.R., Anthony-Cahill, S.J. (2012).
8. Biochemistry (4th Edition). Pearson.
9. Horton, H.R., Moran, L.A., Ochs, R.S., Rawn, J.D., Scrimgeour, K.G. (2011). Principles of Biochemistry (5th Edition). Pearson.
10. Freeman, W.H., Donald, J.V., Judith, G.V., Charlotte, W.P. (2013). Biochemistry (4th Edition). W.H. Freeman and Company.
11. Zubay, G. (1998). Biochemistry (4th Edition). Wm. C. Brown Publishers.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 4**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals: -

1. Extraction of Starch.
2. Qualitative test for Proteins.
3. Qualitative test for DNA.
4. Qualitative test for Glucose.
5. Qualitative test for RNA.
6. Separation of Plant Pigments by paper chromatography.
7. Separation of Lipids by TLC.
8. Separation of Amino acids by chromatography.

SEMESTER IV

IMMUNOLOGY	
Paper: - **Theory**	Course code: - **MJ 5**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to describe and explain the fundamental principles of modern immunology. Understand and apply related immunological techniques in medical laboratories. Relate and apply medical laboratory science knowledge to immunological changes in healthy and disease contexts. Analyze the roles of cytokines, chemokines, and the complement system in immune responses. Evaluate immune disorders, tumor immunology, and transplantation immunology.

UNIT: - I Immunology - History, Microbial infections and host resistance; Immune response: Innate & adaptive responses, humoral and cell mediated Immune responses; Structures, composition and functions of cells of immune system, primary and secondary lymphoid organs of immune system; GALT, MALT & CALT.

UNIT: - II Antigens & Immunogenicity; Antigens - Types, properties, Haptens, Adjuvants, Epitopes, Toxoids; Immunoglobulins- structure, types and properties; Theories of antibody formation, structural and genetic basis of antibody formation.

UNIT: - III Antigen and antibody reactions, Immunodiagnostic methods, Agglutination, Ouchterlony Double Diffusion, Precipitations, Complement fixation, RIA,

ELISA and its types, Gel filtration Immunofluorescence, Production of Monoclonal Antibodies and Hybridoma Technology technique.

UNIT: - IV Cytokines & Chemokines - Classification, types and its functions, Complement system: structure, properties, functions of complement components and its pathways; Humoral and Cell mediated Immunity; Cytotoxicity.

UNIT: - V Immune disorders and tumors: Types of tumors, tumor antigens, immune response to tumors; Immunodeficiency and Auto immune diseases; MHC - Structure and function of class I and class II MHC molecules; Hypersensitivity reactions: Type I, II, III and IV; Transplantation immunology - types and mechanisms involved; Vaccines.

Reference Books: -

1. Roit, I.M., & Delves, P.J. (2001). Essential Immunology (10th ed.). Blackwell Science, Oxford.B.Sc. Biotechnology / B.S Honors in Biotechnology 24-25 onwards
2. Kuby, J. (2013). Immunology (8th ed.). W.H. Freeman and Company, New York.
3. Kumar, M.S., & Sai, L.K. (2014). Microbiology and Immunology (2nd ed.). Jaypee Brothers Medical Publishers.
4. Male, D., & Roth, D. (2013). Immunology (8th ed.). Reed Elsevier India Pvt Limited.
5. Abbas, A.K., Lichtman, A.H., & Pillai, S. (2016). Cellular and Molecular Immunology (8th ed.). Elsevier.
6. Janeway, C.A., Travers, P., Walport, M., & Shlomchik, M.J. (2012). Immunobiology: The Immune System in Health and Disease (8th ed.). Garland Science.
7. Goldsby, R.A., Kindt, T.J., Osborne, B.A., & Kuby, J. (2012). Immunology (7th ed.). W.H. Freeman and Company.
8. Punt, J., Stranford, S., Jones, P., & Owen, J. (2019). Kuby Immunology (8th ed.).W.H. Freeman and Company.
9. Parham, P. (2009). The Immune System (3rd ed.). Garland Science.
10. Murphy, K., Weaver, C., & Berg, L. (2016). Janeway's Immunobiology (9th ed.).Garland Science.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 5**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals

1. Single Immunodiffusion analysis
2. Double Immunodiffusion analysis
3. Separation of PBMC from the blood sample.
4. Slide Agglutination Reaction
5. To perform Dot ELISA
6. To perform the technique of Gel Filtration.
7. To perform the technique of Ion- Exchange Chromatography.

RECOMBINANT DNA TECHNOLOGY	
Paper: - **Theory**	Course code: - **MJ 6**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to apply landmark discoveries to develop molecular techniques in rDNA technology. Select suitable hosts for specific vectors in diverse applications. Utilize restriction enzymes and other tools for genetic manipulations. Conduct PCR applications and gene expression experiments for research purposes. Understand the ethical and safety considerations in genetic engineering applications.

UNIT: - I History and basic steps involved in genetic engineering; Safety measures and guidelines in Genetic Engineering; Enzymes involved in genetic engineering; Restriction enzymes and their types, Nucleases, DNA ligases and ligation, Kinases, Phosphatases, Reverse transcriptase, Deoxynucleotidyl transferases, DNA polymeraseses, Alkaline phosphatases, Restriction digestion and Restriction mapping; Isolation of DNA from Bacteria, Plasmids and Plants.

UNIT: - II Basic design of cloning vectors - plasmid (pBR322 and pUC 18/19), cosmids, phage vectors (lambda and M13), phagemid, yeast vectors (YEp, YRp, YIp), shuttle vectors, BAC and YAC; Expression of cloned genes - general features of an expression vector; Expression of eukaryotic gene in prokaryotes - advantages and limitations; Plant and Animal based vectors.

UNIT: - III Gene transfer techniques - physical (Electroporation, microinjection and biolistic transformation), chemical ($CaCl_2$ mediated transformation and Lipofection), transduction; Selection and screening of recombinant clones; DNA microarray.

UNIT: - IV Construction of genomic and cDNA library; PCR- steps involved, Guidelines for PCR primer designing, variants of PCR (multiplex, nested, quantitative real time, RT- PCR), applications and limitations; Blotting - southern, northern and western blotting; Nucleic acid and immuno probes.

UNIT: - V How to Study Gene regulation- DNA transfection, Northern blotting, Primer extension, S1 mapping, RNase protection, DNA footprinting, Gel Retardation Assay, Modification Intereference Assay, Electron microscopy analysis; Protein Engineering and its applications; Yeast 2 and 3 Hybrid systems; Applications of Genetic engineering in industry, medicine and agriculture; Brief idea of Gene Therapy.

Reference Books: -

1. Primrose, S.B., & Twyman, R. (2006). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell.
2. Brown, T.A. (2010). Gene Cloning and DNAAnalysis: An Introduction (6th ed.).Wiley-B.Sc. Biotechnology / B.S Honors in Biotechnology 24-25 onwards Blackwell.
3. Winnacker, E.L. (2003). From Genes to Clones: Introduction to Gene Technology(4th ed.). Panima Publishing Corporation.
4. Green, M.R., & Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual (4th ed.). Cold Spring Harbor Laboratory Press.
5. Glick, B.R., & Pasternak, J.J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th ed.). ASM Press.
6. Dale, J.W., & von Schantz, M. (2007). From Genes to Genomes: Concepts and Applications of DNATechnology (2nd ed.). Wiley-Blackwell.
7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.
8. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., & Losick, R. (2013). Molecular Biology of the Gene (7th ed.). Cold Spring Harbor Laboratory Press.
9. Clark, D.P., & Pazdernik, N.J. (2012). Biotechnology: Applying the Genetic Revolution (2nd ed.). Elsevier Academic Press.
10. Campbell, A.M., & Heyer, L.J. (2006). Discovering Genomics, Proteomics, and Bioinformatics (2nd ed.). Benjamin Cummings.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 6**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals

1. Plasmid DNA isolation.
2. Isolation of total DNA from Bacteria.
3. Restriction digestion of DNA.
4. Restriction mapping of DNA.
5. Preparation of Competent Cell.
6. Transformation & blue white screening.
7. Polymerase chain reaction.

ANALYTICAL TECHNIQUES IN BIOLOGY	
Paper: - **Theory**	Course code: - **MJ 7**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to grasp intricate water properties, pH, and acid-base theories thoroughly.Know in detail about various spectroscopic techniques for precise biomolecule analysis. Proficiently employ chromatography methods for effective biomolecule separation. Skillfully apply advanced bio-physical techniques for accurate structure prediction. Grasp intricate water properties, pH, and acid-base theories thoroughly.

UNIT: - I **Solutions:** Water- Structure and interaction, water as solvent, pH, Bronsted Lowry concept of acid and bases, ionization, Buffer: Henderson-Hasselbalch equation; Biological buffer system (bicarbonate, phosphate buffers and Tris buffers); Determination of molecular weight- molarity, molality, normality, equivalent weight.

UNIT: - II **Spectroscopy:** Colorimetry, Basic principles, Beer-Lamberts law, instrumentation and application of UV-Vis, Fluorescence, CD, ESR, Raman, IR spectroscopy & NMR Spectroscopy.

UNIT: - III **Chromatography:** Basic principle & types – paper chromatography, thin layer chromatography, column chromatography: gel filtration, adsorption, ion exchange, affinity, HPLC and FPLC; Application of chromatographic technique – separation of biomolecules.

UNIT: - IV **Electrophoresis and Tracer techniques:** – Principle, DNA and RNA gel electrophoresis, protein gel electrophoresis – SDS PAGE, native-PAGE, documentation, 2D-electrophoresis, isoelectric focusing; Nature of radioactivity, isotopes, radioactive decay, α, β and γ radiation, scintillation counter, application of radioisotopes in biological sample.

