

B.Sc. MICROBIOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)

Curriculum and Syllabus Regular
(2023 – 2024)



DEPARTMENT OF MICROBIOLOGY
FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University, Established Under Section 3 of UGC Act, 1956)

(Accredited with A+ Grade by NAAC in the second cycle)

Eachanari (Post), Coimbatore – 641 021.

Phone No. 0422-2980011 – 15

Fax No: +91-422-2980022, 23

Web: www.kahedu.edu.in

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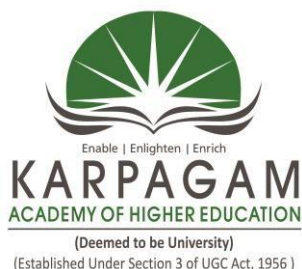
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Under Graduate ProgrammesRegular Programme

Regulations - 2023

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FACULTY OF ARTS, SCIENC, COMMERCE AND MANAGEMENT
UNDERGRADUATE PROGRAMMESREGULAR MODE
REGULATIONS – 2023

The following regulations are effective from the academic year 2023-2024 and are applicable to candidates admitted to Undergraduate (UG) programmes in the Faculty of Arts, Science, Commerce and Management, Karpagam Academy of Higher Education (KAHE) from the academic year 2023-2024 onwards.

1 PROGRAMMES OFFERED, MODE OF STUDY AND ADMISSION REQUIREMENTS

1.1 UG Programmes Offered

A candidate may undergo a programme in any one of the undergraduate programmes approved by the KAHE as given below.

| PROGRAMME | DISCIPLINE |
|-----------|---|
| Com. | Commerce |
| Com. | Computer Applications |
| Com. | Professional Accounting |
| Com. | Business Process Services |
| Com. | Financial Analytics |
| Com. | International Accounting and Finance |
| Com. | Information Technology |
| BA | Business Administration |
| B.Sc. | Biotechnology |
| B.Sc. | Microbiology |
| B.Sc. | Computer Science |
| B.Sc. | Information Technology |
| B.Sc. | Computer Technology |
| B.Sc. | Computer Science (Cognitive Systems) |
| B.Sc. | Computer Science (Artificial Intelligence and Data Science) |
| BA | Computer Applications |

1.2 Mode of Study

Full-Time

All programs are offered under Full-Time Regular mode. Candidates admitted under ‘**Full-Time**’ should be present in the KAHE during the complete working hours for curricular, co-curricular and extra-curricular activities assigned to them.

1.3 Admission Requirements (Eligibility)

A candidate for admission to the first year of the UG degree programme shall be required to have passed the Higher Secondary Examination (10 + 2) [Academic or Vocational] prescribed by the Government of TamilNadu Board or any similar examination of any other Board accepted by the KAHE as equivalent thereto. (Annexure I)

2. DURATION OF THE PROGRAMMES

2.1 The minimum and maximum period for the completion of the UG Programmes are given below:

| Programme(s) | Year of Study | 1 st No. of Semesters | 2 nd No. of Semesters |
|----------------------------|---------------|----------------------------------|----------------------------------|
| B.Sc., B.Com., BCA and BBA | I | | 4 |
| | II | | 8 |
| | III | | 12 |
| | IV | | 16 |

2.2 Each semester normally consists of 90 working days or 450 Instructional hours of study. Examination shall be conducted at the end of every semester for the respective courses.

3. CHOICE BASED CREDIT SYSTEM

3.1. All programmes are offered under Choice Based Credit System with a total credit from 180 to 182 for UG Programme.

3.2. Credit

Credit means the weightage given to each course by the experts of the Board of Studies concerned. Total credits offered are 160 as per the UGC Guidelines for the UG Programme (Four Years).

4. STRUCTURE OF THE PROGRAMME

4.1 Tamil or any one of the Indian / Foreign Languages viz, Malayalam, Hindi, Sanskrit, French is offered as an ability enhancement course for Arts, Science, Commerce and Management Programmes. Four

credits are awarded for each course and the examinations will be conducted at the end of each semester.

4.2. Major Courses, Minor Courses, Multidisciplinary Courses, Skill Enhancement Courses, Project Work, Ability Enhancement Courses, Value Added Courses (Common to all UG Programmes), Summer Internship, Research Project/Dissertation are part of curricular structure.

4.2.1. Major Courses

Major Courses consist of theory and practical of Department domains for which examinations shall be conducted at the end of each semester. The students have to earn a minimum of 80 Credits in Major Courses.

4.2.2. Minor Courses

Students will have the option to choose courses from disciplinary/interdisciplinary minors and skill-based courses. Students have to earn a minimum of 32 Credits in Minor Courses.

4.2.3. Multidisciplinary Courses (MDC)

All UG students are required to undergo 3 introductory-level courses relating to any of the broad disciplines. These courses are intended to broaden the intellectual experience and form part of liberal arts and science education. The students have to study three Multidisciplinary Courses and they have to earn a minimum of 09 Credits.

4.2.4. Skill Enhancement Courses (SEC)

These courses are aimed at imparting practical skills, hands-on training, soft skills, etc., to enhance the employability of students. Three Skill Enhancement Courses are offered in the first, second and fourth semesters. The examination shall be conducted at the end of respective semester. Students have to earn a minimum of 09 Credits in Skill Enhancement Courses.

4.2.5. Project Work

The project work shall start at the beginning of sixth semester in the Department/Industry/Research Institute (National/International) and the project report has to be submitted at the end of the sixth semester. The project may be an individual or group task. The Head of Department concerned shall assign a project supervisor who in turn shall monitor the project work of the student(s). A project / dissertation work shall be carried out by the students and they have to earn minimum of 06 credits.

4.2.6. Ability Enhancement Course (AEC)

There are four Ability Enhancement Courses offered during the first four semesters. Four credits are awarded for each course and the examinations will be conducted at the end of each semester. Students have to earn a minimum of 08 Credits in Ability Enhancement Courses.

4.2.7. Internship

The students exiting the programme after first year or second year must have completed 04 credits internship/apprenticeship during first year or second year summer term.

4.2.8. Value Added Courses (VAC)

The students will study three Value Added Courses in the first three semesters of their programme. Two credits are awarded for each course and the examinations will be conducted at the end of each semester. The various Value Added Courses offered are given below:

| No | of the OfferingDepartment | me of the Course |
|----|--------------------------------------|--------------------------------------|
| | otechnology | vironmental Studies |
| | mmerce | lian Knowledge System |
| | ochemistry | alth and Wellness |
| | mputer Science | ber Security |
| | ificial Intelligence andData Science | ndamentals of ArtificialIntelligence |
| | | ndamentals Of Data Science |
| | | ernet Programming |
| | | botics And Automation |
| | omedical Engineering | man Anatomy and Physiology |
| | | ificial Organs and Implants |
| | o Technology | oreactor Design |
| | | od Processing and Preservation |
| | | sic Bioinformatics |

| | | |
|--|--|---|
| | | ndamentals Of NanoBiotechnology |
| | Civil Engineering | using, Plan and Management |
| | | ilding Services |
| | | pair and rehabilitation of uctures |
| | | mputer-Aided Civil gineering Drawing |
| | | ntracts Management |
| | | r and Noise Pollution andControl |
| | mputer Science andDesign | roduction To 3d Modelling and imation |
| | | gital photography |
| | | obile Application Development |
| | mputer Science andEngineering | ernet of Things |
| | | achine Learning |
| | | ockchain Technologies |
| | ectronics and Communication gineering | ural Networks and Its plications |
| | | nciples of Modern mmunication System |
| | ood Technology | rocessing Of Food Materials |
| | | trition And Dietetics |
| | | ady To eat foods |
| | | gricultural Waste And products Utilization |
| | | sign Of Food process equipment |
| | echanical Engineering | mputer Aided Design |
| | | ustrial Safety and Environment |
| | | n-Destructive testing |
| | ectrical and ElectronicsEngineer | ectric Hybrid Vehicle |
| | | newable Energy Resources |

4.2.9. Research Project /Dissertation

The candidates shall undertake the project work in the eighth Semester either in the Department/Industry/Research Institute (National / International). The project report shall be submitted at the end of the eighth semester. Students have to earn a minimum of 12 Credits in Research Project/Dissertation Work.

If the candidate undertakes the project work outside the Department, the faculty concerned within the Department shall be the Supervisor and the teacher/scientist under whom the work is carried out will be the Co-supervisor. The candidate shall bring the attendance certificate from the place where the project work carried out.

HoD shall assign a project supervisor who shall monitor the student's project work(s). A Project Assessing Committee (PAC) shall be constituted with HoD and two senior faculty members of the Department. The PAC shall announce the dates for the reviews and demonstration. The student shall make a presentation on the progress and demonstration of their project before the PAC in the presence of their supervisor on the scheduled dates.

Approval of the project

The candidate has to submit, in consultation with his/her supervisor, the title, objective and the action plan of his/her project to the PAC on the first review. Only after obtaining the approval of PAC, the student can initiate the project work.

5. Online Course

Students are encouraged to study the online course from SWAYAM/ NPTEL/MOOC in any one of the first seven semesters for which examination shall be conducted at the end of the course by the respective external agencies, if any. The student can register to the courses which are approved by the Department. The student shall produce a Pass Certificate from the respective agencies. The credit(s) earned by the students will be transferred to the concerned course in the mark statement.

6. Extra Curricular Activities

Every student is encouraged to participate in at least any one of the following activities:

- NSS
- NCC
- Sports / Mass drill

- YRC
- Club activities
- Other Co-curricular and Extra curricular activities

The student's performance shall be examined by the staff in-charge of activities along with the faculty mentor and the Head of the respective department on the following parameters.

- 75% weightage for active participation in Extra Curricular Activities in / out of the KAHE.
- 25% weightage for Exemplary Awards/Honours/Prizes secured.

6.1 Marks for Co-curricular and Extra-curricular shall be sent to the Controller of Examination (CoE) before the commencement of the Sixth End Semester Examinations. The above activities shall be conducted outside the regular working hours of the KAHE.

7. MEDIUM OF INSTRUCTION

The medium of instruction and examinations for the courses under Language I – Tamil / Hindi / Malayalam / French / Sanskrit shall be in the language concerned. For all other courses, the medium of instruction and examination should be in English.

8. MAXIMUM MARKS

All the theory and practical courses shall carry a maximum of 100marks, out of which 40 marks is awarded for Continuous Internal Assessment (CIA) and 60 marks for End Semester Examinations (ESE).

Evaluation: Evaluation of the course comprise of two parts such as the Continuous Internal Assessment (CIA) and the End Semester Examination (ESE).

9. a. FACULTY MENTOR

To help students in planning their courses of study and for general advice on the academic programme, the HoD shall allot twenty students to a faculty who will function as a faculty mentor throughout their period of study. A Faculty mentor shall advise the students and monitor their behavior and academic performance. Problems if any shall be counseled by them periodically. The faculty mentor is also responsible to inform the parents of their mentee's progress. The Faculty mentor shall display the cumulative attendance particulars of his / her mentees periodically (once in 2 weeks) on the Notice Board to know their attendance status and satisfy the clause 12 of this regulation.

b. ONLINE COURSE COORDINATOR

To help students in planning their online courses and for general advice on online courses, the HoD shall nominate a coordinator for the online courses. The Online course coordinator shall identify the courses which students can select for their programme from the available online courses offered by different agencies periodically and inform the same to the students. Further, the coordinators shall advise the students regarding the online courses and monitor their participation.

10. CLASS COMMITTEE

Every class shall have a Class Committee consisting of the faculty members of various courses of the class concerned, student representatives (Minimum 2 boys and 2 girls of various capabilities and Maximum of 6 members) and the concerned HoD / senior faculty as Chairperson. The objective of the Class Committee Meeting is all about the teaching – learning process. Class Committee shall be convened at least once in a month. The functions of the Class Committee shall include

1. The class committee shall be constituted during the first week of each semester.
2. The Class Committee of a particular class of any department is normally constituted by the HoD/Chairperson of the Class Committee. However, if the students of different departments are mixed in a class, the Class Committee shall be constituted by the respective Dean of the Faculty.
3. The HoD/Chairperson of the Class committee is authorized to convene the meeting of the class committee.
4. The respective Dean of the Faculty has the right to participate in any Class committee meeting.
5. The Chairperson is required to prepare the minutes of every meeting, and submit the same to the Dean concerned within two days after having convened the meeting. Serious issues if any shall be brought to the notice of the Registrar by the HoD/Chairperson immediately.
6. Analyzing and solving problems experienced by students in the class room and in the laboratories.
7. Analyzing the performance of the students of the class after each test and finding the ways and means to improve the performance.