UNIT: - V **Bio-Physical Techniques:** Crystallography: basic concepts & laws, symmetry of elements in crystal X–ray crystallography, determination of crystal structure; Centrifugation – Principle, sedimentation co-efficient, sedimentation velocity, Types: Differential, Density gradient, Rate zonal & Isopycnic; Ultracentrifugation.

Reference Books: -

1. Skofronick, J.G., Turn, S.Q., & Szuminsky, N.J. (2014). Fundamentals of Analytical Chemistry (9th ed.). Cengage Learning.
2. Christian, G.D., & O'Reilly, J.E. (2018). Instrumental Analysis (7th ed.). Waveland Press.
3. Skoog, D.A., Holler, F.J., & Crouch, S.R. (2007). Principles of Instrumental Analysis (6th ed.). Brooks/Cole.
4. Miller, J.N., & Miller, J.C. (2018). Statistics and Chemometrics for Analytical Chemistry (6th ed.). Pearson.
5. Harris, D.C. (2015). Quantitative Chemical Analysis (9th ed.). W. H. Freeman.
6. Belcher, R. (2019). A Practical Approach to Quantitative Metal Analysis of Organic Matrices (2nd ed.). Springer.
7. Townshend, A. (2015). Chromatographic and Electrophoretic Techniques (5th ed.). Butterworth-Heinemann.
8. Jennings, K.R. (2015). Analytical Atomic Absorption Spectroscopy (2nd ed.). Academic Press.
9. Jenkins, R., & Snyder, L.R. (2013). Introduction to X-ray Powder Diffractometry (2nd ed.). Wiley.
10. Freeman, A., & Hall, A.J. (2019). Basic Analytical Chemistry (2nd ed.). Royal Society of Chemistry.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 7**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals

1. Operating shakers, incubators, pH meters, and centrifuges.
2. Preparing buffers such as Phosphate, Acetate, and Citrate.
3. Performing density gradient centrifugation.
4. Conducting agarose gel electrophoresis for DNA.
5. Staining SDS-PAGE gels using Coomassie Brilliant Blue and silver staining methods.
6. Estimating nucleic acid content via colorimetric methods.
7. Extraction of proteins from Bacterial cells/Animal cells/ Plant cells.

INDUSTRIAL BIOTECHNOLOGY	
Paper: - **Theory**	Course code: - **MJ 8**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to understand principles, history, and types of bioprocess technology and fermentation. Learn microbial growth kinetics, bioprocess control, and fermenter design. Apply downstream processing techniques and waste measurement methods. Evaluate industrial wastewater treatment and disposal methods. Integrate knowledge of bioprocess technology to optimize and innovate industrial microbial processes for various applications.

UNIT: - I Principles of Bioprocess technology – Introduction and history of traditional and modern bioprocess technology; General concepts of fermentation technology – Outline of an integrated bioprocess and various unit operations; Industrially important microbes: Isolation, Screening & Preservation techniques – Slant culture, spore culture, overlaying culture with mineral oil; Lyophilization, Cryopreservation – Strain improvement – mutation, & rDNA techniques for strain development– Maintenance of Industrially important microbes.

UNIT: - II Introduction to fermentation - Types of fermentation processes (Submerged & solid static) - Media formulation - Synthetic and complete media; Sterilization– Air; Filter and Media sterilization. Operation: Inoculum preparation and sampling; Fermenters: Design of a fermenter – Types: Stirred tank; Fluidized bed; Immobilized bed bioreactors; Photo bioreactors; Air lift bioreactors and its other types. Batch; Fed-batch and Continuous culture system.

UNIT: - III Microbial growth and death kinetics - Bioprocess control & monitoring of various factors, temperature, agitation, pressure, pH, dissolved oxygen and foam sensing – online measurements; Control systems – Manual control, Automatic control - on/off control & PID control; Computer applications in fermentation technology - Scale up & Scale down of microbial reactions.

UNIT: - IV Down- stream processing: Removal of microbial cells and solid matter – Precipitation, Filtration, Centrifugation, Liquid – Liquid extraction, Chromatography and membrane processes, BOD and COD measurements, Disposal of industrial wastes.

UNIT: - V Industrial waste water treatment and disposal: Physical treatment, chemical treatment and biological treatments; Aerobic processes - trickling filter, towers, biologically aerated filters, rotating drums, fluidized bed systems, activated sludge process. Anaerobic treatment - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blankets; Disposal - seas and rivers, lagoons, spray irrigation, well-disposal, landfilling, incineration, disposal of effluents to sewers.

Reference Books: -

1. Stanbury P.F., Whitaker. A & Hall. S. J., Principles of Fermentation Technology (2nd edition), Aditya Books Private Ltd., 2000.
2. Crueger, W. and Crueger, A., Biotechnology: A Textbook of Industrial Microbiology (2nd edition), Panima Publishing Corporation, New Delhi, 2000.
3. Waites M.J., Morgan N.L., Rockey J.S., Industrial Microbiology (2nd edition), Blackwell Science, 2002.
4. Demain L. & Davies E., Manual of Industrial Microbiology and Biotechnology (2nd edition), ASM Press, Washington, 2004.
5. Shuler M.L. and Kargi F., Bioprocess Engineering: Basic Concepts (2nd edition), Prentice Hall, 2002.
6. Doran P.M., Bioprocess Engineering Principles (2nd edition), Academic Press, 2012.
8. Patel A.H., Industrial Microbiology (1st edition), Macmillan India Ltd, 1996.
9. El-Mansi E.M.T., Bryce C.F.A., Fermentation Microbiology and Biotechnology (3rd edition), CRC Press, 2011.
10. Moo-Young M., Comprehensive Biotechnology (2nd edition), Pergamon Press, 2011.
11. Casida L.E., Industrial Microbiology (1st edition), New Age International Publishers, 1999.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 8**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals

1. Fermenter design and structure.
2. Inoculum preparation and sterilization
3. Preparation of Wine
4. Isolation of lactic acid bacteria from curd
5. Estimation of COD.
6. Estimation of BOD.
7. Immobilization of bacterial cells.

ANIMAL CELL SCIENCES AND TECHNIQUES	
Paper: - **Theory**	Course code: - **MJ9**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to explain the fundamental scientific principles of animal cell culture and techniques for cell isolation, maintenance, and growth. Gain insight into mammalian cell culture techniques, disaggregation methods, and various culture types. Understand artificial insemination, IVF, transgenic animals, and production of proteins through biotechnological methods. Recognize the significance of animal models, molecular markers, cloning techniques, and bioethics in animal research. Analyze and interpret the impact of various animal diseases on livestock and poultry, and understand the role of vaccines and bioethics in disease management.

UNIT: - I Introduction, history, basic concepts of animal cell culture, primary cell culture and established cell lines, maintenance of cultures, requirements of animal cell culture, media - natural (clots, biological fluids and tissue extracts) and synthetic (serum containing media, serum free media, chemically defined media, protein free media).

UNIT: - II Basic techniques of mammalian cell culture, disaggregation of animal tissues - mechanical, enzymatic and EDTA, evolution of cell line, monolayer culture, suspension culture, immobilized culture, organ culture - plasma clot, raft method, agar gel, grid method, embryo culture, maintenance of cell culture.

UNIT: - III In vitro fertilization and embryo transfer, applications and limitation; Transgenic animals (avian, rodent & ruminants); Transgenic methods,

Embryonic Stem cell transfer; Targeted Gene Transfer; Detection of transgenic animals; Production of useful proteins in transgenic animals.

UNIT: - IV Introduction to Stem Cells: Definition and types (Embryonic, adult, iPSCs); Properties: Self-renewal and differentiation; Stem Cell Niches: Microenvironment and signaling pathways, regulation, differentiation and mechanisms; Culture and Maintenance: Isolation, culturing methods, markers; Therapeutics: Applications in regenerative medicine, therapy for neurodegenerative and cardiovascular diseases; Ethical and Regulatory Considerations: Issues and frameworks

UNIT: - V Sustaining proliferative signaling, evading growth suppressors, Cell Biology: Growth, division mechanisms, genetic mutations, Tumor Microenvironment: Interactions, angiogenesis, metastasis; Oncogenes and tumor Suppressors genes and functions; Cell Cycle and Apoptosis- Regulation in cancer, apoptosis in cancer cell survival, Cancer Stem Cells: Characteristics and implications for therapy

Reference Books: -

1. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th edition), ASM Publisher, 2009.
2. Michael Wink, An Introduction to Molecular Biotechnology: Fundamentals, Methods and Applications (2nd edition), John Wiley and Sons, 2013.
3. Ganga. G & Slochanachetty, An Introduction to Sericulture (2nd edition), Oxford and IBH Publishers Pvt. Ltd., Delhi, 2012.
4. Old R.W, Primrose S.B, Twyman R. M, Principles of Gene Manipulation (6th edition), Blackwell Sciences, 2001.
5. R.I. Freshney, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6th edition), Wiley-Blackwell, 2010.
6. Ian Freshney, Animal Cell Culture: A Practical Approach (3rd edition), Oxford University Press, 2000.
7. John M. Walker and Ralph Rapley, Molecular Biology and Biotechnology (5th edition), Royal Society of Chemistry, 2014.
8. John R. Masters, Animal Cell Culture: Practical Approach (3rd edition), Oxford University Press, 2000.
9. Bruce Alberts, Molecular Biology of the Cell (5th edition), Garland Science, 2007.
10. Julian Davies, Recombinant DNA Techniques: An Introduction (1st edition), Jones and Bartlett Publishers, 1993.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 9**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals

1. Sterilization techniques: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Preparation of Hanks Balanced salt solution.
3. Preparation and filter sterilization of Animal cell culture media.
4. Isolation of chick embryos.
5. Dye exclusion assay- Trypan blue assay and cell counting using Hemocytometer.
6. SDS-PAGE of proteins isolated from hPBCs.