11. COURSE COMMITTEE FOR COMMON COURSES

Each common theory course offered to more than one discipline or department shall have a “Course Committee” comprising all the teachers

handling the common course with one of them nominated as CourseCoordinator. The nomination of the course coordinator shall be made by the respective Dean depending upon whether all the teachers handling the common course belong to a single department or to various other departments. The 'Course Committee' shall meet in order to arrive at a common scheme of evaluation for the tests to ensure a uniform evaluation of the tests. If feasible, the course committee shall prepare a common question paper for the Internal Assessment test(s). Course CommitteeMeeting is conducted once in a semester.

12. REQUIREMENTS TO APPEAR FOR THE END SEMESTER EXAMINATION

a. Ideally, every student is expected to attend all classes and should secure 100% attendance. However, in order to allow for certain unavoidable circumstances, the student is expected to attend at least 75% of the classes and the conduct of the candidate has been satisfactory during the course.

b. A candidate who has secured attendance between 65% and 74% (both included), due to medical reasons (Hospitalization / Accident / Specific Illness) or due to participation in University / District / State / National / International level sports or due to participation in Seminar / Conference / Workshop / Training Programme / Voluntary Service / Startup Activity / Extension activities or similar programmes with prior permission from the Registrar shall be given exemption from prescribed minimum attendance requirements and shall be permitted to appear for the examination on the recommendation of the Head of Department concerned and the Dean to condone the shortage of attendance. The Head of Department has to verify and certify the genuineness of the case before recommending to the Dean concerned. However, the candidate has to pay the prescribed condonation fee to the KAHE.

c. However, a candidate who has secured attendance less than 65% in the current semester due to any reason shall not be permitted to appear for the current semester examinations. But he/she will be permitted to appear for his/her supplementary examinations, if any and he/she has to re-do the same semester with the approval of the Dean, Students Affairs and Registrar.

13. PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT

13.1 Attendance and assessment: Every Faculty is required to maintain an **Attendance and Assessment Record (Log book)** which consists of attendance of students marked for each lecture/practical/ project workclass, the test marks and the record of class work (topic covered),

separately for each course. This should be submitted to the HoD once in a week for checking the syllabus coverage, records of test marks and attendance. The HoD shall sign with date after due verification. The same shall be submitted to respective Dean once in a fortnight. After the completion of the semester the HoD should keep this record in safe custody for five years as records of attendance and assessment shall be submitted for inspection as and when required by the KAHE/any other approved body.

13.2 Continuous Internal Assessment (CIA): The performance of students in each course will be continuously assessed by the respective faculty. The Retest will be conducted and considered based on the requirements and recommendations by the Head of the Department. The guidelines for the Continuous Internal Assessment (CIA) are given below:

Theory Courses

| No. | Category | Maximum Marks |
|--|---------------------------------------|---------------|
| 1. | Assignment | |
| 2. | Attendance | |
| 3. | Miniatur | |
| 4. | Test – I (1 ½ units- Unit I and II) | |
| 5. | Test – II (1 ½ units Unit II and III) | |
| 6. | Test III (2 units Unit IV and V) | |
| Continuous Internal Assessment: Total | | |

Practical Courses

| No. | Category | Maximum Marks |
|--|------------------------------|---------------|
| 1. | Attendance | 5 |
| 2. | Observation work | 5 |
| 3. | Record work | 5 |
| 4. | Model Examination | 20 |
| 5. | Viva – voce [Comprehensive]* | 5 |
| Continuous Internal Assessment: Total | | 40 |

* Includes Viva- voce conducted during the model Exam practical.

Every practical Exercise / Experiment shall be evaluated based on the conduct of Exercise/ Experiment and records maintained.

13.3 Portions for Test Question Paper

Portions for Internal Test – I : First 1 ½ Units (Unit I and II) Portions for Internal Test – II : Second 1 ½ Units (Unit II and III) Portions for Internal Test – III : Two units (Unit IV and V)

13.4 Pattern of Test Question Paper

| Instruction | Remarks |
|---------------|--|
| Maximum Marks | marks |
| Duration | Hours |
| Part – A | Subjective type (20 x1=20) |
| Part - B | Short Answer Type (3 x2 = 6) |
| Part - C | Eight mark questions ‘either – or’ choice(3 x 8 Marks) |

13.5 Attendance

Marks Distribution for Attendance

| No. | Attendance (%) | Maximum Marks |
|-----|--------------------------|---------------|
| 1 | 90 and above | 5 |
| 2 | 80 - 90 | 4 |
| 3 | 70 - 80 | 3 |
| 4 | Less than or equal to 75 | 0 |

14. ESE EXAMINATIONS

14.1 End Semester Examination (ESE): End Semester Examination will be held at the end of each semester for each course. The question paper is for a maximum 60 marks.

Pattern of ESE Question Paper:

| Instruction | Remarks |
|---------------|---|
| Maximum Marks | marks for ESE. |
| Duration | 3 hours (½ Hr for Part – A Online & 2 ½ Hours for Part – B and C) |
| Part - A | Questions of 1 mark each (20 * 1 = 20 Marks) Question No. 1 to 20 Online Multiple Choice Questions |
| Part- B | Questions of 2 marks each (5 * 2 = 10 Marks) Covering all the five units of the syllabus Question No. 21 to 25 |
| Part- C | Questions of 6 marks each (5 * 6 = 30 Marks.) Question No. 26 to 30 will be 'either-or' type, covering all five units of the syllabus; i.e., Question No. 26: Unit - I, either 26 (a) or 26 (b), Question No. 27: Unit - II, either 27 (a) or 27 (b), Question No. 28: Unit - III, either 28 (a) or 28 (b), Question No. 29: Unit - IV, either 29 (a) or 29 (b), Question No. 30: Unit - V, either 30 (a) or 30 (b)) |

14.2 Practical: There shall be combined valuation by the Internal and External examiners. The pattern of distribution of marks shall be as given below.

| | |
|--------------|-------------------|
| Experiments | : 40 Marks |
| Record | : 10 Marks |
| Viva-voce | : 10 Marks |
| Total | : 60 Marks |

Record Notebooks for Practical Examination

Candidate taking the practical examination should submit Bonafide Record Notebook prescribed for the practical examination; failing which the candidate will not be permitted to take the practical examination.

In case of failures in Practical Examination, the marks awarded for the Record at the time of first appearance of the Practical Examination shall remain the same at the subsequent appearance also by the candidate.

14.3. Evaluation of Project Work

14.3.1 The project work shall carry a maximum of 100 marks. (CIA -40 and ESE – 60*)

*Combined valuation of Internal and External Examiners.

- 14.3.2** The project report prepared according to the approved guidelines and duly signed by the supervisor(s) shall be submitted to HoD.
- 14.3.3** The evaluation of the project will be based on the project report submitted and a *viva-voce* examination by a team consisting of the supervisor, who will be the Internal Examiner and an External Examiner who shall be appointed by the Controller of Examination. In case the supervisor is not available, the HoD shall act as an Internal Examiner for the same.
- 14.3.4** If a candidate fails to submit the project report on or before the specified date given by the Examination Section, the candidate is deemed to have failed in the Project Work and shall re-enroll for the same in a subsequent semester.
- If a candidate fails in the respective viva-voce examinations he/she has to resubmit the Project Report within 30 days from the date of declaration of the results. For this purpose, the same Internal and External examiner shall evaluate the resubmitted report in the subsequent semester.
- 14.3.5** Copy of the approved project report after the successful completion of *viva-voce* examination shall be kept in the KAHE library.

15. PASSING REQUIREMENTS

- 15.1** Passing minimum: There is a passing minimum, 20 marks out of 40 marks for CIA and the passing minimum is 30 marks out of 60 marks in ESE. The overall passing in each course is 50 out of 100 marks (Sum of the marks in CIA and ESE examination).
- 15.2** If a candidate fails to secure a pass in a particular course (either CIA or ESE or Both) as per clause 15.1, it is mandatory that the candidate has to register and reappear for the examination in that course during the subsequent semester when examination is conducted for the same till, he / she receives pass both in CIA and ESE (vide Clause 2.1).
- 15.3** Candidate failed in CIA will be permitted to improve CIA marks in the subsequent semesters by writing tests and by re-submitting Assignments.
- 15.4** CIA marks (if it is pass) obtained by the candidate in the first appearance shall be retained by the Office of the Controller of

Examinations and considered valid for all subsequent attempts till the candidate secures a pass in ESE.

- 15.5** Candidate who is absent in ESE in a Course / Practical / Project Work after having enrolled for the same shall be considered to have Absent (AAA) in that examination.

16. IMPROVEMENT OF MARKS IN THE COURSES ALREADY PASSED

Candidates desirous to improve the marks secured in a passed course in their first attempt shall reappear once (**only in ESE**) in the subsequent semester. **The improved marks shall be considered for classification but not for ranking.** If there is no improvement, there shall be no change in the marks awarded earlier.

17. AWARD OF LETTER GRADES

All the assessments of a course will be done on absolute marks basis. However, for the purpose of reporting the performance of a candidate, letter grades, each carrying certain number of points, will be awarded as per the range of total marks (out of 100) obtained by the candidate in each course as detailed below:

| Letter grade | Marks Range | Grade Point | Description |
|--------------|-------------|-------------|---------------|
| O | 90 - 100 | 10 | OUTSTANDING |
| A+ | 80 - 90 | 9 | EXCELLENT |
| A | 70 - 80 | 8 | VERY GOOD |
| B+ | 60 - 70 | 7 | GOOD |
| B | 50 - 65 | 6 | ABOVE AVERAGE |
| C | 40 - 60 | 5 | AVERAGE |
| D | 30 - 54 | 4 | POOR |
| RA | 0 - 30 | - | NO APPEARANCE |
| AAA | | - | ABSENT |

18. GRADE SHEET

After the declaration of the results, Grade Sheets will be issued to each student which will contain the following details:

- The list of courses enrolled during the semester and the grades scored.
- The Grade Point Average (**GPA**) for the semester and

- iii. The Cumulative Grade Point Average (**CGPA**) of all courses enrolled from first semester onwards.
- iv. Remark on Extension Activities (only in the 6th Semester Grade Sheet)
GPA of a Semester and CGPA of a programme will be calculated as follows.

$$\text{GPA of a Semester} = \frac{\text{Sum of the product of the GP by the corresponding credits of the courses offered in that Semester}}{\text{Sum of the credits of the courses of that Semester}}$$

$$\text{i.e. GPA of a Semester} = \frac{\sum_i C_i GP_i}{\sum_i C_i}$$

Sum of the product of the GPs by the corresponding credits of the courses offered for the entire programme

$$\text{CGPA of the entire programme} = \frac{\text{Sum of the product of the GP by the corresponding credits of the courses offered for the entire programme}}{\text{Sum of the credits of the courses of the entire programme}}$$

$$\text{i.e. CGPA of the entire programme} = \frac{\sum_n \left(\frac{\sum_i C_{ni} GP_{ni}}{\sum_i C_{ni}} \right)}{\sum_n 1}$$

where,

n i

C_i is the credit fixed for the course 'i' in any semester

GP_i is the grade point obtained for the course 'i' in any semester 'n' refers to the Semester in which such courses are credited.

Note: RA grade will be excluded for calculating **GPA** and **CGPA**.

19. REVALUATION

A candidate can apply for revaluation or re-totaling of his / her semester examination answer script (**theory courses only**), within 2 weeks from the date of declaration of results, on payment of a prescribed fee. For the same, the prescribed application has to be sent to the Controller of Examinations through the HoD. **A candidate can apply for revaluation of answer scripts not exceeding 5 courses at a time.** The Controller of Examinations will arrange for the revaluation and the results will be intimated to the candidate through the HoD concerned. Revaluation is not permitted for supplementary theory courses.

20. TRANSPARENCY AND GRIEVANCE COMMITTEE

Revaluation and Retotaling are allowed on representation (clause 19). Student may get the Xerox copy of the answer script on payment of prescribed fee, if he / she wishes. The student may represent the grievance, if any, to the Grievance Committee, which consists of Dean of the Faculty, (if Dean is HoD, the Dean of another Faculty nominated by the KAHE), the HoD of Department concerned, the faculty of the course and Dean from other discipline nominated by the KAHE and the CoE. If the Committee feels that the grievance is genuine, the script may be sent for external valuation; the marks awarded by the External examiner will be final. The student has to pay the prescribed fee for the same.

21. ELIGIBILITY FOR THE AWARD OF THE DEGREE

A student shall be declared to be eligible for the conferment of the Degree if he / she has

- Successfully completed all the components prescribed under Part I to Part IV in the CBCS pattern to earn the minimum required credits as specified in the curriculum corresponding to his / her programme within the stipulated period vide class 2.1.
- Not any disciplinary action pending against him / her.
- The award of the degree must be approved by the Board of Management.

22. CLASSIFICATION OF THE DEGREE AWARDED

22.1 Candidate who qualifies for the award of the Degree (vide clause 21) having passed the examination in all the courses in his / her first appearance, within the specified minimum number of semesters and securing a **CGPA not less than 8** shall be declared to have passed the examination in the **First Class with Distinction**.