ENVIRONMENTAL BIOTECHNOLOGY	
Paper: - **Theory**	Course code: - **MJ 10**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to comprehend environmental issues and the role of biotechnology in the cleanup of contaminated environments. Comprehend the fundamentals of biodegradation, biotransformation, and bioremediation of organic contaminants and toxic metals. Apply biotechnological processes in wastewater and solid waste management. Comprehend biofuels/bioenergy systems; attributes for biofuel/bioenergy production and demonstrate innovative solutions for environmental challenges. Understand and evaluate the applications of biosensors, biochips, and bio restoration in environmental biotechnology.

UNIT: - I Introduction to environmental biotechnology; Non Renewable resources - coal, petroleum, and natural gas; Renewable resources - solar, wind, tidal, biomass, nuclear, geothermal and hydroelectric resources; Current status and environmental impact of renewable and non-renewable resources.

UNIT: - II Methanogenic bacteria and biogas, microbial hydrogen production, conversion of sugars to alcohols, plant-based petroleum industry, cellulose as the source of energy; Environmental impact of modern fuels.

UNIT: - III Principles of waste management, types, sources and effects of solid waste; Physical and biological treatment methods; Concept of composting and vermicomposting; Waste to energy conversion; Disposal of wastes.

UNIT: - IV Basics and types of bioremediation; Bioremediation of oil, heavy metals, pesticides contaminated soil and water; Phytoremediation and its types; Biochemical and genetic basis of biodegradation; Xenobiotic compounds and recalcitrance; Biodegradation of pesticides and petroleum products; Biotransformation of heavy metals; Biopolymers and Biodegradable plastics.

UNIT: - V Biomonitoring – Bioassays; Biosensors; Biochips; Biological indicators and Biomarkers; Biorestoration of waste land; Bioleaching – microbes involved; Role of Biotechnology in pollution abatement; Biofertilizers.

Reference Books: -:

1. Scragg A. H, Environmental Biotechnology (2nd revised edition), Oxford University Press, 2005.
2. Jogdand S. N, Environmental Biotechnology (3rd edition), HimalayaPublishing House Pvt. Ltd., 2012.
3. Thakur I. S, Environmental Biotechnology: Basic Concepts and Applications (2nd revised edition), I K International Publishing House Pvt. Ltd., 2011.
4. Varnam A. H, Environmental Microbiology (1st Edition), ASM Press, 2001.
5. Rittmann B.E. and McCarty P.L, Environmental Biotechnology: Principles and Applications (1st edition), McGraw-Hill, 2001.
6. Jordening H.J. and Winter J., Environmental Biotechnology: Concepts and Applications (1st edition), Wiley-VCH, 2005.
7. Evans G.M. and Furlong J.C., Environmental Biotechnology: Theory and Application (1st edition), John Wiley & Sons, 2003.
8. Maier R.M., Pepper I.L., and Gerba C.P., Environmental Microbiology (2nd edition), Academic Press, 2009.
9. Singh A. and Ward O.P., Biodegradation and Bioremediation (2nd edition), Springer, 2004.
10. Atlas R.M. and Bartha R., Microbial Ecology: Fundamentals and Applications (4th edition), Benjamin Cummings, 1997.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 10**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals

1. Estimation of D.O. in water sample.
2. Estimation of T.D.S. in water sample.
3. Estimation of C.O.D. in water sample.
4. Estimation of Chlorine in water sample.
5. Estimation of total hardness in water sample.
6. TDP and TDT of Microbes.

ENZYMOLOGY	
Paper: - **Theory**	Course code: - **MJ 11**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): The course is designed to provide a detailed knowledge of the nomenclature and classification of enzymes, the mechanism and kinetics of an enzymatic reaction, and the types and kinetics of enzyme inhibition. The course will also help to understand practically and determine the kinetics of enzymatic reactions and to study the effect of pH and temperature. Upon successful completion of the course, students are able: to understand the concepts of enzymes, and the mechanics and kinetics of enzymatic reactions to independently perform enzymology experiments and learn to calculate enzyme activity and kinetics.

UNIT: - I Overview and Classification of Enzymes: Historical perspective and definition of enzymes; Nomenclature of enzymes, enzyme classification and characteristics; Co-enzymes and cofactors; Isoenzymes, abzymes and ribozymes; Metalloenzymes and metal-activated enzymes; Units of enzyme activity; Proteolytic enzymes; Multienzyme complexes: pyruvate dehydrogenase and fatty acidsynthase.

UNIT: - II Enzyme Kinetics: Factors affecting enzyme activity: pH, temperature and substrate concentration; Derivation of Michaelis– Menten equation; Limitations and transformation of the MM equation: Lineweaver– Burk plot and Eadie Hottse; Hanes Woolf plot; Km, Vmax and Kcat; Turnover number, catalytic efficiency and enzyme specificity.

UNIT: - III Mechanism of Enzyme Catalysis: Enzyme active site and its general characteristics; Mechanism of enzyme action; Lock-and key model, induced-fit hypothesis; Mechanisms of enzyme catalysis: acid– base catalysis, covalent catalysis, substrate strain and entropy effect; Mechanisms of action of chymotrypsin, lysozyme and carboxypeptidase.

UNIT: - IV Enzyme Regulation: Enzyme inhibition - reversible (competitive, uncompetitive and non-competitive) and irreversible; Enzyme regulation: covalent modification, allosteric, end-product, and feedback regulation; Brief idea about Enzyme Engineering.

UNIT: - V Applications of Enzymes: Immobilization techniques- adsorption, covalent binding, cross linking, entrapment, encapsulation; Properties of immobilized enzymes to free enzymes; Applications of enzymes in Food and Drink industries; Artificial kidney machines, pharmaceutical industries and washing powder manufacturing industries.

Reference Books: -

1. Lehninger AL, Nelson DL and Cox MM, Lehninger principles of biochemistry (7th ed.), New York:W.H.Freeman, 2017.
2. Rodwell VW, Bender DA, Botham KM, et al., Harper's illustrated biochemistry (31st ed.), London: McGraw Hill, 2018.
3. Palmer T and Bonner PL, Enzymes (2nd ed.), Cambridge: Woodhead Publishing, 2007.
4. Bisswanger H,Practical enzymology (3rd ed.), Weinheim:John Wiley& Sons, 2019.
5. Plummer DT, Introduction to practical Biochemistry. Tata McGraw-Hill, New Delhi Education, 2001.
6. Berg JM, Stryer L, Tymoczko J and Gatto G, Biochemistry (9th ed.), New York: WHFreeman, 2019.
7. Devlin TM, Textbook of biochemistry with clinical correlations (7th ed.), New York: John Wiley&Sons, 2010.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 11**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals: -

1. Isolation and quantification of starch from potatoes.
2. Isolation and quantification of casein and lact albumin from mil.
3. Isolation and quantification of ovalbumin from egg.
4. Extraction of pectinase.
5. Determination of acid number.
6. Spectrophotometric estimation of protein by A280 method.
7. Effect of pH and temperature on enzyme activit.

PLANT TISSUE CULTURE	
Paper: - **Theory**	Course code: - **MJ 12**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to gain a good understanding of r-DNA technology, methods of gene transfer, molecular markers, and marker-assisted selection. Understand traditional and modern plant breeding methods for crop improvement. Develop transgenics resistant to biotic and abiotic stresses, and quality characteristics and understand their role in crop improvement. Evaluate transgenic plants for traits like pest resistance, improved yield, and abiotic stress tolerance. Apply plant biotechnology techniques in crop improvement and bio production for enhanced agricultural sustainability and productivity.

UNIT: - I Conventional breeding for crop improvement- Introduction, domestication, methods of Plant Breeding- hybridization; Clonally Propagated Species; Breeding Enhancements- Marker-Assisted Selection, mutation breeding; Plant genome organization, organization of chloroplast genome, cytoplasmic male sterility, genetic male sterility.

UNIT: - II Basics of Plant tissue culture, Sterilization – Surface and Dry, Components (inorganic, organic and plant hormones) and types of nutrient media; Callus and Suspension cultures; Micropropagation; Somatic embryogenesis & Organogenesis; Germplasm conservation; Embryo culture and artificial seeds; Somaclonal variations; Production of haploid plants (microspores and ovules); Applications and limitations of haploid plants.

UNIT: - III Introduction and Principles of Somatic Hybridization – Protoplast isolation; Protoplast fusion; Selection of hybrid cell; Regeneration of hybrid plants;

Somatic hybrids and cybrids – cytoplasm transfer; Genetic transformation; Advantages and Limitations; Molecular markers – RFLP, RAPD, DNA fingerprinting; Production and applications of Secondary metabolites from plants.

UNIT: - IV Genetic engineering of plants: Vectors- Plasmid vectors and plant viral vectors (CaMV, Gemini virus, Tobacco Mosaic virus), cloning vectors for higher plants - Genetic manipulation using Agrobacterium tumefaciens; Gene transfer in plants - Electroporation, particle gun method, microinjection, polyethylene glycol mediated transformation, chloroplast transformation (brief idea).

UNIT: - V Applications of transgenic plants- Pest resistance, herbicide resistance, virus resistance and bacterial resistance, delay of fruit ripening, salt & drought tolerance, improvement of crop yield and quality, improved nutrition.