22.2 Candidate who qualifies for the award of the Degree (vide clause 21) having passed the examination in all the courses within the specified maximum number of semesters (vide clause 2.1), securing a **CGPA**

not less than 6.5 shall be declared to have passed the examination in the **First Class**.

22.3 All other candidates (not covered in clauses 22.1 and 22.2) who qualify for the award of the degree (vide Clause 21) shall be declared to have passed the examination in the **Second Class**.

23. PROVISION FOR WITHDRAWAL FROM END-SEMESTER EXAMINATION

23.1 Based on valid reasons and on prior application the Candidate may be granted permission to withdraw from appearing for the examination of any one course or consecutive examinations of more than one course in a semester examination.

23.2 Such withdrawal shall be permitted only once during the entire period of study of the degree programme.

23.3 Withdrawal of application is valid only if it is made within 10 days prior to the commencement of the examination in that course or courses and recommended by the HoD / Dean concerned and approved by the Registrar.

23.3.1 Notwithstanding the requirement of mandatory TEN days notice, applications for withdrawal for special cases under extraordinary conditions will be considered on the merit of the case.

23.4 Withdrawal shall not be construed as an appearance for the eligibility of a candidate for First Class with Distinction. This provision is not applicable to those who seek withdrawal during **VI/VIII semester**.

23.5 Withdrawal from the End semester examination is **NOT** applicable to arrear courses of previous semesters.

23.6 The candidate shall reappear for the withdrawn courses during the examination conducted in the subsequent semester.

24. PROVISION FOR AUTHORISED BREAK OF STUDY

24.1 Break of Study shall be granted only once for valid reasons for a maximum of one year during the entire period of study of the degree programme. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for break of study. If a candidate intends to temporarily discontinue the programme in the middle of the semester for valid reasons, and to rejoin the programme in a subsequent year, permission may be granted based on the merits of the case provided he / she applies to the Registrar, but not later than the last date for registering for the end semester examination of the semester, through the Head of

the Department stating the reasons therefore and the probable date of rejoining the programme.

- 24.2** The candidate thus permitted to rejoin the Programme after the break shall be governed by the Curriculum and Regulations in force at the time of rejoining. Such candidates may have to do additional courses as per the Regulations in force at that period of time.
- 24.3** The authorized break of study (for a maximum of one year) will not be counted for the duration specified for passing all the courses for the purpose of classification. (vide clause 22). However, additional break of study granted will be counted for the purpose of classification.
- 24.4** The total period for completion of the Programme reckoned from, the commencement of the first semester to which the candidate was admitted shall not exceed the maximum period specified in clause 2.1 irrespective of the period of break of study (vide clause 24.1) in order that he/she may be eligible for the award of the degree.
- 24.5** If any student is detained for want of requisite attendance, progress and good conduct, the period spent in that semester shall not be considered as permitted 'Break of Study' or 'Withdrawal' (Clause 23 and 24) is not applicable for this case.

25. RANKING

A candidate who qualifies for the UG Degree programme passing all the Examinations in the first attempt, within the minimum period prescribed for the programme of study from Semester I through Semester VI/VIII to the programme shall be eligible for ranking. Such ranking will be confined to 10% of the total number of candidates qualified in that particular programme of study subject to a maximum of 10 ranks.

26. SUPPLEMENTARY EXAMINATION

Supplementary Examination will be conducted only for the final semester students within ten days from the date of publication of results for students who have failed in one theory course only. Such students shall apply with prescribed fee to the Controller of Examinations within the stipulated time.

27. DISCIPLINE

- 27.1.** If a student indulges in malpractice in any of the Internal / External Examinations he / she shall be liable for punitive action as prescribed by the KAHE from time to time.
- 27.2.** Every student is required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity which will tend to bring down the prestige of the KAHE. The erring

students will be referred to the disciplinary committee constituted by the KAHE, to enquire into acts of indiscipline and recommend the disciplinary action to be taken.

28. REVISION OF REGULATION AND CURRICULUM

Karpagam Academy of Higher Education may from time-to-time revise, amend or change the Regulations, Scheme of Examinations and syllabi if found necessary.

29. MULTIPLE ENTRY AND EXIT

The students are allowed to exit the programme after 2 or 4 or 6 or 8 semesters with Undergraduate Certificate, Undergraduate Diploma, Undergraduate Degree and Undergraduate with Honors/Honors (Research) respectively as per the regulations of NEP 2020. Similarly, the students from other institutions can join our university in the 3rd or 5th or 7th semester with an appropriate Undergraduate Certificate or Undergraduate Diploma or Undergraduate Degree certificates respectively.

(A Section 8 Company)

Based on the 2019 National Innovation and Startup Policy and the 2019–2023 TamilNadu Startup Policy, KIIC has recommended to the KAHE students who are affiliated with the KIIC that it be incorporated in the university Program Regulations 2023-24 and implement from this academic year.

Norms to Student Start-Ups

- a) Any (UG/PG / (Ph.D.) Research scholars, student, right from the first year of their program is allowed to set a startup (or) work part time/ full time in a startup or work as intern in a startup
- b) Any (UG/PG / (Ph.D.) Research scholars) student right from the first year of their program is allowed to earn credit for working on Innovative prototypes/business Models/ Pre incubation (case to case basis).
- c) Start Up activities will be evaluated based on the guidelines being given by the expert committee of the KIIC
- d) Student Entrepreneurs may use the address of incubation center (KIIC) to register their venture while studying in KAHE.
- e) Students engaged in startups affiliated with the KIIC or those who work for them may be exempted from KAHE's attendance requirements for academic courses under current regulations, up to a maximum of 30% attendance per semester, including claims for ODs and medical emergencies Potential Students who have been incubated at KIIC may be permitted to take their University semester exams even if their attendance is below the minimum acceptable percentage, with the proper authorization from the head of the institution. (On case-to-case basis depends upon the applicability strength, societal benefits and quality of the Innovation and Subsequent engagement of the students with the/ her business)
- f) Any Students Innovators/entrepreneurs are allowed to opt their startup in place mini project /major project, /seminar and summer training etc. (In plant training, Internship, value added Course.). The area in which the student wishes to launch a Startup may be interdisciplinary or multidisciplinary.
- g) Student's startups are to be evaluated by Expert committee, formed by KIIC and KAHE

Guide lines to award Credits/ Marks to a Student startup

Student's startup stages are divided into five phases and these startup phases can be considered equally in place of the course title as mentioned below with the same credits allotted to the course title in a University curriculum.

| | scription/Startup phases | In place of the Subject Course title | Grades/Credits /Marks |
|---|---|--------------------------------------|--|
| 1 | ea stage/Problem Identification | minar | Same Marks/Credits awarded that are listed in the course title's curriculum for the respective startup phases. |
| 2 | Proof of Concept (POC) /Solution development | In-plant training /Internship | |
| 3 | Product Development (Lab scale) Prototype Model/ Company Registered | Mini Project/Value added Course | |
| 4 | Validation/Testing | Main Project Phase I | |
| 5 | Business Model/Ready for Commercialization/Implementation | Main Project phase II, | |

Annexure I

| Programme | Subject | Eligibility |
|-----------|--------------------------------------|---|
| Sc. | Biotechnology | Candidates who have passed Higher Secondary Education (HSE) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern taking Biology or Botany or Zoology or chemistry as one of the subjects at the Higher Secondary level. |
| Sc. | Computer Science | Candidates who have passed Higher Secondary Education (HSE) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern taking Mathematics/Statistics/Computer/Information Science being one of the subjects (OR) 3 year diploma after 10 th or 10+2 pattern of education taking computer science/maths as one of the subject. |
| Sc. | Microbiology | Candidates who have passed Higher Secondary Education (HSE) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern taking Biology or Botany Zoology or chemistry as one of the subjects at the Higher Secondary level. |
| Sc. | Information Technology | Candidates who have passed Higher Secondary Education (HSE) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern taking Mathematics/Statistics/Computer/Information Science being one of the subjects (OR) 3 year diploma after 10 th or 10+2 pattern of education taking computer science/maths as one of the subject. |
| Sc. | Computer Technology | Candidates who have passed Higher Secondary Education (HSE) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern taking Mathematics/Statistics/Computer/Information Science being one of the subjects (OR) 3 year diploma after 10 th or 10+2 pattern of education taking computer science/maths as one of the subject. |
| Sc. | Computer Science (Cognitive Systems) | Candidates who have passed Higher Secondary Education (HSE) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern taking Mathematics/Statistics/Computer/Information Science being one of the subjects (OR) 3 year diploma after 10 th or 10+2 pattern of education taking computer science/maths as one of the subject. |

| | | | |
|--|-----------|--|---|
| | Sc. | Computer Science(Artificial Intelligence and Data Science) | Candidates who have passed Higher Secondary Education (II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern preferably taking Mathematics/Statistics/Computer/Information Science being one of the subjects (OR) 3 year diploma after 10 th or 10+2 pattern of education taking computer science/maths as one of the subject. |
| | CA | Computer Application | Candidates who have passed Higher Secondary Education (II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern preferably taking Mathematics/Statistics/Computer/Information Science being one of the subjects (OR) 3 year diploma after 10 th or 10+2 pattern of education taking computer science/maths as one of the subject. |
| | Com. | Commerce | Candidates who have passed Higher Secondary Education (II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern of commerce as a subject under the academic or vocational stream at the Higher Secondary level |
| | Com(CA) | Commerce with Computer Applications | Candidates who have passed Higher Secondary Education (II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern of commerce as a subject under the academic or vocational stream at the Higher Secondary level |
| | Com.(PA) | Commerce with Professional Accounting | Candidates who have passed Higher Secondary Education (II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern of commerce as a subject under the academic or vocational stream at the Higher Secondary level |
| | Com.(BPS) | Commerce with Business Process Services | Candidates who have passed Higher Secondary Education (II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern of commerce as a subject under the academic or vocational stream at the Higher Secondary level |
| | B.A. | Business Administration | Candidates who have passed Higher Secondary Education (II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern of commerce as a subject under the academic or vocational stream at the Higher Secondary level |
| | Com | Financial Analytics | Candidates who have passed Higher Secondary Education (II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pattern of commerce as a subject under the academic or vocational stream at the Higher Secondary level |

| | | | |
|--|-----|---|--|
| | Com | International Accounting and Finance | Candidates who have passed Higher Secondary Education II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pa rty Commerce as a subject under the academic or vocational stream at the Higher Secondary level |
| | Com | Information Technology | Candidates who have passed Higher Secondary Education II) or any equivalent Examination conducted by a Government or a University or Board under the 10+2 pa rty Commerce as a subject under the academic or vocational stream at the Higher Secondary level |

PREAMBLE

Microbiology is the study of microscopic living organisms; which includes the study of bacteria, viruses, yeasts, molds, protozoa, and other forms of life that do not fit well into any of these groups. Microbiology has made possible in our ability to control many infectious diseases. Both beneficial and harmful impact of microbes to the mankind has been explored. Microbiology has developed from the angle of other disciplines of biological sciences in such a way that problems of cell structure related to evolution are solved. In addition, microorganisms have been used to study many normal biochemical processes including metabolism that subsequently have been shown to occur in higher forms of life.

This course is framed to give knowledge with understanding of Microbiology to undergraduate students. The goal of the syllabus is to make the study of Microbiology, popular, interesting and encouraging to the young students. In this major you will also develop an understanding of the importance of microbiology in medical, immunology, environmental, food and agricultural, microbial technology, industrial and pharmaceutical settings. The new and updated syllabus is based on a basic and applied approach, comparable to the syllabi of other universities and the needs of industries and research. The syllabus was prepared after discussion at length with number of faculty members of the subject and field experts from industries and research. The units of the syllabus are well defined, taking into consideration the level and capacity of students. Training in microbiology can lead to exciting career opportunities in various fields in microbiology.

Objectives is

- to promote the importance of the science of microbiology.
- to study the useful and disease-producing microorganisms.
- to study the biological activities of microbes.
- to make the students familiar with the subject.
- to make the students expertise in terms of its practical applicability.
- to develop good laboratory practices that will be useful in subsequent courses as well as in many careers.
- to expose the students to various emerging areas of Microbiology.
- to prepare students for further studies, helping in their bright career.
- to demonstrate the relationship between microbiology and other disciplines of biology.
- to prepare and also to expertise the students to accept the challenges in life sciences.
- to develop skills required in research labs, diagnostic labs and in various other microbiology laboratories.

DEPARTMENT OF MICROBIOLOGY
FACULTY OF ARTS, SCIENCE, COMMERCE AND
MANAGEMENT
UG PROGRAM (CBCS) – B.Sc. Microbiology
(2023–2024 Batch and onwards)

| Course code | Name of the course | Objectives and out comes | | Instruction hour / week | | | Cre dits | Maximum marks | | | Category | P.No., |
|----------------|--|--------------------------|------|-------------------------|----|----|----------|---------------|-----|-------|----------|--------|
| | | PEOs | Pos | L | T | P | | CIA | ESE | Total | | |
| SEMESTER I | | | | | | | | | | | | |
| 23LSU101 | Language – I | I | a | 4 | - | - | 4 | 40 | 60 | 100 | AEC 1 | 13 |
| 23ENU101 | English I | I | a | 3 | - | - | 3 | 40 | 60 | 100 | MDC 1 | 19 |
| 23MBU101 | Introduction to Microbiology and Microbial Diversity | I | a | 5 | 1 | - | 5 | 40 | 60 | 100 | CC 1 | 21 |
| 23MBU102 | Biochemistry I | I | a | 4 | 1 | - | 4 | 40 | 60 | 100 | MC 1 | 23 |
| 23MBU111 | Introduction to Microbiology and Microbial Diversity Practical | I | b | - | - | 4 | 2 | 40 | 60 | 100 | SEC 1 | 25 |
| 23MBU112 | Biochemistry I Practical | I | a | - | - | 4 | 2 | 40 | 60 | 100 | MC 2 | 27 |
| 23VAC101 | Value Added Courses Environmental Studies | II | d | 2 | - | - | 2 | 40 | 60 | 100 | VAC 1 | 29 |
| | Activity: Library/Seminar | - | - | - | - | 02 | - | - | - | - | - | |
| Semester Total | | | | 18 | 02 | 10 | 22 | 280 | 420 | 700 | - | |
| SEMESTER II | | | | | | | | | | | | |
| 23LSU201 | Language – II | I | a | 4 | - | - | 4 | 40 | 60 | 100 | AEC 2 | 31 |
| 23ENU201 | English II | I | a | 3 | - | - | 3 | 40 | 60 | 100 | MDC 2 | 36 |
| 23MBU201 | Microbial Physiologyand Metabolism | I, II | a | 5 | 1 | - | 5 | 40 | 60 | 100 | CC 2 | 38 |
| 23MBU202 | Bio Chemistry II | I | a | 5 | 1 | - | 5 | 40 | 60 | 100 | MC 3 | 40 |
| 23MBU211 | Microbial Physiologyand Metabolism Practical | I, II | a | - | - | 4 | 2 | 40 | 60 | 100 | CC 3 | 42 |
| 23MBU212 | Bio Chemistry II Practical | I | a | - | - | 3 | 1 | 40 | 60 | 100 | SEC 2 | 44 |
| 23VAC201 | Value Added Courses Indian Knowledge System | II | d | 2 | - | - | 2 | 40 | 60 | 100 | VAC 2 | 46 |
| | Activity: Library/Seminar | - | - | - | - | 02 | - | - | - | - | - | |
| Semester Total | | | | 19 | 02 | 09 | 22 | 280 | 420 | 700 | | |
| SEMESTER III | | | | | | | | | | | | |
| 23LSU301 | Language - III | I | a | 4 | - | - | 4 | 40 | 60 | 100 | AEC 3 | 48 |
| 23ENU301 | English - III | I | a | 3 | - | - | 3 | 40 | 60 | 100 | MDC 3 | 51 |
| 23MBU301 | Virology | II, III | e, k | 4 | 1 | - | 4 | 40 | 60 | 100 | CC 4 | 53 |

| | | | | | | | | | | | | |
|--------------------------|---|------------|------|-----------|-----------|-----------|-----------|------------|------------|------------|-------|----------|
| 23MBU302 | Microbial Genetics | II, III | e | 4 | - | - | 4 | 40 | 60 | 100 | CC 5 | 55 |
| 23MBU303A/ 23MBU303 B | Microbial Biotechnology/ Biosafety and Intellectual Property Rights | II, III | g | 3 | - | - | 3 | 40 | 60 | 100 | MC 4 | 57 59 |
| 23MBU311 | Virology and Genetics practical | II, III | e, k | - | - | 4 | 2 | 40 | 60 | 100 | CC 6 | 61 |
| 23MBU312A/ 23MBU312B | Microbial Biotechnology Practical / Biosafety and Intellectual Property Rights Practical | II, III | f | - | - | 3 | 1 | 40 | 60 | 100 | MC 5 | 63 65 |
| 23VAC303 | Value added course : Cyber security | | d | 2 | - | - | 2 | 40 | 60 | 100 | VAC 3 | 67 |
| 23MBU391 | Internship* | | | - | - | - | 2 | 100 | - | 100 | SEC 3 | 70 |
| | Activity: Library/Seminar | - | - | - | - | 02 | - | - | - | - | - | |
| Semester Total | | | | 20 | 01 | 09 | 25 | 420 | 480 | 900 | | |
| SEMESTER IV | | | | | | | | | | | | |
| 23LSU401 | Language - IV | I | a | 4 | - | - | 4 | 40 | 60 | 100 | AEC 4 | 71 |
| 23ENU401 | English - IV | I | a | 3 | - | - | 3 | 40 | 60 | 100 | SEC 4 | 74 |
| 23MBU401 | Immunology | II, III | e | 5 | - | - | 5 | 40 | 60 | 100 | CC 7 | 76 |
| 23MBU402 | Medical Microbiology | II, III | c | 4 | 1 | - | 4 | 40 | 60 | 100 | CC 8 | 78 |
| 23MBU403A/ 23MBU403B | Molecular Biology/ Plant Tissue and Animal Tissue Culture | II, III | g | 3 | - | - | 3 | 40 | 60 | 100 | MC 6 | 80 82 |
| 23MBU411 | Immunology Practical | II, III | e,g | - | - | 4 | 2 | 40 | 60 | 100 | CC 9 | 84 |
| 23SEC412 | Medical Microbiology Practical | II, III | c | - | - | 4 | 2 | 40 | 60 | 100 | SEC 5 | 86 |
| | Activity: Library/Seminar | | | | | 02 | | | | | | |
| Semester Total | | | | 19 | 01 | 10 | 23 | 280 | 420 | 700 | | |
| SEMESTER V | | | | | | | | | | | | |
| 23MBU501 | Industrial Microbiology and Biotechniques | II, III | i | 5 | - | - | 5 | 40 | 60 | 100 | CC 10 | 88 |
| 23MBU502 | Environmental Microbiology | II, III | i | 5 | - | - | 5 | 40 | 60 | 100 | CC 11 | 90 |

| | | | | | | | | | | | | |
|----------------------------------|--|---------|---|------------|-----------|-----------|------------|-------------|-------------|-------------|-------|------------|
| 23MBU503 | Recombinant DNA Technology | II, III | g | 5 | - | - | 5 | 40 | 60 | 100 | CC 12 | 92 |
| 23MBU504A/ 23MBU504B | Bioinformatics/ Metagenomics and Forensic Microbiology | II, III | g | 4 | 1 | - | 4 | 40 | 60 | 100 | MC 7 | 94 96 |
| 23MBU511 | Industrial Microbiology and Biotechniques Practical | II, III | i | - | - | 4 | 2 | 40 | 60 | 100 | CC 13 | 98 |
| 23MBU512 | Environmental Microbiology and Recombinant DNA Technology Practical | II, III | j | - | - | 4 | 2 | 40 | 60 | 100 | CC 14 | 100 |
| 23MBU591 | Internship* | | | - | - | - | 2 | 100 | - | 100 | SEC 6 | 102 |
| | Activity: Library/Seminar | | | | | 02 | | | | | | |
| Semester Total | | | | 19 | 01 | 10 | 25 | 340 | 360 | 700 | | |
| SEMESTER VI | | | | | | | | | | | | |
| 23MBU601 | Food and Dairy Microbiology | II, III | f | 5 | - | - | 5 | 40 | 60 | 100 | CC 15 | 103 |
| 23MBU602 | Microbes in Sustainable and Agriculture Development | II, III | d | 5 | - | - | 5 | 40 | 60 | 100 | CC 16 | 105 |
| 23MBU603A/ 23MBU603B | Biopharmacy / Bionanotechnology | II, III | e | 5 | - | - | 5 | 40 | 60 | 100 | MC 8 | 107 109 |
| 23MBU611 | Food and Dairy Microbiology Practical | II, III | d | - | - | 4 | 2 | 40 | 60 | 100 | CC 17 | 111 |
| 23MBU612 | Microbes in Sustainable and Agriculture Development Practical | II, III | e | - | - | 4 | 2 | 40 | 60 | 100 | SEC 7 | 113 |
| 23MBU691 | Project | II, III | | - | - | 7 | 4 | 80 | 120 | 200 | CC 18 | 115 |
| Semester Total | | | | 15 | - | 15 | 23 | 280 | 420 | 700 | | |
| 3rd year total | | | | 110 | 07 | 63 | 140 | 1880 | 2520 | 4400 | | |
| SEMESTER VII | | | | | | | | | | | | |
| 23MBU701 | Textile Microbiology | II, III | k | 5 | 01 | - | 5 | 40 | 60 | 100 | CC 19 | 116 |
| 23MBU702 | Poultry and Veterinary Microbiology | II, III | k | 5 | 01 | - | 5 | 40 | 60 | 100 | CC 20 | 118 |
| 23MBU703A/ 23MBU703B | Drug Design and Development / Bioproduct Development and Entrepreneurial Microbiology | II, III | e | 4 | 01 | - | 4 | 40 | 60 | 100 | MC 9 | 120 122 |
| 23MBU704 A/ 23MBU704 B | Inheritance Biology / Biostatistics and Research Methodology | II, III | k | 4 | 01 | - | 4 | 40 | 60 | 100 | MC 10 | 124 126 |
| 23MBU711 | Textile Microbiology Practical | II, III | k | - | - | 3 | 1 | 40 | 60 | 100 | CC 21 | 128 |
| 23MBU713A / | Drug Design and Development Practical | II, III | k | - | - | 3 | 1 | 40 | 60 | 100 | MC 11 | 130 |

| | | | | | | | | | | | | |
|-----------------------|---|---------|---|------------|-----------|-----------|------------|-------------|-------------|-------------|-------|-----|
| 23MBU713B | / Bioproduct Development and Entrepreneurial Microbiology Practical | | | | | | | | | | | 132 |
| | Activity: Library/Seminar | | | | | 02 | | | | | | |
| Semester Total | | | | 18 | 04 | 08 | 20 | 240 | 360 | 600 | | |
| SEMESTER VIII | | | | | | | | | | | | |
| A | | | | | | | | | | | | |
| 23MBU801 | Bioprocess Engineering | II, III | k | 4 | 01 | - | 4 | 40 | 60 | 100 | CC 22 | 134 |
| 23MBU802 | Microbial Enzymology | II, III | a | 4 | 01 | - | 4 | 40 | 60 | 100 | MC 12 | 136 |
| 23MBU803 | Marine Microbiology | II, III | k | 4 | 01 | - | 4 | 40 | 60 | 100 | CC 24 | 138 |
| 23MBU804 | Biomedical Research and Animal Management | II, III | k | 4 | 01 | - | 4 | 40 | 60 | 100 | CC 25 | 140 |
| 23MBU805 | Medical Coding and Pharmacovigilance | II, III | k | 4 | 01 | - | 4 | 40 | 60 | 100 | MC 13 | 142 |
| 23MBU811 | Bioprocess Engineering Practical | II, III | k | - | - | 4 | 2 | 40 | 60 | 100 | CC 23 | 144 |
| | Activity: Library/Seminar | | | | | 01 | | | | | | |
| Semester Total | | | | 20 | 05 | 05 | 22 | 240 | 360 | 600 | | |
| | | | | 148 | 16 | 76 | 182 | 2360 | 3240 | 5600 | | |
| SEMESTER VIII | | | | | | | | | | | | |
| B | | | | | | | | | | | | |
| 23MBU801 | Bioprocess Engineering | II, III | k | 4 | - | - | 4 | 40 | 60 | 100 | CC 22 | 134 |
| 23MBU802 | Microbial Enzymology | II, III | a | 4 | - | - | 4 | 40 | 60 | 100 | MC 12 | 136 |
| 23MBU811 | Bioprocess Engineering Practical | II, III | k | - | - | 4 | 2 | 40 | 60 | 100 | CC 23 | 144 |
| 23MBU891 | Research Project | II, III | l | | - | 18 | 12 | 120 | 180 | 300 | CC 26 | 146 |
| Semester Total | | | | 08 | - | 22 | 22 | 240 | 360 | 600 | | |
| 4th Year Total | | | | 136 | 11 | 93 | 182 | 2360 | 3240 | 5600 | | |