Reference Books: -

1. Trivedi P.C. Plant Biotechnology: Perspectives and Prospects. Pointer Publishers, 2007.
2. Slater A., Scott N., Fowler M. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press, 2008.
3. Hans-Walter Heldt. Plant Biochemistry (4th ed.). Academic Press, 2010.
4. Old R.W., Primrose S.B., Twyman R.M. Principles of Gene Manipulation (6th ed.). Wiley-Blackwell, 2002.
5. Bhojwani S.S. & Razdan M.K. Plant Tissue Culture: Theory and Practice.Elsevier, 1996.
6. Smith R.H. Plant Tissue Culture: Techniques and Experiments (3rd ed.). Academic Press, 2012.
7. Stewart C.N. Jr. Plant Biotechnology and Genetics: Principles, Techniques, and Applications. Wiley, 2008.
8. Kumar H.D. A Textbook on Biotechnology (2nd ed.). Affiliated East-West Press, 1998.
9. Gamborg O.L., Phillips G.C. Plant Cell, Tissue and Organ Culture: Fundamental Methods. Springer, 1995.
10. Chawla H.S. Introduction to Plant Biotechnology (3rd ed.). Science Publishers, 2012.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 12**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals: -

1. Plant Tissue culture technique - Preparation of Media
2. Effect of solidification on tissue culture media.
3. Callus Induction and shoot regeneration.
4. Shoot multiplication
5. Anther culture.

BIOINFORMATICS	
Paper: - **Theory**	Course code: - **MJ 13**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to apply computational methods to solve biological problems and utilize biological databases effectively. Analyze DNA and protein sequences using alignment methods and sequence analysis tools. Understand phylogenetic analysis techniques and construct phylogenetic trees. Predict protein structures, identify motifs and domains, and explore applications of bioinformatics in drug discovery and genomics. Employ bioinformatics tools for data mining, microarray analysis, and genome-wide expression analysis to contribute to advancements in genomics and personalized medicine.

UNIT: - I Bioinformatics: an overview - Introduction to Computational Biology and Bioinformatics; some of the biological problems that require computational methods for their solutions; Role of internet and www in bioinformatics.
Biological Databases Acquisition –Primary and Secondary databases; Nucleotide sequence databases; Types of DNA sequences – genomic DNA, cDNA, recombinant DNA, Expressed sequence tags (ESTs).

UNIT: - II Sequence Analysis – Methods of sequence alignment: Dot plots; Scoring matrices – identify matrix, genetic code matrices (GCM); Substitution matrices, percentage accepted Mutation (PAM); Block Substitution Matrices (BLOSUM), dynamic programming algorithms; Needlman-Wunch and Smith Waterman; alignment scores and gap penalties; Database searching (BLAST

and FASTA); Multiple Sequence alignment (MSA) – significance; Softwares : ClustalW and Meme.

UNIT: - III Phylogenetic analysis – Phylogenetics, cladistics and ontology; Phylogenetic representations – graphs, trees and cladograms; Classification and ontologies; Steps in phylogenetic analysis; Methods of phylogenetic analysis – similarity and distance tables, distance matrix method; Method of calculation of distance matrix (UPGMA, WPGMA); The Neighbor Joining Method; The Fitch/Margoliash method; Steps in constructing alignments and phylogenies; Phylogenetic softwares –PHYLIP

UNIT: - IV Structure prediction: Protein- methods for prediction of secondary and tertiary structures of protein – knowledge-based structure prediction; fold recognition; ab initio methods for structure prediction; comparative protein modeling; Identification of motifs and domains, protein family database; RNA structure prediction.

UNIT: - V Applications of bioinformatics in Drug discovery: Finding new drug targets to treat diseases – Pharmacophore identification - Structure based drug design; Mining of sequence data - Mining data from Yeasts; Microarray and genome wide expression analysis: transcriptomes, proteome; Genomics in medicine, disease monitoring, and profile for therapeutic molecular targeting.

Reference Books: -

1. Mount, D. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York, 2004.
2. Baxevanis, A.D. and Ouellette, B.F. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley and Sons, New Jersey, USA, 1998.
3. Lesk, A.M. Introduction to Bioinformatics. First edition, Oxford University Press,UK, 2002.
4. Rastogi, S.C., Mendiratta, N., and Rastogi, R. Bioinformatics: Concepts, Skills and Applications. CBS Publishers, New Delhi, India, 2006.
5. Pevsner, J. Bioinformatics and Functional Genomics. John Wiley & Sons, 2015.
6. Durbin, R., Eddy, S.R., Krogh, A., and Mitchison, G. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.
7. Westhead, D.R., Parish, J.H., and Twyman, R.M. Bioinformatics: Instant Notes. Garland Science, 2003.
8. Bergeron, B.P. Bioinformatics Computing. Prentice Hall, 2002.
9. Claverie, J.M., and Notredame, C. Bioinformatics for Dummies. Wiley Publishing, 2003.
10. Attwood, T.K., and Parry-Smith, D.J. Introduction to Bioinformatics. Addison Wesley Longman, 1999.

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 13**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals: -

1. Open access bibliographic resources and literature databases: PubMed, BioMed Central.
2. Nucleic acid sequence databases: GenBank, EMBL, DDBJ.
3. Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL.
4. Genome Databases at NCBI, EBI, TIGR, SANGER
5. Sequence file formats: GenBank, FASTA, GCG, MSF.
6. Pairwise sequence alignment: BLAST
7. Multiple sequence alignment: ClustalW, MEGA
8. Protein structure database: PDB, Rasmol.
9. Sequence editing and manipulation: Bioedit and Sequence manipulation suite.

MICROBIAL BIOTECHNOLOGY	
Paper: - **Theory**	Course code: - **MJ 14**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes: Comprehend the metabolic diversity, physiology, and genetics of microorganisms. Apply recombinant DNA technology, metabolic engineering, and synthetic biology to manipulate microbial strains. Explain how microbes are utilized in large-scale fermentation for the production of pharmaceuticals (e.g., antibiotics, vaccines) and biofuels. Analyze microbial processes for bioremediation, waste treatment, and bio-fertilizer production. Evaluate the safety, ethical, and patenting regulations relevant to microbial biotechnology and biosafety.

UNIT: - I **Microbial Biotechnology:** Scopes and challenges; Industrial microorganisms: Growth metabolism regulation, Isolation and preservation of industrially important microorganisms; Production of metabolites- Microbial production and applications of primary metabolites: Citric acid, Ethanol, L Glutamic acid, L Lysine, Vitamins B; Industrially important microbial enzymes: Types, mode of action and industrial applications of microbial amylases and proteases

UNIT: - II **Production of important microbial products:** Antibiotics (Penicillin and Streptomycin), Ergot alkaloids; Biotransformations of steroids: Hydroxylations and dehydrogenation, Sterol biotransformations; Probiotics, prebiotics and synbiotics: Products of Probiotics, health benefits, Vaccines production by bacteria.

UNIT: - III **Microbes and society:** Microbes in agrobiotechnology; microbial pesticides; integrated pest management, nano fertilizers, environmental biotechnology; food production involving microorganisms and their products, microbes in medical biotechnology, microbes in alternative energy, microbes in detergent, textile industries.

UNIT: - IV **Bioplastics and Bioweapons:** Plastics vs. Bioplastics; History, chemical nature and production of bioplastics, health benefits of bioplastics; Microplastics: Microbial degradation of microplastics; Bioterrorism/bioweapons– History, microbes used in bioterrorism, threats and policy to control bioterrorism.

UNIT: - V **Biosurfactants and Biosensors:** Biosurfactants: History, Characteristics, Sources, types and production, application in agriculture, food, medical and paper industries; Biosensors: History, types, characteristics and Application in food quality monitoring, soil quality monitoring, water quality monitoring, environmental monitoring and environmental monitoring.

Reference Books: -

1. R.C. Dubey (2014), Advanced Biotechnology, S. Chand, New Delhi, ISBN: 9788121942904
2. Alexander N. Glazer (2012), Microbial Biotechnology: Fundamentals of Applied Microbiology, Cambridge University Press, ISBN : 9780511811227
3. Relevant research articles

PRACTICAL	
Paper: - **Practical**	Course code: - **MJ 14**
Total Marks: - **25**	Credits: - **1 (P)**

List of Practicals: -

1. Isolation of bacteria from soil.
2. Isolation of bacteria from water.
3. Demonstration of isolation and production of microbial pesticides.
4. Biochemical Characterization of Bacteria.

BIOSTSTATISTICS & COMPUTER APPLICATIONS IN BIOLOGY	
Paper: - **Theory**	Course code: - **MJ 15**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to Explain the fundamentals of bio-statistics including probability and central tendency. Understand the basics of statistical tools used in Biotechnology. Gain insight into the concepts of bio statistics. Understand the concept of various computer based programming languages. Apply biotechnological approaches for research purpose.

UNIT: - I Importance and scope of statistics in biological experimentation; Elements of probability; Mathematical and statistical definitions; Addition and Multiplication theorems; Probability distribution functions-Binomial, Poisson and Normal; Area under normal distribution curve; Measures of central tendency: Arithmetic, geometric & harmonic means.

UNIT: - II Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean; Tests of significance, hypothesis and errors; student t statistics-population means equals a specified value; equality of 2 independent means (equal and unequal variance), equality of 2 means (paired samples).

UNIT: - III Analysis of variance: one way analysis (sample sizes equal and unequal), completely randomized design; two way analysis (one observation per cell); Linear regression: regression diagram and equation, regression coefficient, standard error, significance tests, prediction of dependent variable from the

independent variable; linear correlation-scatter diagram , correlation coefficient, standard error, significance tests.

UNIT: - IV Relationship between regression and correlation coefficients; Non parametric tests: Chi square statistics, tests of goodness of fit, test of independence of attributes, standard line interpolation.

UNIT: - V Introduction to computers: Basic Architecture, generations of computer hardware and software; operating systems-WINDOWS system and application software; Introduction to internet-LAN, MAN, WAN, Programming language C (Introduction) and presentation software, Flow charts & Programming techniques.

Reference Books: -

1. Fingerman, Milton, and Nagabhushanam, R. Recent Advances in Marine Biotechnology, Vol. 8. Science Publisher, 2003.
2. Kim, Se-Kwon. Springer Handbook of Marine Biotechnology. Springer Handbooks, 2014.
3. Pillay, T. V. R., and Kutty, M. N. Aquaculture: Principles and Practices, 2nd edition. Blackwell Publishing, 2005.
4. Atlas, Ronald M., and Bartha, Richard. Microbial Ecology: Fundamentals and Applications, 4th edition. Benjamin Cummings, 1997.
5. Laboratory Manual on Methodologies for Assessing Biodiversity in Estuaries, Mangroves, and Coastal Waters. Annamalai University.
6. Munro, Paul D. Marine Microbial Ecology, Cambridge University Press, 2005.
7. Lalli, Carol M., and Parsons, Timothy R. Biological Oceanography: An Introduction, 2nd edition. Butterworth-Heinemann, 2006.
8. Levings, Colin D., and Browne, Robert B. Marine and Estuarine Ecosystem Processes. Springer, 2011.
9. Bardach, John E., Ryther, John H., and McLarney, William O. Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, 1972.
10. Gosling, Elizabeth. Marine Bivalve Molluscs. Wiley-Blackwell, 2003.

PRACTICAL	
Paper: **- Practical**	Course code: **- MJ 15**
Total Marks: **- 25**	Credits: - **1 (P)**

List of Practicals: -

1. C' programming language
2. if-else, nested if-else, ladder if-else related programs
3. looping
4. arrays
5. MS- Office
6. MS-Word
7. MS-Excel
8. MS-Power Point
9. MS-DOS

RESEARCH METHODOLOGY	
Paper: - **Theory**	Course code: - **MJ 16**
Total Marks: - **100 (IA 30 + EA 70)**	Credits: - **4 (T)**

Question Paper Pattern (Theory)

Total Marks: - 70 **Time: - 3 Hours**

SECTION – A: (10 x 2 = 20 Marks)

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

SECTION – B: (5 x 4 = 20 Marks)

- It is of short answer type. Each question carries 4 marks.
- Questions to be given by setting 2 question from each unit.
- Candidate should Answer 5 questions out of 10 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to learn about the research aptitude and how to deal with different types of research problems.

UNIT: - I Research- Purpose, Types & Characteristics. Process of Research; Formulation of objectives, Hypothesis- Types of Hypothesis; Methods of testing Hypothesis; Research plan and its components; Survey, observation, case study.

UNIT: - II Research problem: Identification and formation of research problem; Elements in research methodology; Research Design, components of research.

UNIT: - III Role of IPR and patenting in Research and Development; Ethical, legal, social and scientific issues in research.

UNIT: - IV Data Collection; Sources of Data, primary Data, secondary Data; Procedure Questionnaire; Sampling, merits & demerits.

UNIT: - V Experiments; kinds and procedure; Control Observation- Merits & Demerits; Kinds, procedure; Brief idea of Sampling errors.

MEDICAL BIOTECHNOLOGY	
Paper: - **Theory**	Course code: - **MJ 17**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to explain insights about genetic diseases and also about the molecular aspects related to human disease. Gain new insights into molecular mechanisms of nucleic acid and gene therapy. Gain knowledge about therapeutic recombinant proteins and immunotherapy for the treatment of different diseases.
Understand the applications of stem cell technology and regenerative medicine in medical biotechnology. Utilize advanced techniques in medical biotechnology for diagnosis, treatment, and therapeutic development.

UNIT: - I Introduction – Origin, significance & worldwide market of Medical Biotechnology; Revolution in clinical diagnosis; Antibody and Nucleic Acid Hybridization techniques; Imaging techniques (Nanodiagnosis).

UNIT: - II Genetic & Metabolic Disorders – Introduction, classification, Impact of genetic diseases on human health - Chromosome errors - Down syndrome, Klinefelter's and Turner's syndrome; Metabolic disorders – Phenylketonuria, Homocystinuris, Mucopolysaccharidosis, Gangliosidosis, Gaucher's disease, Diabetes, Hemophilia and sickle cell anemia; Treatment of Genetic diseases - prenatal diagnosis; Genetic Counseling - Ethical, Legal and Social Issues.

UNIT: - III Revolution in treatment – Recombinant DNA technology for human insulin, Hepatitis B vaccine; Therapeutic proteins and peptides – Erythropoietin, Tissue plasminogen activator, clotting factor VIII; Antibody Engineering and Therapeutic Antibodies; Phage therapy.

UNIT: - IV Cancer - Molecular, cellular and genetic basis of cancer, tumor virus and oncogenes, tumor suppressor genes and mechanism of action of p53 proteins; Stem Cells - Sources and types of stem cells; Stem cell transplant and its types; Potential targets for stem cell treatment; Therapeutic applications of stem cells; Regenerative medicine and Stem cell ethics.

UNIT: - V Gene therapy- basic approaches and types of gene therapy, vectors used in gene therapy, application of gene therapy in medicine; Nanobiotechnology - Introduction, types and structures of nanoparticles, biosynthesis of nanoparticles, application of nanoparticles in treatment.

Reference Books: -

1. Glick B.R. and Pasurank..Molecular biotechnology – Principle and Applications of Recombinant DNA-J.I.(4th edition), ASM Press. 2010.
2. Anthony D. Ho, Hoffman. R, and Esmail D. Zanjani, Stem Cell Transplantation (4th edition), Wiley – liss publishers, 2006.
3. Hornyak.
4. Jogdand. S. N. Medical Biotechnology –, (4th edition), Himalayan publishing house, 2004.
5. Chaudhury, S., & Dash, A. Therapeutic Proteins and Peptides, CRC Press, 2015.
6. Holliger, P., & Hudson, P.J. Engineering Bispecific Antibodies, Springer, 2012.
7. Lanza, Robert, et al. Essentials of Stem Cell Biology, 3rd edition, Academic Press, 2013.
8. Gupta, R.C. Repurposing of FDA-Approved Drugs for Neurological and Neuropsychiatric Disorders: Rethinking the Potential of Off-Label Uses, Academic Press, 2015.
9. Kay, Mark A. Gene Therapy: Therapeutic Mechanisms and Strategies, 3rd edition, CRC Press, 2015.
10. Zhang, L., & Webster, T.J. Nanotechnology for Cancer Therapy, Springer, 2016.

PRACTICAL	
Paper: **- Practical**	Course code: **- MJ 17**
Total Marks: **- 25**	Credits: - **1 (P)**

List of Practicals: -

1. Biochemical test for identification of bacteria.
2. Extraction and separation of Antigen proteins from Bacteria & protozoa
3. Estimation of blood glucose.
4. Estimation of cholesterol in blood.
5. Estimation of iron in blood.
6. Biological synthesis of nanoparticles.
7. Detection of plasmodium pathogen using peripheral smear
8. Widal test.

AGRICULTURAL BIOTECHNOLOGY	
Paper: - **Theory**	Course code: - **MJ 18**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to demonstrate an understanding of microbial diversity and its significance in agriculture. Apply marker-assisted selection techniques and transgenic breeding methods for crop improvement. Evaluate the principles and practices of organic and integrated farming systems for sustainable agriculture. Analyze the economic implications of agricultural biotechnology and innovative technologies in agro ecosystems. Develop practical skills in soil analysis, microbial enumeration, and agricultural field assessment.

UNIT: - I Microbes in soil fertility and plant-microbe interactions; Exploration of microbial applications in agriculture, including bioremediation and biocontrol agents.

UNIT: - II Nutrient Cycles: Exploration of carbon, nitrogen, phosphorus, and sulfur cycles in soil; Biological Nitrogen Fixation: Symbiotic, associative, and asymbiotic nitrogen fixation, including the role of Azolla, blue-green algae, and mycorrhiza; Soil Health Management: Strategies for maintaining soil health through microbial interventions and sustainable agricultural practices.

UNIT: - III Marker-Assisted Selection (MAS) in back crossing, heterosis breeding, and gene introgression; Transgenic Crops: Principles of transgenic breeding, genetic modification in agriculture, and the ecological impact of transgenic plants; Genome Editing Technologies: Applications of CRISPR/Cas9 and other genome editing tools in crop improvement and trait modification.

UNIT: - IV Principles of Organic Farming: Organic farming practices, including crop rotation, composting, and biological pest control; Integrated Farming Systems: Integration of crop farming with livestock rearing, aquaculture, and agroforestry for sustainable agriculture; Agro-ecology and Biodiversity: Understanding agro ecosystems, promoting.

UNIT: - V Biodiversity and enhancing ecosystem services in agricultural landscapes.

UNIT: - VI Economic Perspectives in Agriculture: Principles of agro-economics, cost benefit analysis, and market dynamics in agricultural biotechnology; Innovative Technologies: Exploration of emerging technologies such as precision agriculture, vertical farming, and digital agriculture in improving agricultural productivity and sustainability.