CC: Core Courses (Major); MC-Minor Courses; SEC: Skill Enhancement Courses; AEC: Ability Enhancement Courses;MDC-Multidisciplinary Courses; VAC-Value added courses P-Project

| MAJOR COURSES | | | |
|---------------|-------------|--|-----------|
| Semester | Course code | Name of the course | Credit(s) |
| I | 23MBU101 | Introduction to Microbiology and Microbial Diversity | 5 |
| II | 23MBU201 | Microbial Physiology and Metabolism | 5 |
| | 23MBU211 | Microbial Physiology and Metabolism Practical | 2 |
| III | 23MBU301 | Virology | 4 |
| | 23MBU302 | Microbial Genetics | 4 |
| | 22BTU311 | Virology and Genetics practical | 2 |
| IV | 23MBU401 | Immunology | 5 |
| | 23MBU402 | Medical Microbiology | 4 |
| | 23MBU411 | Immunology and Medical Microbiology Practical | 2 |
| V | 23MBU501 | Industrial Microbiology and Biotechniques | 5 |
| | 23MBU502 | Environmental Microbiology | 5 |
| | 23MBU503 | Recombinant DNA Technology | 5 |
| | 23MBU511 | Industrial Microbiology and Biotechniques Practical | 2 |
| | 23MBU512 | Environmental Microbiology Practical | 2 |
| VI | 23MBU601 | Food and Dairy Microbiology | 5 |
| | 23MBU602 | Microbes in Sustainable and Agriculture Development | 5 |
| | 23MBU611 | Food and Dairy Microbiology Practical | 2 |
| | 23MBU691 | Project | 4 |
| VII | 23MBU701 | Textile Microbiology | 5 |
| | 23MBU702 | Poultry and Veterinary Microbiology | 5 |
| | 23MBU711 | Textile Microbiology Practical | 1 |
| VIII | 23MBU801 | Bioprocess Engineering | 4 |
| | 23MBU811 | Bioprocess Engineering Practical | 2 |
| | 23MBU803 | Marine Microbiology | 4 |
| | 23MBU804 | Biomedical Research and Animal Microbiology | 4 |
| | 23MBU891 | Research Project | 12 |
| TOTAL | | | 105 |

| MINOR COURSES | | | |
|---------------|---------------------------|---|-----------|
| Semester | Course code | Name of the course | Credit(s) |
| I | 23MBU102 | Biochemistry I | 4 |
| | 23MBU112 | Biochemistry I Practical | 2 |
| II | 23MBU202 | Bio Chemistry II | 5 |
| III | 23MBU303A/ 23MBU303 B | Microbial Biotechnology/ Biosafety and Intellectual Property Rights | 3 |
| | 23MBU312 | Microbial Biotechnology Practical / Biosafety and Intellectual Property Rights Practical | 1 |
| IV | 23MBU403A/ 23MBU403B | Molecular Biology/ Plant Tissue and Animal Tissue Culture | 3 |
| V | 23MBU504A/ 23MBU504B | Bioinformatics/ Metagenomics and Forensic Microbiology | 4 |
| VI | 23MBU603A/ 23MBU603B | Biopharmacy / Bionanotechnology | 5 |
| VII | 23MBU703A/ 23MBU703B | Drug Design and Development / Bioproduct Development and Entrepreneurial Microbiology | 4 |
| | 23MBU704 A/ 23MBU704 B | Inheritance Biology / Biostatistics and Research Methodology | 4 |
| | 23MBU713A / 23MBU713B | Drug Design and Development Practical / Bioproduct Development and Entrepreneurial Microbiology Practical | 1 |
| VIII | 23MBU802 | Microbial Enzymology | 4 |
| | 23MBU805 | Medical Coding and Pharmacovigilance | 4 |
| TOTAL | | | 44 |

| MULTI - DICIPLINARY COURSES | | | |
|-----------------------------|-------------|--------------------|-----------|
| Semester | Course code | Name of the course | Credit(s) |
| I | 23ENU101 | English - I | 3 |
| II | 23ENU201 | English - II | 3 |
| III | 23ENU301 | English - III | 3 |
| TOTAL | | | 9 |

| ABILITY ENHANCEMENT COURSES | | | |
|------------------------------------|--------------------|---------------------------|------------------|
| Semester | Course code | Name of the course | Credit(s) |
| I | 23LAU101 | Language - I | 4 |
| II | 23LAU201 | Language – II | 4 |
| III | 23LAU301 | Language – III | 4 |
| IV | 23LAU401 | Language – IV | 4 |
| TOTAL | | | 16 |

| SKILL ENHANCEMENT COURSES | | | |
|----------------------------------|--------------------------|--|------------------|
| Semester | Course code | Name of the course | Credit(s) |
| I | 23MBU111 | Introduction to Microbiology and Microbial Diversity Practical | 2 |
| II | 23MBU212 | Bio Chemistry II Practical | 1 |
| III | 23MBU391 | Internship* | 2 |
| IV | 23ENU401 | English - IV | 3 |
| | 23SEC412 | Medical Microbiology Practical | 2 |
| V | 23MBU591 | Internship* | 2 |
| VI | 23MBU613A / 23MBU613B | Biopharmacy Practical / Bionanotechnology Practical | 2 |
| TOTAL | | | 14 |

| VALUE ADDED COURSES | | | |
|----------------------------|--------------------|---------------------------|------------------|
| Semester | Course code | Name of the course | Credit(s) |
| I | 23VAC101 | Environmental Studies | 2 |
| II | 23VAC201 | Indian knowledge system | 2 |
| III | 23VAC301 | Cyber Security | 2 |
| TOTAL | | | 6 |

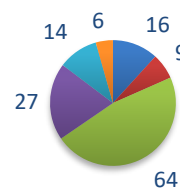
| S.NO. | CATEGORIES | NO. OF COURSES |
|--------------|------------------------------------|-----------------------|
| 1 | ABILITY ENHANCEMENT COURSES | 4 |
| 2 | MULTI - DICIPLINARY COURSES | 3 |
| 3 | MAJOR COURSES | 26 |
| 4 | MINOR COURSES | 13 |
| 5 | SKILL ENHANCEMENT COURSES | 7 |
| 6 | VALUE ADDED COURSES | 3 |

Number of Courses 3 Year B.Sc Microbiology



■ 1 ABILITY ENHANCEMENT COURSE ■ 2 MULTI-DISCIPLINARY COURSES
 ■ 3 MAJOR COURSES ■ 4 MINOR COURSES
 ■ 5 SKILL ENHANCEMENT COURSES ■ 6 VALUE ADDED COURSES

Total number of credits - 3 Year B.Sc Microbiology



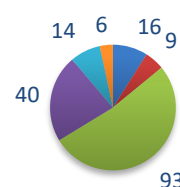
■ 1 ABILITY ENHANCEMENT COURSE ■ 2 MULTI-DISCIPLINARY COURSES
 ■ 3 MAJOR COURSES ■ 4 MINOR COURSES
 ■ 5 SKILL ENHANCEMENT COURSES ■ 6 VALUE ADDED COURSES

Number of Courses 4 Year B.Sc Microbiology (Hons) with Research



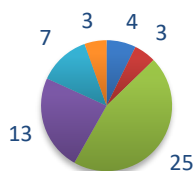
■ 1 ABILITY ENHANCEMENT COURSE ■ 2 MULTI-DISCIPLINARY COURSES
 ■ 3 MAJOR COURSES ■ 4 MINOR COURSES
 ■ 5 SKILL ENHANCEMENT COURSES ■ 6 VALUE ADDED COURSES

Total number of credits- 4 Year B.Sc Microbiology (Hons) with Research



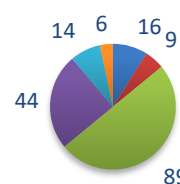
■ 1 ABILITY ENHANCEMENT COURSE ■ 2 MULTI-DISCIPLINARY COURSES
 ■ 3 MAJOR COURSES ■ 4 MINOR COURSES
 ■ 5 SKILL ENHANCEMENT COURSES ■ 6 VALUE ADDED COURSES

Number of Courses 4 Year B.Sc Microbiology (Hons) without Research



■ 1 ABILITY ENHANCEMENT COURSE ■ 2 MULTI-DISCIPLINARY COURSES
 ■ 3 MAJOR COURSES ■ 4 MINOR COURSES
 ■ 5 SKILL ENHANCEMENT COURSES ■ 6 VALUE ADDED COURSES

Total number of credits- 4 Year B.Sc Microbiology (Hons) without Research



■ 1 ABILITY ENHANCEMENT COURSE ■ 2 MULTI-DISCIPLINARY COURSES
 ■ 3 MAJOR COURSES ■ 4 MINOR COURSES
 ■ 5 SKILL ENHANCEMENT COURSES ■ 6 VALUE ADDED COURSES

Programme Outcomes of UG Microbiology: Students of all undergraduate microbiology degree Programmes at the time of graduation will be able to

- a. Scientific Knowledge: Microbiology majors able to make observations, develop hypotheses and design and execute experiments using advanced methods. Able to discuss science and scientific methodology. They will have a good knowledge of Intellectual Property Rights.
- b. Laboratory Skills: Microbiology students will master the following laboratory skills: aseptic culture techniques, microscopy, use of appropriate methods to identify microorganisms. They are able to practice safe microbiology using appropriate protective and emergency procedures.
- c. Able to Focus on innovation and entrepreneurial thinking to be successful in a changing world.
- d. Problem-Solving Skills: Microbiology students will be able to analyze and interpret results from a variety of microbiological methods and apply these methods to analogous situations. Use mathematical and graphing skills and reasoning to solve problems and able to analyze data systematically.
- e. Communication Skills: Students will demonstrate competence in written and oral communication.
- f. Cooperation/Social Responsibility: Microbiology majors able to understand and appreciate the value of cooperating and working effectively with peers and be able to demonstrate a commitment to the process of developing such skills.
- g. Able to understand the importance of microorganisms in various industries such as pharmaceuticals, food, biofertilizers and biopesticides etc.
- h. Students able to gain the knowledge on concepts of immunology, biotechnology, molecular biology, biochemistry, genetics. Able to describe how microorganisms are used as model systems to study basic biology.
- i. Identify ways microorganisms play an integral role in disease and microbial and immunological methodologies are used in disease treatment and prevention. Able to explain the beneficial and harmful role of microorganisms in environment.
- j. Graduates are expected to be team players, with productive cooperation involving members from diverse socio-cultural backgrounds. Able to identify societal problem and develop solution for issue
- k. Able to understand the special features of Bacteria, Virus algae, fungi and protozoa.
Manipulate the microbes using various molecular biology techniques for the benefit of the society.
- l. Students are able to explain the beneficial and harmful role of microorganisms in environment.

Programme Specific Outcomes (PSOs)

m. Students able to understand the Microbiology concepts as applicable to diverse areas such as Medical, Industrial, Environment, Agriculture, Food and others.

n. Demonstrate key practical skills/competencies in working with microbes for study and use in the laboratory as well as outside including the use of good microbiological practices.

o. Students able to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems.

PROGRAMME EDUCATIONAL COURSE OBJECTIVES (PEOs)

Programme Educational course objectives of UG Microbiology: The major course objectives of the undergraduate course is

PEO-I: To impart knowledge on basic concepts of microbiology. To understand the beneficial and harmful role of microorganisms in the environment.

PEO-II: To understand the fundamentals of physiological reactions including metabolic pathways and biochemical reactions in microorganisms.

PEO-III: To develop human resource and entrepreneurs in Microbiology with the ability to independently start their own ventures or small biotech units in the field of biotechnology.

PEO-IV: Understand modern microbiology - practices and approaches with an emphasis in technology application in pharmaceutical, medical, industrial, environmental and agricultural areas.

PEO-V: Become familiar with public policy, bio-safety, and intellectual property rights issues related to microbiology applications nationally and globally

PEO-VI: Gain experience with standard bioinstrumentations and molecular tools and approaches utilized: manipulate genes, gene products and organisms.

PEO-VII: To demonstrate the written and oral communication skill. To develop the problem solving and data interpretationskills.

| POs | a | B | c | d | e | f | g | h | i | j | k | l | m | n | o |
|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PEO I | X | | | | | | | X | | X | | X | | | |
| PEO II | X | | | | | | | X | X | | | X | X | | |
| PEO III | | | | X | | | X | X | | | X | | | | |
| PEO IV | | | | X | | | X | | X | | | X | | X | |
| PEO V | X | | | | | X | | | | X | X | | X | | X |
| PEO VI | | X | X | X | | | | | | | | | X | X | |
| PEO VII | X | | X | X | X | | | | | | | | | | X |

Bachelor of Science, Microbiology, Karpagam Academy of Higher Education (Deemed to be University),
Coimbatore – 641 022

கற்பகம் உயாகல்விக்கழகம் மமாழிகள்துறை - தமிழ்ப்பிரிவு
தமிழ்ப்பாடத்திட்டம் (2023-2024)

முதல்பருவம் - பகுதி – I, தமிழ், தாள் 1 - 23LSU101 4 - H, 4 - C(இளநிலை
அறிவியல் பட்ட வகுப்புகளுக்குரியது)
(For I-UG Science DegreeClasses)

இைக்கிய இன்பம்

அலகு – I

(10 மணிநேரம்)

சங்க இைக்கியம் – எட்டுத்மதுவக - முச்சங்கங்கள் பற்றிய மசய்திகள் – சங்க இைக்கியத்தின்
கதுற்றுவாய் – எட்டுத்மதுவக அறிமுகம்
சங்க இைக்கியம் - ழுற்றண - நின்ற மசுல்ை - குறிஞ்சி – தவவை கூற்று-1
சங்க இைக்கியம் - குறுந்பதாறக - நிைத்தினும் மபுிகத-குறிஞ்சி – தவவை கூற்று- 3
இைக்கியம் - திருவள்ளுவர் – திருக்குறள் (எண்கள்-திருக்குறள் வரிவச எண்வணக்
குறிப்பன)

பாயிரம் – 8 அறவாழி அந்தணன்,13 - விண்ணின்று மபுய்ப்பின்,

34 - மனத்துக்கண் மசுின் ஆதல்

இல்ைற இயல் - இல்வாழ்க்வக - 41- அன்பும் அறனும் உவடத்து 50-வவயத்துள்வாழ்வாங்கு

அன்புவடவம - 80 - அன்பின்வழியது, விருங்கதும்பல் - 90 –

கமபுப்பக்குவழயும், இனியவவகூறல் - 95 – பணிவுவடயன்

இன்மசுைன்,

மசய்நன்றி அறிதல் - 103 – பயன் தூக்கார்,

புறங்கூறுவம - 190 – ஏதிைர் குற்றம், ஒப்புரவுஅறிதல் - 216 – பயன்மரம்

ஈவக: 228 – ஈத்துவக்கும் இன்பம், துறவற இயல் - தவம் - 261 – உற்றகநுய்

வாய்வம - 291 – வாய்வம எனப்படுவது, மவகுளவம - 306 - சினமமன்னும்

இன்னமசய்யவம: 316-இன்னு எனத்துன் உணர்ந்தவவ

நிலையவம - 331 – நிலைதவற்றவற, ஊழியல் - ஊழ் - 373 – நுண்ணியநூல்

ஆள்விவன உவடவம - 618 – மபுறியின்வம யார்க்கும், 620-ஊவழயும் உப்பக்கம்

நட்பு - 792-ஆய்ந்தாய்ந்து, 794-குடிப்பிறந்து, 797-ஊதியம் என்பது

காப்பியம் - சிைப்பதிகாரம்:

மங்கைவாழ்த்துப் பாடல் - மபுதியில்ஆயினும் – ‘ககுவைன் என்பன்மன்கனு’ (14-38),

‘நீைவிதனத்து’ – ‘கநுன்புஎன்வன’(48-53).

மவனயறம்படுத்த காவத - ‘வார்ஒலிகூந்தவவை’ – ‘சிறப்பின்

கண்ணகிதனக்குஎன்’ (84-90) அரங்ககற்று காவத - ‘முமைாம்நடுங்கண்’ -

‘அகம்மறந்து’ (170-175).

மதுவரக்குண்டம் - மகுவைக்களக்குவத, 'இருமுதாசுரவா' - 'எழுந்தனன்யுன்' (67-83), 'விவனவிவளகூடம்' - 'மகாணர்காங்குளன்' (148-153)

கட்டுவர காவத - 'கடிமபுழில்' - 'இல்சுபம்பட்டனார்' (138-170)

வழக்குவரக் காவத - 'அல்வவ மசய்துர்க்கு' - 'கதுற்றுன்யுயிர்' (82-93)

வஞ்சிக் குண்டம் - நடுகல்காவத - 'மதுவரமுதாசு' - 'மன்னவான்று' (218-234)

வாழ்த்துக் காவத - 'என்கனஇஃது' - 'கதுன்றுமால்' (9)

எழுத்தினைக்கணம் - முதல் மற்றும் சூர்மபழுத்துகள்

அலகு-2

(10 மணிநேரம்)

சங்க இலக்கியம் - பத்துப்பாட்டு அறிமுகம்

சங்க இலக்கியம் - பதற்றப்பத்து: ஏழம்பத்து- எறிபிணம் இடறிய மசம்மறா- 65

சங்க இலக்கியம் - கலித்தொகை: அகன்னுடம் விளக்கும் - மநய்தல்கலி - தவைவிகுற்று- 119.

அற இலக்கியம் - முன்றுவறயவரயனார் - பழமமபுழி நுனாறு 5 பாடல்கள்

காப்பியம் - மணிகமகவை: விழுவவறகாவத: 'கதவரும் மக்களும்' - 'மருங்குளன்' (66-72)

ஊரண் உவரத்தகாவத: 'நுவல்ஓங்கிய' - 'உண்டுமகால்' (1-17),

'கற்றாத்தாவறகபுகிய' - 'தீதமபுழில்படாஅள்' (32-57).

பாத்திரம் மபற்றகாவத: 'கபுதிநீழல்' - 'நல்அறம்கண்டவன்' (73-98)

சிவறக்ககாட்டம் அறக்ககாட்டம் ஆக்கியகாவத - 'வாழிஎம்ககா' - 'அரசஆள்கவந்துளன்'

(129-163)

மசுல்இலக்கணம் - மபயாண், விவன, இவட, உரிச்சமசுல்-விளக்கமும்பயிற்சியும்

அலகு-3

(10 மணிநேரம்)

அறஇலக்கியங்கள் அறிமுகம்

சங்க இலக்கியம் - பரிபாடல்: வவவய: பாடல்-6. - நிவறகடல் முகந்து உராய் -

கசறுஆடுபுனைதுமசைவு 1-50.

சங்க இலக்கியம் - அகநானூறு - ஈன்று புறம்தந்த எம்மும் உள்ளுள் - புவை- நற்றுய்குற்று-

35 அற இலக்கியம் - ஓளவவயார்- மகான்வற கவந்தன் (1-50 பாடல்கள்)

காப்பியம் - சூளமணி-அரசியல்சருக்கம்- 1. நுவிகய கமழும் (1131), 2. கண்மிவச கனிந்த

(1132), 3. விவரமசைலிவாளித் (1133), 4. அவரசுள்கள் வருக (1134), 5. அருளுமறடிகள் (1135),

6. விஞ்சயருகை (1136), 7. மசுலிகதிர் (1137), 8. கூரியவன் வவளந்த (1138), 9.

மடித்தவமயயிறு (1139), 10. விஞ்சயரதவனக் (1140), துறவுச்சருக்கம் - பயபதி மன்னனின்

துறவுமநறி

-1. மன்னிய புகழி (1840), 2. திருமகிழலங்கன் (1841) , 3. ஆங்கவ ரறணந்த (1842),

4. அலகுடன் விளங்கு (1843), 5. தன்றைநயார் அரசாக்கி (1844), 6. பசன்முள் (1845),

7. எரிபுற (1846.), 8. பிண்ணை (1847), 9. பிண்ணுமாம் (1848), 10. பதாறகமலர் (1849)

11. ஒழுகிய (1850).

பபாருள் இலக்கணம் - அகத்திவண மற்றும் புறத்திவண இலக்கணங்கள்.

அலகு - 4

(10 மணிநேரம்)

சுற்றிணைக்கியங்கள் கதுற்றமும் வளர்ச்சியும்

சங்க இலக்கியம் - ஐங்குறுநூறு: தாய்சுப்பிறக்கும் - கதுழிகூற்று - மருதம் - களவன்பத்து: 24

சங்க இலக்கியம் - புறநானூறு: உற்றுழிஉதவியும்-183, பல்சுன்றீகர - மபுதுவியல்-195

அற இணைக்கியம் - கவதநயகம் பிள்வள -நீதி நூல்- கதர்ந்மதடுக்கப்பட்ட 5 பாடல்கள் மட்டும் சின்னகவர் மபுருள், கடவுவள வருத்தி, எப்புவிகளும், வவத்தவர், ஈன்றவர் காப்பியம்- கம்பரமயணம் - சுந்தரகாண்டம்(கதர்ந்மதடுக்கப்பட்ட பாடல்கள் மட்டும்)

வண்வமயில்வை 84 - தாய் ஒக்கும் 171 - ஒரு பகல் 284 - எதிர் வரும் 314 - தருவனத்துள் 327 -

எண் இவை 328 - மசுலம் ஒக்கும் 413 - இவ்வண்ணம் 559 - எண் அரண் 598 - தடுத்து

இவமயமல் 1979 - கதுள் கண்டார் 1008 - வமந்தவர் 1339 - அந்நகர் 1445 - சிவந்த வயம்

1550 - ஏய வரங்கள் 1593 - நின்மகன் 1526 - ஆழிசூழ் 1601 - மன்னவன் 1604 - பின்னும்

1752 - கிள்வளமயுடு 1701 - எந்வதயும் 2159 - பஞ்சி ஒளிர் 2762 - மயில் உவட 3248 -

ஆண்டு 3390 -மற்றுஇனி 3812- கண்டனன் 5249 - கவவையுள் 6037 -மண்மணுடும் 6038-

வங்கிய 6170 - இங்குஉள 6172 - கண்டமனன் 6031 - வபய வபய 6174 - அந்மநறி 6185 -

குமமணுடும் 6507 -கூவி 7131 -முக்குடு 7760 - அற்றவன் 9168 - ஆள் ஐயு 7271 -

கார்நின்ற-10043

கடிதப்பயிற்சி

1. கவவகைவண்டி விண்ணப்பம் எழுதுதல்

2.பல்கவைக்கழகப் பன்னுட்டுக் கருத்தரங்கச் மசய்திவய நுளிதழில் மவளியிட கவண்டி நுளிதழின் பதிப்புசூரியருக்குக் கடிதம்

3. கருத்தரங்கப் பங்ககற்புக்கான அனுமதிக் கடிதம்

4. பல்கவைக்கழக விழவுக்குத் தவைவமகயற்க கவண்டி, மவட்ட ஆட்சியருக்கு விண்ணப்பம்

அலகு - 5

(8 மணிநேரம்)

கூப்பியங்கள் - கதுற்றமும் வளர்ச்சியும்

சங்க இலக்கியம் - பத்தாப்பாட்டம்: சிறுபுணுற்றுப்பவட

வனம் வய்த்த - யும் அவண்ணின்றும் வருதும் (அடிகள்: 84-143),

மசய்நன்றி அறிதலும் - நல்லியக்ககூடவன நயந்தனிர் மசலிகன (207-269).

அற இணைக்கியம் - காமரகுருபரர் - நீதி மநறி விளக்கம் (கதர்ந்மதடுக்கப்பட்ட 5 பாடல்கள் மட்டும்)

உறுதி பயப்ப, முயைது வவத்து, உவையமுயற்சி, கும் அறிந்து,

மமய்வருத்தம்**கடிதப்பயிற்சி**

5. கல்விக் கடன்கவண்டி வங்கிகமையுருக்கு விண்ணப்பம்

6. வசிப்பிடத்திற்கு அடிப்பவட வசதிகவண்டி வட்டாட்சியருக்கு விண்ணப்பம்

7. விருதுமபற்ற நண்பனுக்குப் பாராட்டுக் கடிதம்

பார்வவ நூல்கள்

1. கற்பகச் கசுவை – தமிழ்ப்ப்புட நூல், இணக்கிய மநறிகள், தமிழ்த்துவற மவளியீடு, கற்பகம் உயர்கல்விக்கழகம், கசுயம்புத்தூர் – 21.
2. தமிழ் இணக்கிய வரைறு, முவனவர் கசு.கசு. கவங்கடருமன், கவையக மவளியீடு, நுமக்கல்.

இவணயதளம்

1. www.tvu.org.in
2. www.maduraitamilproject.com

இதழ்கள்

1. International Research Journal of Indian Literature, irjil.in
2. International Tamil Research Journal, iorpress.in

வினுத்துள் கட்டவமப்பு

இவடக்கதுள் வினுத்துள்

மமுத்த மதிப்பமபண்கள் 50

பகுதி – அ (ஒரு மதிப்பமபண் வினுக்கள்) $20 \times 1 = 20$ (சுரியுன விவடயிவனத் கதுளம்மதடுதம்மதமுதலு) பகுதி – ஆ (இரு மதிப்பமபண் வினுக்கள்) $3 \times 2 = 6$ (அவனத்து வினுக்களுக்கும் விவடயளித்தல்) பகுதி – இ (ஆறுமதிப்பமபண் வினுக்கள்) $6 \times 4 = 24$ (அவனத்து வினுக்களுக்கும் விவடயளித்தல்)

பருவக்கதுள் வினுத்துள் - மமுத்த மதிப்பமபண்கள் 60

பகுதி – அ (ஒரு மதிப்பமபண் வினுக்கள்) $20 \times 1 = 20$ (சுரியுன விவடயிவனத் கதுளம்மதடுதம்மதமுதலு) பகுதி – ஆ (இரு மதிப்பமபண் வினுக்கள்) $5 \times 2 = 10$ (அவனத்து வினுக்களுக்கும் விவடயளித்தல்) பகுதி – இ (ஆறுமதிப்பமபண் வினுக்கள்) $5 \times 6 = 30$ (அல்லை வவகயில் கதுளம்மதடுத்து எழுதுதல்)

23ENU101

English I

Semester I
(3H–3C)

Instruction Hours / week: L: 3 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To enable the learner to communicate effectively and appropriately in real life situation
- To develop and integrate the use of the four language skills.
- To give basic knowledge on grammar.
- To train students to acquire proficiency in English by reading different genres of literature and learning grammar.
- To identify the meaning of words using context clues.