Reference Books: -

1. Brady, Nyle C., and Ray R. Weil. The Nature and Properties of Soils, 15th edition, Pearson, 2017.
2. Nair, P. K. R. Agroecological Innovations: Increasing Food Production with Participatory Development, Earthscan, 2007.
3. Arora, Naveen K., et al. Advances in Plant Breeding Strategies: Breeding, Biotechnology and Molecular Tools, Springer, 2015.
4. Altieri, Miguel A., and Clara I. Nicholls. Agroecology and the Search for a Truly Sustainable Agriculture, United Nations University Press, 2005.
5. Paul, Elizabeth A., and Francis Clark. Soil Microbiology, Ecology, and Biochemistry, 4th edition, Academic Press, 2014.
6. Rehman, Abdul, et al. Soil Health and Intensification of Agroecosystems, CRC Press, 2017.
7. Van Ittersum, Martin K., et al. Ecosystem Services for Agriculture: Nature's Solution to Pest Control, Springer, 2013.
9. Wani, Shabir H., et al. Plant Microbiome: Stress Response, Springer, 2018.
10. Stolton, Sue, et al. Agroecology for Food Security and Nutrition: Proceedings of the FAO International Symposium, Routledge, 2018.
11. De Datta, S. K. Principles and Practices of Rice Production, John Wiley & Sons, 1981.

PRACTICALS	
Paper: **- Practical**	Course code: **- MJ 18**
Total Marks: **- 25**	Credits: - **1 (P)**

List of Practicals: -

1. Determination of Soil pH by pH Meter.
2. Determination of Soil Moisture Using the Gravimetric Method.
3. Enumeration of Bacteria from Vermicompost Soil and Wash.
4. Enumeration of Fungi from Vermicompost Soil and Wash.
5. Determination of Soil Organic Matter Content Using the Walkley-Black Method.
6. Determination of Soil Carbonates Using Acid Titration Method.
7. Isolation of Soil Metagenomes.
8. Agricultural Field Visit.

PHARMACEUTICAL BIOTECHNOLOGY	
Paper: - **Theory**	Course code: - **MJ 19**
Total Marks: - **75 (IA 15 + EA 60)**	Credits: - **3 (T)**

Question Paper Pattern (Theory)

Total Marks: - 60 **Time: - 3 Hours**

SECTION – A: (10 x 1.5 = 15 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 3 = 15 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit. A or B
- Candidate should Answer 3 questions out of 5 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to explain the strategies and various steps of the new drug discovery process. Explain the concept of pharmacodynamics and pharmacokinetics. Apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins, and hormones. Carry out the quality control procedures in the production of various biopharmaceuticals and understand the regulatory aspects in the development of pharmaceuticals. Evaluate the applications and economic considerations of biopharmaceuticals, including probiotics, nutraceuticals, and novel vaccine types.

UNIT: - I Definition and scope of Pharmaceutical Biotechnology, sources of drugs, classification of pharmacological agents (based on chemistry, mode of action, dosage forms), route of administration, absorption and bioavailability of drugs, distribution and liver detoxification metabolism and drug excretion.

UNIT: - II General classes and properties of phytopharmaceuticals; Extraction of phytochemicals; Phytochemical screening of medicinal plants; Bioassay guided fractionation methods- TLC, HPTLC, GC, and HPLC; Role of NMR and Mass spectrometry in drug discovery.

UNIT: - III Antimicrobial agents, Antibiotics - source, classification, mode of action, antimicrobial resistance, and antimicrobial activity studies (antibacterial, antiviral, antifungal and antiparasitic activity); Pharmacological Assays - In-

vitro assays - chemical (anti-oxidant), Biological (anti- cancerous and assay system based on enzymes and cells), and immunological (RIA and ELISA) - In vivo assays (Anti-inflammatory and Anti-analgesic).

UNIT: - IV Process of drug discovery and development- Target identification and validation; Assay development, lead optimization, pre-clinical testing, clinical trials involved in drug discovery and development, regulatory approvals and phase IV trials; High throughput screening; CPCSEA guidelines; ICMR guidelines for drug testing.

UNIT: - V Vaccines: concept, production and types - Inactivated, attenuated, toxoid, recombinant vaccines, peptide and DNA vaccines, edible vaccines, nanodrugs; Recombinant proteins, approved rDNA drugs in market, probiotics, nutraceuticals, Economic and legal considerations in Pharmaceutical Biotechnology

Reference Books: -

1. Satoskar R.S., Nirmala N. Rege, and Bhandarkar S. D. Pharmacology and Pharmacotherapeutics (Revised 23rd Edition), Popular Prakashan, Mumbai.
2. Tripathy K. D. Essentials of Medical Pharmacology (6th edition), Jaypee publishers.
3. Shoba Rani R. Hiremath, Textbook of Industrial Pharmacy, Orient Longman Pvt Ltd, 2008.
4. Crommelin Daan J. A., Sindelar D. Robert (3rd edition) Pharmaceutical Biotechnology: Fundamentals and Applications, CRC Press, 2007.
5. Remington, The Science and Practice of Pharmacy (22nd Edition), Pharmaceutical Press, 2012.
6. Walsh, G. Biopharmaceuticals: Biochemistry and Biotechnology (2nd Edition), Wiley-Blackwell, 2013.
7. Gennaro, A. R. Remington: The Science and Practice of Pharmacy (21st Edition), Lippincott Williams & Wilkins, 2005.
8. Aggarwal, S. Essentials of Industrial Pharmacy, CRC Press, 2018.
9. Katzung, B.G. Basic and Clinical Pharmacology (14th Edition), McGraw-Hill Medical, 2018.
10. Ahuja, S. Handbook of Bioanalysis and Drug Metabolism, Academic Press, 2005.

PRACTICAL	
Paper: **Practical**	Course code: **- MJ 19**
Total Marks: **- 25**	Credits: - **1 (P)**

List of Practicals: -

1. Preparation of different methods of medicinal plant extracts.
2. Antibacterial activity.
3. Antifungal activity.
4. Total antioxidant activity.
5. Phytochemical screening of Primary metabolites.
6. Phytochemical screening of Secondary metabolites.
7. Separation of medicinal plant extracts by chromatography.
8. Estimation of ascorbic acid in multivitamin formulations.

Entrepreneurial Development, IPRs, Biosafety and Bioethics	
Paper: - **Theory**	Course code: - **MJ 20**
Total Marks: - **100 (IA 30 + EA 70)**	Credits: - **4 (T)**

Question Paper Pattern (Theory)

Total Marks: - 70 **Time: - 3 Hours**

SECTION – A: (10 x 2 = 20 Marks)

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

SECTION – B: (5 x 4 = 20 Marks)

- It is of short answer type. Each question carries 4 marks.
- Questions to be given by setting 2 question from each unit.
- Candidate should Answer 5 questions out of 10 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to understand and apply the principles of GLP and GMP to ensure quality and compliance in research and industry.
Evaluate and implement ethical and biosafety practices in biotechnology. Navigate the patenting process, manage intellectual property, and understand IPR conventions. Develop entrepreneurial skills in demand surveying, product identification, process design, and business resource management within the legal and regulatory framework.
Analyze the economic and societal impacts of biotechnological innovations and entrepreneurial ventures.

UNIT: - I Ethics/bioethics: Introduction to ethics/bioethics; Framework for ethical decision making; Animal rights/welfare; Ethical, Legal and Social Implications (ELSI) of biotechnological products and techniques; Social and ethical implications of biological weapons.

UNIT: - II Biosafety and biosecurity framework: Roles and responsibilities of IBSC, RCGM in biosafety and biosecurity regulation; Source of biosafety and biosecurity risks; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety and Biosecurity risk, assessment and management; Bio-containment principles and practices; Applicable national guidelines; Compliance adherences accidents and emergency managements.

UNIT: - III International instruments on Biosafety Regulation: Cartagena Protocol and supplementary protocols; Implementation bodies; National focal points; Responsibility of nation as a party to these instruments; Impact on research, international trade and travel.

UNIT: - IV Intellectual property rights: Introduction to intellectual property and its rights – types: patents, copyrights, trademarks, design rights, geographical tag – importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions; Agreements and Treaties: History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments.

UNIT: - V Patent filing procedures: National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting– disclosure/non-disclosure; Financial assistance for patenting-introduction to existing schemes; Patent licensing and agreement; Patent infringement-meaning, scope, litigation, case studies.

Reference Books: -

1. Sandy Weinberg. (2007). Good Laboratory Practice Regulations. 4th Edition. CRC Press.
2. Sidney H. Willig. (2016). Good Manufacturing Practices for Pharmaceuticals. 6th Edition. CRC Press.
3. CDC and NIH. (2009). Biosafety in Microbiological and Biomedical Laboratories. 5th Edition. U.S. Department of Health and Human Services.
4. Deborah E. Bouchoux. (2016). Intellectual Property Rights. 5th Edition. Cengage Learning.
5. Robert Patrick Merges and John Fitzgerald Duffy. (2017). Patent Law and Policy: Cases and Materials. 7th Edition. Carolina Academic Press.
6. Jay P. Kesan and Gideon Parchomovsky. (2017). Biotechnology and Software Patent Law: A Comparative Review of New Developments. Edward Elgar Publishing
7. Carlos M. Correa. (2007). Trade Related Aspects of Intellectual Property Rights: A Commentary on the TRIPS Agreement. Oxford University Press.
8. Antony Taubman. (2012). The TRIPS Agreement: Drafting History and Analysis. 4th Edition.
9. Sweet & Maxwell. Ryan Abbott. (2015). The Reasonable Robot: Artificial Intelligence and the Law. Cambridge University Press.
10. Ruth L. Okediji. (2016). Copyright Law in an Age of Limitations and Exceptions. Cambridge University Press.