COURSE OUTCOMES

At the end of this course, students will be able to

| COs | Course Outcomes | BT Level |
|-----|--|------------|
| CO1 | Retrieve fundamentals of English language to construct error free sentences. | Apply |
| CO2 | Discover the knowledge of interpersonal skills. | Analyze |
| CO3 | Construct and maintain social relationships. | Apply |
| CO4 | Classify communication skills in business environment. | Understand |
| CO5 | Explain communication competency through LSRW skills. | Understand |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | | | | | S | | | | | | | |
| CO2 | | | | | M | | | | | | | |
| CO3 | | | | | | M | | | | S | | |
| CO4 | | | | | S | | | | | | | |
| CO5 | | | | | S | | | | | M | | |

S-Strong; M-Medium; L-Low

UNIT I

(7 Hours)

LISTENING: Listening –Types of Listening**SPEAKING:** Face to Face Conversation**READING:** Reading – Types of Reading**WRITING:** Jumbled Sentences**LITERATURE:** Ode on a Grecian Urn by John Keats**GRAMMAR:** Parts of Speech**UNIT II**

(7 Hours)

LISTENING: Principles of Listening Skills**SPEAKING:** Descriptions**READING:** Reading Techniques

WRITING: Paragraph Writing
LITERATURE: Of Friendship by Francis Bacon
GRAMMAR: Articles

UNIT III

(7 Hours)

LISTENING: Barriers of Listening
SPEAKING: Telephone Conversations
READING: Reading Comprehension Passages
WRITING: Precise Writing
LITERATURE: The Umbrella man by Roald Dahl
GRAMMAR: Tense

UNIT IV

(7 Hours)

LISTENING: Story Narrations
SPEAKING: Group Discussion
READING: Reading Reports and Profiles
WRITING: Letter Writing
LITERATURE: Tyger by William Blake
GRAMMAR: Subject and Predicate – Question Tags

UNIT V

(8 Hours)

LISTENING: Listening Strategies
SPEAKING: Interview Skills
READING: Tips for MOC- Anchoring
WRITING: Circular Writing and Summary Writing
LITERATURE: Short story: Rapunzel by the Brothers Grimm
GRAMMAR: Framing Questions

Books for Reference:

1. Wren & Martin, 2008, *High School English Grammar & Composition*, S.Chand & Company Ltd, Board of Editors,
2. Krashen, Stephen D (1982) *Principles and practice in second language acquisition*. New York: Pergamon Press.

23MBU101

**INTRODUCTION TO MICROBIOLOGY AND
MICROBIAL DIVERSITY**
**Semester- I
(6H- 5C)**
Instruction Hours / week: L: 5 T: 1 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- To provide a fundamental knowledge about history of microbiology and classification of microorganisms for advanced studies in biological sciences, particularly to improve their skills in microbiology field.
- To understand the working principle, components, types and applications of microscope
- To provide an overview of the biology of algae, ii) use the study of algae to provide a basis for understanding the evolutionary pathways to higher plants
- To explain the viral structure, Replication and cultivation
- To describe the unique characteristics of fungi
- To explain about the prevention and control of protozoa

COURSE OUTCOME (CO'S)

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | After completion of this course, the students clearly understand the contributions of various scientists for development of microbiology field and skills associated with it. | Understand |
| CO2 | This course will demonstrate the diversity of microbes and their applications. | Apply |
| CO3 | Students will know about the various field of Microbiology | Apply |
| CO4 | Students will know the viral genome, Replication and Cultivation. | Analyze |
| CO5 | Able to understand the special features of algae, fungi and protozoa | Analyze |
| CO6 | Familiarize with morphologic criteria to differentiate the most common protozoan | Understand |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | S | M | M | M | M | S | M | M | M | M | M | M |
| CO2 | M | S | M | M | M | M | M | M | M | M | S | M |
| CO3 | M | M | M | M | M | M | M | S | M | M | L | M |

| | | | | | | | | | | | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | S | M | M | M | M | M | M | S | M | M | M | M |
| CO5 | M | M | M | M | L | M | M | M | M | M | S | M |
| CO6 | M | M | M | M | M | M | M | M | L | M | S | M |

S-Strong; M-Medium; L-Low

Unit I- History of microbiology

(10 Hours)

Development of microbiology as a discipline, spontaneous generation vs biogenesis. Contribution of Anton von Leewenhoek, Golden era of Microbiology Louis Pasteur, Robert Koch, Joseph Lister, Alexander Flemming. Germ theory of disease, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Ellie Metchnikoff, Edward Jenner. Role of microorganism in fermentation, Application in industries, medicine, agriculture, biotechnology and biology.

Unit II-Microscopes

(10 Hours)

Microscope – principles and application – simple and compound microscope – dark field – phase contrast, fluorescent microscope, SEM and TEM.

Unit III- Classification of microorganisms

(10 Hours)

Bergey's Manual, Binomial Nomenclature. Classification system: Phenetic and Phylogenetic, Whittaker's Five Kingdom and Carl Woese's three kingdom classification system and their utility. Difference between prokaryotic and eukaryotic microorganism. Major diversity of microbial life. General characteristics of Bacteria, Bacterial ultra-structure and Nutrients. General characteristics of Actinobacteria.

Unit IV- Algae & Fungi

(15 Hours)

General characteristics of algae including algal cell ultra-structure. Classification of algae- Chlamydomonas, Volvox, Diatoms, red algae and brown algae. Algal cell cultivation and preservation Application of Algae in agriculture, industry, environment and food. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure. Economic importance of fungi. Virulence factors of fungi causing infection. Classification of fungi.

Unit V- Virus & Parasites

(15 Hours)

General properties of viruses – Structure, Genome, Replication and Cultivation. Morphology, classification, characteristics of Protozoa, Platyhelminthes, Molluscs, Echinodermata, Coelenterata, Porifera.

SUGGESTED READINGS

1. Tortora, G.J., Funke, B.R., and Case CL. (2014). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan, M.T., Martinko J.M., Dunlap, P.V., and Clark, D.P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Cappuccino, J., and Welsh CT. (2020). Microbiology: A Laboratory Manual. 12th edition. Pearson Education Limited.
4. Wiley, J.M., Sherwood, L.M., and Woolverton, C.J. (2013) Prescott's Microbiology. 9th edition. McGrawHill International.

5. Atlas, R.M. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar, M.J., Chan, E.C.S., and Krieg, N.R. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. (2005). General Microbiology. 5th edition. McMillan.
8. Duby, R.C. (2014) Textbook of Microbiology. 5th edition. S. Chand Publishing.
9. Talaro, Kathleen, P.T., Chess., and Berry, C., (2018). Foundations in Microbiology. (10th Ed). McGraw-Hill Higher Education, United States.

Instruction Hours / week: L: 4 T: 1 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To provide the knowledge on basics of biochemistry and its applications.
- To describe the classification and functions of lipids.
- To summarize the structure and classification of enzymes
- To state the Structure and types of DNA and RNA
- To analyze the functions and properties of phosphoglycerides
- To understand about storage and structural polysaccharides.

COURSEOUTCOME (CO'S)

At the end of this course, students will be able to

| Cos | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Understand the structures of enzymes, proteins, carbohydrates and fats | Understand |
| CO2 | Understand the functions of biomolecules | Understand |
| CO3 | Analyze the process of metabolism | Analyze |
| CO4 | Understand the nucleic acids and their importance to combine and analyses information. | Understand |
| CO5 | Understand the Structure and classification of enzymes, specificity of enzymes | Understand |
| CO6 | Summarize the DNA & RNA structure and base pairing schemes | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | S | M | M | M | M | S | M | M | M | M | M | M |
| CO2 | M | S | M | M | M | M | M | M | M | M | S | M |
| CO3 | M | M | S | M | S | M | M | S | M | M | M | M |
| CO4 | S | M | M | M | M | M | L | S | M | M | M | M |
| CO5 | M | M | M | M | L | M | M | M | M | M | S | M |
| CO6 | M | M | M | M | M | M | M | M | L | M | S | M |

S-Strong; M-Medium; L-Low

Unit I- Carbohydrates**(9 Hours)**

Monosaccharides-families, stereo isomerism, epimers, Mutarotation and anomers. Forms of glucose and fructose, Fischer and Haworth projection. Sugar derivatives. Disaccharides- occurrence, concept of reducing and non-reducing sugars. Polysaccharides-storage and structural polysaccharides.

Unit II- Lipids**(9 Hours)**

Classification and functions of lipids. Storage lipids- structure and function of fatty acids. Triacylglycerols. Saponification. Structural lipids- structure, functions and properties of phosphoglycerides: glycogen and sphingolipids.

Unit III- Proteins**(9 Hours)**

Classification and functions of proteins and amino acids, Structure of amino acids and concept of zwitterion. Ninhydrin reaction. Natural modifications of amino acids in proteins. Non protein amino acids, Primary and Secondary structure of proteins- alpha helix, beta pleated sheet. Tertiary and quaternary structures of proteins. Structure of haemoglobin in mammals.

Unit IV- Enzymes**(10 Hours)**

Structure and classification of enzymes, specificity of enzymes. Michaelis-Menten equation, K_m , V_{max} , isoenzymes. Allosteric enzyme and its mechanism. Multienzyme complex. Enzyme inhibition.

Unit V- Nucleic Acids**(11 Hours)**

Nucleic Acids-Purines & Pyrimidines nucleotides, RNA, & DNA base pairing schemes, types of RNA: mRNA, rRNA, tRNA, Secondary structure of DNA, Watson and Crick model, Vitamins and its types.

SUGGESTED READINGS

1. Campbell, M.K. (2012) Biochemistry, 7th edition. Published by Cengage Learning.
2. Campbell, P.N., and Smith, A.D., (2011) Biochemistry Illustrated, 4th edition. Published by Churchill Livingstone.
3. Tymoczko, J.L., Berg, J.M., and Stryer, L. (2012) Biochemistry: A short course, 2nd edition. W.H. Freeman.
4. Berg, J.M., Tymoczko, J.L., and Stryer, L. (2011) Biochemistry, W.H. Freeman and Company.
Nelson, D.L. and Cox, M.M. (2008) Lehninger Principles of Biochemistry, 5th edition. W.H. Freeman and Company.
5. Willey, M.J., Sherwood, L.M., & Woolverton, C. J. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill.
6. David L Nelson, Michael M. Cox, W.H. Freeman 2022. Lehninger Principles of Biochemistry, 8th edition.
7. Chakarapani, V, Sathyanarayana V 2020. Biochemistry, 5th edition, Elsevier.

23MBU111 INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (4H-2C)
PRACTICAL

Instruction Hours / week: L: 0 T: 0 P:4**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 6 Hours****COURSE OBJECTIVES**

- To provide a strong base in the fundamentals of bacteria.
- To learn techniques and methods used in the cultivation and isolation of bacteria.
- To develop skills related to preservation of bacterial cultures.
- To learn about bacterial specialized structure using staining methods
- To learn the bacterial special structure capsule and spore
- To measure the bacterial size

COURSE OUTCOME (CO'S)

After Completion of this course candidate can able to demonstrate:

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Theory and practical skills in staining procedures | Understand |
| CO2 | Various Culture media and their applications | Apply |
| CO3 | Various microbial culture techniques to obtain isolation of pure cultures of bacteria | Apply |
| CO4 | Differentiate Bacterial endospore and capsule | Analyze |
| CO5 | Able to analyze the Bacterial size | Analyze |
| CO6 | Able to explain the bacterial motility and flagella | Understand |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | S | M | M | M | M | S | M | M | M | M | M | M |
| CO2 | S | S | M | M | M | M | M | M | M | M | S | M |
| CO3 | M | M | S | M | S | M | M | S | M | M | M | M |
| CO4 | S | M | M | M | M | M | L | S | M | M | M | M |
| CO5 | M | M | M | M | L | M | M | M | M | M | S | M |
| CO6 | M | M | M | M | M | M | M | M | L | M | S | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(48 Hours)

1. Preparation of different media: synthetic media BG-11, Complex media - Nutrient agar, MacConkey agar, EMB agar.
2. Examination of bacterial colony with morphological features.
3. Estimation of Colony Forming Unit (CFU) count by spread plate method/pour plate method.
4. Isolation of pure cultures of bacteria by streaking method - Quadrant, Continuous and T-streaking.
5. Preservation of bacterial cultures by various techniques - Agar slants and deeps - Mineral Oil, Glycerol stocks
6. Micrometry.
7. Motility by hanging drop method.
8. Simple staining
9. Negative staining
10. Gram's staining
11. Acid fast staining – demonstration permanent slide only.
12. Capsule staining
13. Endospore staining.