Advanced Major Paper (AMJ) in 7th and 8th Semester

Structural Biology (in 7th Semester)	
Paper: - **Theory**	Course code: - **AMJ 1**
Total Marks: - **100 (IA 30 + EA 70)**	Credits: - **4 (T)**

Question Paper Pattern (Theory)

Total Marks: - 70 **Time: - 3 Hours**

SECTION – A: (10 x 2 = 20 Marks)

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

SECTION – B: (5 x 4 = 20 Marks)

- It is of short answer type. Each question carries 4 marks.
- Questions to be given by setting 2 question from each unit.
- Candidate should Answer 5 questions out of 10 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to understand folding and functions of biological macromolecules. Students will also be able to analyze 3D structures by applying experimental and computational techniques. Understand the principle, advantages and limitations of structure determination techniques such as X-ray crystallography, NMR etc. Students will learn structure based drug design, vaccine development and protein engineering.

UNIT: - I Introduction to Structural Biology: Scope and importance of Structural Biology. Levels of protein structure (Primary, Secondary, Tertiary and Quaternary), Forces stabilizing biomolecular structures (Hydrogen bonding, Hydrophobic interactions, Ionic interactions and Vander waals forces).

UNIT: - II Protein Structures: Amino acids and peptide bonds, Ramachandran plot, Alpha helix and Beta sheet, protein folding and stability, Domains and motifs, Fibrous vs globular proteins, Protein denaturatuion and renaturation.

UNIT: - III Nucleic acid structure: DNA structure models, A, B and Z forms of DNA, RNA structure and folding, Chromatin organization, DNA supercoiling.

UNIT: - IV Structural Determination Techniques: Principle, Crystal formation, Diffraction, electron density maps and applications and limitations of X-ray Crystallography. Basic principles, applications and limitations of Nuclear Magnetic Resonance (NMR).

UNIT: - V Protein folding and Dynamics: Protein Folding pathways, Levinthal paradox, Chaperones and Chaperonins, Misfolding and aggregation, Protein Dynamics and conformational changes. Enzymes structure and functions, Protein ligand interactions including Drug discovery.

Reference Books: -

1. Compeau P, and Pevzner, P.(2014). Bioinformtics Algorithms: Sequence Analysis, Genome Rearrangements, and Phylogenetic Reconstruction. 1st edition.
2. Branden C., & Tooze J (1999). Introduction to Protein Structure. 2nd edition. Garland Science.
3. Alberts B.,Johnson A.,Lewis J.,Raff, M; Roberts, K.,& Walter P.(2014). Molecular Biology of the Cell. 6th edition, Garland Science.

Molecular Diagnostic and Forensic Science (in 8th Semester)	
Paper: - **Theory**	Course code: - **AMJ 2**
Total Marks: - **100 (IA 30 + EA 70)**	Credits: - **4 (T)**

Question Paper Pattern (Theory)

Total Marks: - 70 **Time: - 3 Hours**

SECTION – A: (10 x 2 = 20 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (5 x 4 = 20 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 2 question from each unit.
- Candidate should Answer 5 questions out of 10 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be able to 1. Grasp the basics of molecular diagnostic techniques and their clinical applications. 2. Explore advanced molecular diagnostic methods including CRISPR and proteomics. 3. Understand the principles of forensic science and crime scene investigation. 4. Acquire skills in DNA profiling and forensic genomics, including legal and ethical considerations. 5. Apply interdisciplinary approaches integrating molecular diagnostics into forensic science and clinical diagnostics.

UNIT: - I Introduction to Molecular Diagnostics, definition, scope, and significance. Molecular Biology Techniques: DNA/RNA extraction and purification, Polymerase Chain Reaction (PCR) and its variants (qPCR, RTPCR), Gel electrophoresis and blotting techniques. DNA sequencing methods (Sanger, Next Generation Sequencing).

UNIT: - II In Situ Hybridization, Fluorescence in situ hybridization (FISH), CRISPR and Genome Editing, Principles and techniques of CRISPR/Cas9, Proteomics and Metabolomics.

UNIT: - III Introduction to Forensic Science definition, scope, and history, Crime Scene Investigation, Principles and biological evidence preservation, Forensic Biology and Serology, Blood, semen, and saliva analysis, Forensic Toxicology, Analysis of drugs, alcohol, and poisons.

UNIT: - IV History, Characteristics; Pattern Characteristics; Type of Pattern. Classification and types of Fingerprints; Location and Preservation of fingerprints; Development of Latent prints; Matching of fingerprints, Presentation in Courts.

UNIT: - V DNA Profiling and Fingerprinting, Techniques for DNA profiling (STR, VNTR) Forensic Genomics, Mitochondrial DNA analysis, Y-chromosome analysis.

Reference Books: -

1. Buckingham, L., & Flaws, M. (2016). Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications (3rd ed.).
2. F.A. Davis Company. 2.James, S. H., & Nordby, J. J. (2014) Forensic Science: An Introduction to Scientific and Investigative Techniques (4th ed.). CRC Press.
3. Alberts, B., et al. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.
4. Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology (7th ed.). Cambridge University Press.
5. Houck, M. M. (2009). Essentials of Forensic Science. Academic Press.
6. Coleman, W. B., & Tsongalis, G. J. (2016). Diagnostic Molecular Pathology: A Guide to Applied Molecular Testing (2nd ed.). Academic Press.
7. Butler, J. M. (2009). Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers. Academic Press.
8. Rapley, R., & Whitehouse, D. (Eds.). (2007). Molecular Forensics. Wiley.
9. Karmakar, R. N. (2012). Principles of Forensic Medicine and Toxicology. Academic Publishers.
11. Kennedy, S. (2011). PCR Troubleshooting and Optimization: The Essential Guide. Caister Academic Pres

Genomics and Proteomics (in 8th Semester)	
Paper: - **Theory**	Course code: - **AMJ 3**
Total Marks: - **100 (IA 30 + EA 70)**	Credits: - **4 (T)**

Question Paper Pattern (Theory)

Total Marks: - 70 **Time: - 3 Hours**

SECTION – A: (10 x 2 = 20 Marks)

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

SECTION – B: (5 x 4 = 20 Marks)

- It is of short answer type. Each question carries 4 marks.
- Questions to be given by setting 2 question from each unit.
- Candidate should Answer 5 questions out of 10 questions.

SECTION – C: (3 x 10 = 30 Marks)

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

Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Explain the properties of genetic materials and storage and processing of genetic information.Analyze genomic data. Explain biological phenomena based on comparative genomics.Design transcriptomics and proteomics experiments for studying differential gene expression and related analysis.Utilize advanced proteomics techniques for protein characterization and understand their applications in drug development.

UNIT: - I Definition: Genome organizations, Principles of gene expression, C-value paradox, Genome mapping – Physical mapping and Genetic mapping, Chromosome walking, Linkage analysis

UNIT: - II Comparative genomics - genome annotation and analysis, Genome-based search for mutations.

UNIT: - III Functional genomics: RNA interference, Microarrays, Sequencing – Maxam Gilbert and Sanger's methods; Next Generation Sequencing technologies.

UNIT: - IV Proteomics – Introduction; Protein detection & Methods of Analysis of Proteins, Protein purification and Separation techniques, Two dimensional PAGE for proteome analysis; Image analysis of 2D gels.

UNIT: - V Protein sequencing, Protein-protein interactions (Two hybrid interaction screening), Applications of proteome analysis to drug development.

Reference Books: -

1. Terence A. Brown, Genomes 2, 2nd edition, Garland Science Publishing, 2002.
2. Old R.W. & Primrose S. B, Principles of Gene Manipulation – An Introduction to Genetic Engineering, 5th edition, Blackwell Publishers, 2000.
3. Helen Kreuzer and Adrianne Massey, Recombinant DNA and Biotechnology, 2nd edition, ASM Press, 2001.
4. Primrose S.B. & Twyman R.M., Principles of Genome Analysis and Genomics, 3rd edition, Blackwell Publishing, 2003.

SEC (Skill Enhancement Course)

Food Science and Technology (in 1st Semester)	
Paper: **Theory with practical Paper**	Course code: Sec (Skill Enhancement Course)
Total Marks: **50 (IA 10 + EA 40)**	Credits: **2 (T) + 1(P)**

Question Paper Pattern (Theory)

Total Marks: - 40 **Time: - 2 Hours**

SECTION – A: (10 x 1 = 10 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (4 x 2.5 = 10 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit.
- Candidate should Answer 4 questions out of 5 questions.

SECTION – C: (2 x 10 = 20 Marks)

- It is of essay answer type. Each question carries 10 Marks.
- 5 questions will be given by setting one question from each unit.
- Candidate should answer 2 questions out of 5 questions.
- Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes: After the completion of the course, the students can opt for jobs in various domains such as restaurants, hospitals, food processing companies, soft drink manufacturing firms, cereal and spice, rice mills, catering establishments, packaging industries and food research laboratories.

UNIT: - I **Food microbiology:** Basics Microbiological history of food; Types of micro-organism normally associated with food- mold, yeast, and bacteria; Sterilization - Basics; Microorganisms in natural food products and their control; Brief idea of Physical, Chemical and Biochemical changes caused by microorganisms, deterioration and spoilage of various types of food products; Analytical techniques in Microbiology- Screening and Enumeration of spoilage microorganisms.

UNIT: - II **Food spoilage and Fermented Foods**: Microbial spoilage of foods – food borne pathogens, food poisoning, food infection and intoxication; Examples: *E. coli* O157:H7, *Salmonella*, *Campylobacter jejuni, Bacillus cereus, Shigella sp., Clostridium sp., Staphylococcus sp.*, Norwalk like viruses; Hepatitis; Elementary idea of Detection of pathogens in food; Traditional fermented foods of India and other Asian countries Probiotics and prebiotics; Fermented foods based on milk, meat and vegetables, Fermented beverages.

UNIT: - III **Food Chemistry and Nutrition**: Importance of food; Scope of food chemistry; Introduction to different food groups: their classification and importance; Water in food, water activity and shelf life of food; Carbohydrates, Proteins, Lipids, Vitamins: Structure, classification and industrial uses; Minerals; Processing and preservation of food; Food pigments and synthetic dyes; Natural pigments, their occurrence and characteristic properties, applications; Enzymes used in food industry: Applications of enzymes in food processing.

UNIT: - IV **Food Packaging and Quality control**: Food packaging: Definitions, objectives and functions of packaging and packaging materials; Packaging requirements and selection of packaging materials; Types of packaging materials; Food packaging systems: Different forms of packaging and packaging systems for dehydrated foods , frozen foods , dairy products, fresh fruits and vegetables and meat, poultry and sea foods; Packaging equipment and machinery: Elementary idea; Food Quality: importance and functions of quality control; Sanitation and hygiene, GMP, GLP. Food laws and standard, PFA, AGMARK; Food adulteration and food safety; HACCP; ISO system – 9001, 14001 17025 and 22000.

Reference Books: -

1. Food Science: B. Srilakshmi (New Age International Publishers).3rd edition, 2017.
2. Food Science & Technology: B.K. Sakhala & N.A. Giri (Brillion Publishing), 3rd edition 2018. 3. Theoretical Approaches in Food Science & Technology: Anjineyulu Kothakota & R. Pandiselvam (Jain Brothers). 1st edition, 2021.
3. Food Microbiology (William C. Fraizer and Dennis C. Westhoff) - Mc Graw Hill education.5th edition, 2017. 5. Food Processing & Preservation (S. Sumathi) : B S Publication. 2nd edition 2018.

Practical Marks: 25
Credits: 1

List of Practicals: -

1. Introduction to basic microbiology, laboratory practices.
2. Cultivation and sub-culturing of Microbes.
3. Direct microscopic examination of foods.
4. Estimation of total microbial count of yeast and molds.
5. Estimation of total microbial bacterial plate count of food sample by direct microscopic and SPC method.
6. Study of the microbiological quality of milk by MBR test.
7. Estimation of total microbial count of (a) milk products (b) fruits and vegetable products (c) meat, fish and poultry products (d) canned foods.
8. Determination of protein and carbohydrates in a given food sample.
9. Detection of adulteration in foods.

Biofertilizers and Organic farming (in 2nd Semester)	
Paper: - **Theory with practical Paper**	Course code: - **SEC (Skill Enhancement Course)**
Total Marks: - **50 (IA 10 + EA 40)**	Credits: **2 (T) + 1 (P)**

Question Paper Pattern (Theory)

Total Marks: - 40 **Time: - 2 Hours**

SECTION – A: (10 x 1 = 10 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (4 x 2.5 = 10 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit.
- Candidate should Answer 4 questions out of 5 questions.

SECTION – C: (2 x 10 = 20 Marks)

- It is of essay answer type. Each question carries 10 Marks.
- 5 questions will be given by setting one question from each unit.
- Candidate should answer 2 questions out of 5 questions.
- Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes: On successful completion of this course the students will be able to become completely familiar with biofertilizers. Start their own start-up with Organic Farming. Describe the ecological, economic, and health-related benefits of organic agriculture. Articulate the role of biofertilizers in sustainable soil fertility management. Identify key microbial groups (e.g., Rhizobium, Azotobacter, Mycorrhiza) and their functions.

UNIT: - I **General account about the microbes used as biofertilizer:**Rhizobium – isolation, identification, mass multiplication, carrier-based inoculants, Actinorhizal symbiosis. Azospirillum: isolation and mass multiplication – carrier-based inoculant, associative effect of different microorganisms.

UNIT: - II **Azotobacter:** classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.

UNIT: - III **Cyanobacteria (blue green algae):** Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.

UNIT: - IV **Mycorrhiza:** Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield –

colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

UNIT: - V **Organic farming: Green** manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.

Reference Books: -

1. Dubey, R.C. (2005). A Text book of Biotechnology S.Chand & Co, New Delhi.
2. John Jothi Prakash, E. (2004). Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
3. Kumaresan, V .(2005). Biotechnology, Saras Publications, New Delhi.
4. NIIR Board. (2012). The complete Technology Book on Biofertilizer and organic farming. 2nd Edition. NIIR Project Consultancy Services.
5. Sathe, T.V. (2004) Vermiculture and Organic Farming. Daya publishers.
6. Subba Rao N.S. (2017). Biofertilizers in Agriculture and Forestry. Fourth Edition. Medtech.
7. Vayas,S.C, Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic Farming Akta Prakashan, Nadiad.

Practical Marks: 25
Credits: 1

List of Practicals: -

1. Sterilization of glassware, culture media, other substances, materials and equipment.
2. Preparation of media for fungi and bacteria (PDA and NA medium).
3. Isolation and culturing of Rhizobium from root nodules of leguminous crops.
4. Preparation of media for microbial biofertilizers: Yeast extract mannitol medium (YEMA), Frankia broth, Burk's medium, Azospirillum media
5. Isolation of Azotobacter from root nodules of leguminous crops.
6. Study of different Ectomycorrhizae using prepared slides.
7. Study of different types of Cyanobacteria used for nitrogen fixation.
8. Preparation of Vermicompost.

Herbal Drug Development (in 3rd Semester)	
Paper: - **Theory with practical Paper**	Course code: - SEC (Skill Enhancement Course)
Total Marks: - **50 (IA 10 + EA 40)**	Credits: **2 (T) + 1(P)**

Question Paper Pattern (Theory)

Total Marks: - 40 **Time: - 2 Hours**

SECTION – A: (10 x 1 = 10 Marks)

- It is of short answer type. Each question carries 1.5 marks.
- 10 questions to be given by setting 2 questions from each unit.
- Candidate should answer all the questions.

SECTION – B: (4 x 2.5 = 10 Marks)

- It is of short answer type. Each question carries 5 marks.
- Questions to be given by setting 1 question from each unit.
- Candidate should Answer 4 questions out of 5 questions.

SECTION – C: (2 x 10 = 20 Marks)

- It is of essay answer type. Each question carries 10 Marks.
- 5 questions will be given by setting one question from each unit.
- Candidate should answer 2 questions out of 5 questions.
- Equal weightage will be given to all the units while setting the question paper

Course Learning Outcomes (CLO): Students will be introduced with the history and scope of herbal medicine and able to learn about the process of Herbal Drug Development, i.e., converting botanical extracts into standardized, scientifically validated therapeutic agents. Know about various herbs, methods of crude herbal extraction and processing and types of formulations used in traditional system of medicine. ¬ To study about the ethno-botanical and medicinal importance of medicinal plants. Students will learn the phytochemical profiling preclinical evaluations, and Good Clinical Practices (GCP) ensuring the safety, quality, and efficacy of natural medicines. Learn about the Herbal drug formulation.

UNIT: - I Introduction to Herbal Drugs- History and scope of herbal medicine; Traditional systems of medicine: Ayurveda, Unani, siddha and Homeopathy; Sources of herbal drugs and classification, medicinal plants used in common diseases, advantages and limitations of herbal medicines.

UNIT: - II Herbs phytochemistry and extraction Techniques: Concepts of herbs; Collection, processing and storage of herbs; Primary and Secondary metabolites; Alkaloids, glycosides; Tannins, flavonoids, terpenoids and essential oils; Types of extracts-Decoction, Infusion, Digestion, Tinctures, Liquid extracts, Soft extracts, Dry extracts; Methods of extraction- Maceration and Digestion Percolation, Soxhlet Extraction, Extraction of essential oils (Water and Steam Distillation); Isolation and purification of phytoconstituents; Chromatographic and spectroscopic techniques in herbal drug analysis.

UNIT: - III Development of herbal formulations: tablet, syrups, ointments, capsules; Novel drug delivery systems for herbal medicines; Toxicity studies and clinical evaluation; Current trends and future prospects of herbal products.

UNIT: - IV Herbs in cosmetics: Herbal sources of fixed oils, waxes, gums, bleaching agents, antioxidants for skin and hair care; Herbs in Shampoos, surfactants and conditioners; Biobased hair colourants; Biobased products in hair fall control; Herbs in oral health and hygiene; Herbs as sources of fragrances (lavender, rose, rosemary).

UNIT: - V WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs; Patenting and Regulatory requirements of natural products: a) Definition of the terms: Patent, IPR, Farmers right, Breeder's right, Bioprospecting and Biopiracy b) Patenting aspects of traditional knowledge and natural products.

Reference Books: -

1. Agarwal, S.S. and Paridhavi, M., Herbal Drug Technology‖ Universities Press (India) Private Limited, 2007.
2. Vipin Kumar Singh, VP, Das S, Kumar M.(2018) Bioprospection of Traditionally used Medicinal Plants: An Overview.
3. Panda H (2004) Handbook of Herbal Drugs and its plant sources.
4. Khare, C.P (2004) Indian Herbal remedies-Rational Western therapy, Ayurvedic and other usage, Botany, Springer.
5. Daniel, M., ―Herbal Technology: Concepts and Advances‖ Satish Serial Publishing House, 2008.
6. Cosmetic Science and Technology Vol I, II, III by Sagarin. ¬ Cosmetics Analysis selective methods with techniques by P. Bare.
7. Bannerman, R.H., Burton, J. and Wen Chen, C. (eds). 1983. Traditional medicine and health care coverage. WHO, Geneva.
8. Pushpangadan, P. 1995. Ethnobiology in India: a Status Report. All India Coordinated Research Project on Ethnobiology. Ministry of Environment and Forests, Govt. of India, New Delhi.

Practical Marks: 25
Credits: 1

List of Practicals: -

1. Extraction of phyto constituents from medicinal plants.
2. Determination of ash value, extractive value and moisture content.
3. Thin Layer Chromatography (TLC) of herbal extracts.
4. Isolation of essential oils by steam distillation.