SUGGESTED READINGS

1. Madigan, M.T., Kelly, S.B., Daniel, H.B., Mathew, S and David, A.S (2017). Brock Biology of Micro-organisms. 15th edition. Parker J. Prentice Hall International, Inc.
2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2019). Prescott's Microbiology. 11th edition. McGraw Hill.
3. Talaro, Kathleen, P.T., Chess, and Berry, C., (2018). Foundations in Microbiology, 10th Ed., McGraw Hill.
4. Benson's Microbiological Applications Laboratory Manual-Complete Version, 2015, 13th Edition, McGraw Hill.
5. Kathleen Park Talaro and Barry Chess, 2018. Foundations in Microbiology: Basic Principles, 10th Edition, McGraw Hill
6. Cappuccino, J., and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

Instruction Hours / week: L: 0 T: 0 P:4**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 6 Hours****COURSE OBJECTIVES**

- To familiarize the students with the basic cellular processes at molecular level
- To make students familiar with practical techniques used for studying biochemical structure and analysis of biochemical methods.
- To expertise in Qualitative/Quantitative tests of carbohydrates, reducing sugars, Protein and lipids
- To study the protein secondary and tertiary structures
- To study the effect of temperature, pH and heavy metals on enzyme activity.
- To gain the knowledge on vitamin estimation

COURSE OUTCOME**Upon the completion this course student will acquire**

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | The practical knowledge and the skills associated about various techniques used in Biochemistry. | Understand |
| CO2 | The skill in qualitative and quantity analysis of carbohydrates, protein and lipid | Apply |
| CO3 | An understanding in protein secondary and tertiary structures | Apply |
| CO4 | An insight in enzyme activity and its physical factors influence the activity | Analyze |
| CO5 | Knowledge on vitamin estimation | Analyze |
| CO6 | Cognitive skill and students able to solve the numerical problems | Understand |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | M | M | M | M | M | M | M | M |
| CO2 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO3 | M | M | M | S | M | L | M | S | S | M | M | M |
| CO4 | M | M | M | M | M | M | M | S | L | M | L | M |
| CO5 | M | M | M | M | M | M | M | S | L | M | L | M |
| CO6 | M | M | S | M | M | M | S | S | M | M | M | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(48 Hours)

1. Properties of water, concept of pH and buffers, preparation of buffers and numerical problems to explain the concepts of molarity, normality and their calculation.
2. Numerical problems on calculations of standard free energy change and equilibrium constant.
3. Standard free energy change of coupled reactions.
4. Qualitative tests for carbohydrates, reducing sugars, and non-reducing sugars.
5. Qualitative tests for lipids and proteins.
6. Quantitative tests for carbohydrates.
7. Quantitative tests for proteins.
8. Study effect of temperature, pH and heavy metals on enzyme activity.
9. Estimation of any four vitamins.

SUGGESTED READING

1. Campbell, M.K. (2012) Biochemistry, 7th edition. Published by Cengage Learning.
2. Campbell, P.N., and Smith, A.D. (2011) Biochemistry Illustrated, 4th edition. Published by Churchill Livingstone.
3. Tymoczko, J.L., Berg, J.M., and Stryer, L. (2012) Biochemistry: A short course, 2nd edition.
4. Berg, J.M., Tymoczko, J.L., and Stryer, L. (2011) Biochemistry, W.H. Freeman and Company.
5. Nelson, D.L., and Cox, M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman and Company.
6. Willey, M.J. Herwood, L.M. & Woolverton, C.J. (2013) Prescott, Harley and Klein's Microbiology 9th Edition. McGraw Hill
7. Voet, D., and Voet, J.G. (2004) Biochemistry 3rd edition, John Wiley and Sons.
8. Donald Voet, J.G. Voet, CW Pratt Fundamentals of Biochemistry, CBS Publishers.

23VAC101

ENVIRONMENTAL STUDIES

Semester – I
(2H–2C)**Instruction Hours / week: L: 2 T: 0 P:0****Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

The main objectives of the course are

- To create awareness about environmental problems among people
- To develop an attitude of concern for the environment
- To motivate public to participate in environment protection and improvement
- To learn about the environment, resources available, biodiversity and its conservation
- To understand the current scenarios- to find ways for protection and betterment of or habitat
- To understand the concepts and methodologies to analyze the interactions between social and environmental processes

COURSE OUTCOMES

The learners will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Understand the concepts and methods from ecological and physical sciences and their application in environment. | Understand |
| CO2 | Study the concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions | Understand |
| CO3 | Learn the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems | Apply |
| CO4 | Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales | Apply |
| CO5 | Apply systems concepts and methodologies to analyse and understand interactions between social and environmental processes | Apply |
| CO6 | Creating the awareness about environmental problems among people | Create |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | L | L | M | M | M | M | M | M | M |
| CO2 | L | L | M | L | L | M | M | M | M | M | L | L |
| CO3 | M | L | M | L | L | L | M | S | S | M | L | L |
| CO4 | M | L | M | M | M | M | M | S | L | M | L | L |
| CO5 | M | M | M | M | M | M | M | S | L | M | L | M |
| CO6 | M | M | S | M | M | M | S | S | M | M | M | M |

S-Strong; M-Medium; L-Low

Unit I**(4 Hours)****INTRODUCTION - ENVIRONMENTAL STUDIES & ECOSYSTEMS:**

Environment Definition, Scope and importance; Ecosystem, Structure, classification, and functions of ecosystem. Energy flow, Food chains and food webs, Ecological succession. Forest ecosystem, Grassland Ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Unit II**(4 Hours)****NATURAL RESOURCES - RENEWABLE AND NON-RENEWABLE RESOURCES:**

Natural resources - Renewable and Non – Renewable resources. Land resources, Land degradation, desertification. Forest resources – Deforestation: Causes and impacts due to mining. Water resources- Use and over- exploitation of surface and ground water.

Unit III**(4 Hours)****BIODIVERSITY AND ITS CONSERVATION:**

Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity. Values of Biodiversity - Ecological, economic, social, ethical, aesthetic value. Bio-geographical classification of India. Hot-spots of biodiversity. Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man- wildlife conflicts.

Unit IV**(6 Hours)****ENVIRONMENTAL POLLUTION:**

Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution. Nuclear hazards and human health risks.

Unit V**(6 Hours)****SOCIAL ISSUES AND THE ENVIRONMENT:**

Concept of sustainability and sustainable development. Climate change, global warming, ozone layer depletion, acid rain and its impacts on human communities and agriculture. Environment Laws (Environment Protection Act, Air Act, Water Act, Wildlife Protection Act, Forest Conservation Act).

SUGGESTED READINGS:

1. Anonymous. 2004. A text book for Environmental Studies, University Grants Commission and BharatVidypeeth Institute of Environmental EducationResearch, New Delhi.
2. Anubha Kaushik., and Kaushik, C.P. 2008. Perspectives in Environmental Studies. (3rd ed.). New AgeInternational Pvt. Ltd. Publications, New Delhi.
3. Arvind Kumar. 2009. A Textbook of Environmental Science. APH Publishing Corporation, New Delhi.
4. Botkin., and Keller. 2014. Environmental Science: Earth as a Living Planet. (9th ed.) Wiley
5. Mishra, D.D. 2010. Fundamental Concepts in Environmental Studies. S.Chand & Company Pvt. Ltd., NewDelhi.
6. Odum,E.P., Odum, H.T. and Andrews, J. 1971. Fundamentals ofEcology. Philadelphia: Saunders.
7. Rajagopalan, R. 2016.Environmental Studies: From Crisis to Cure, Oxford University Press.
8. Sing, J.S., Sing. S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand &Publishing Company, New Delhi.
9. Singh, M.P., Singh, B.S., and Soma, S. Dey. 2004. Conservation of Biodiversity and Natural Resources. DayaPublishing House, New Delhi.
10. Tripathy. S.N., and Sunakar Panda. (2011). Fundamentals of Environmental Studies (3rd ed.). VriandaPublications Private Ltd, New Delhi.
11. Uberoi, N.K. 2010. Environmental Studies. (2nd ed.). Excel Books Publications, New Delhi.
12. Verma, P.S., and Agarwal V.K. 2016. Environmental Biology (Principles of Ecology).S. Chand and CompanyLtd, New Delhi.

கற்பகம் உயுகல்விக்கழகம்

மமழிகள் துவற - தமிழ்ப்பிவி

தமிழ்ப் பட்டத்திட்டம் (2023-2024)

இரண்டாம் பருவம் -பகுதி - I, தமிழ், தாள் II - 23LSU201 4 - H, 4 - C

(இளநிவை அறிவியல்பட்ட வகுப்புகளுக்குரியது)

(For I-UG Science Degree Classes) இைக்கிய

மநறிகள்

ைஅகு - I

(8 மணிநேரம்)

நயன்மர்கள் : தமிழ் இைக்கிய வுிவசயில் திருமுவறகளும் நுயிரத் திவ்யப்பிரபந்தமும் -பன்ைிரு திருமுவறகள் அறிமுகம் - திருமுவற ஆசுியர்களின் இைக்கியப் பங்களிப்பு வசவம்-மபுியபுரணம் - குவரக்கால் அம்வமயுர் புரணம் .

முக்குடற்பள்ளு - 2 பட்டல்கள் - சித்திரக்காலிவனுன் (மநல் வவககள்)

குற்றுதைத் திுகுடமல்வவர (மீன்வவககள், குவள வவககள்)

கவிவத : மகுகவி பாரதியார் - கயுகசித்தி

கவிவத : கவிமணி கதசிக விநயகம் பிள்வள - வுழ்க்வகத் தத்துவங்கள்

கவிவத : கவிஞர் சுகந்திசுப்பிரமணியம் - புவதயுண்டவுழ்க்வக

சிறுகவத : மகாமசுண்ம் - புவதவமப்பித்தன்

இைக்கணம் - வுக்கியஅவமப்பு : தைவுக்கியம் - மதுடர்வுக்கியம் - கைவவவுக்கியம் - தன்விவை வுக்கியம் - பிறவிவை வுக்கியம்- மசய்விவை, மசயப்பட்டு விவைவுக்கியம், கட்டவளவுக்கியம் - விவைவுக்கியம் - உணர்ச்சி வுக்கியம். நன்னூல் - மபுதுவியல் - அறுவவகவிவை (385) - எண்வவகவிவட (386).

ைஅகு - 2

(8 மணிநேரம்)

ஆழ்வர்கள் : இைக்கியப் பங்களிப்பு - திவ்யப் பிரபந்தத்தில் பக்திமநறியும் இைக்கிய நயமும்

உவரநவட : கதுற்றமும் வளர்ச்சியும்

வவணவம் : மபுியுழ்வார் திருமமழி: 3-ஆம் பத்து - பத்தும் திருமமழி

‘மநறிந்தகருங்குழல்மடவாய்’ - சீவதக்கு அனுமன் மதுிவித்த

அவடயுளம்.

கவிவத - கவிஞர் வவரமுத்து - வித்தியசமுண் துண்டி

சிற்பி பாசுப்பிரமணியன் - புரதி எங்கள் கண்மணி
அரங்க புயி - கண்ணீர்!
கண்ணீர்!

தமிழைங்காரம் - வண்ணச்சரபம் தண்டபுணி சுவாமிகள் - 10 புடல்கள்

1. கடல் நீரில் கல்மிதக்கும், 2. வண்டமிழ் ஆற்றுதி, 3. ககுவத்வத முட்டி
4. எக்குமைமென்று, 5. கடலூர் மயுதைமதுர், 6. கதவதிகதவன், 7. விண்மயி,
8. கதவர்முனைவர், 9. அழுகதங்கிநஞ்சிட்ட, 10. அத்தவைமபுத்து.

சிறுகவத : ஆ. குடமணி - அந்நியர்கள்

கட்டுவர : ஆளுவமத்திறன் அறிகவாம்- தன்மைப்பிக்வக மதுதமிழிலிருந்து
அணிஇக்கணம் : உவவமயணி - பிறிதுமமழிதல் அணி - சிகைவட அணி - தீவக அணி-
ஏககதச உருவக அணி - கவற்றுவமயணி - பின்வருநிவையணி

அகு - 3

(8 மணிநேரம்)

புதுக்கவிவத - கதுற்றமும் வளர்ச்சியும்

சிறினைக்கியம் - கதுற்றமும்வளர்ச்சியும்

மதுவரமசுக்கநுதர் - தமிழ்விடுதாத - தமிழின் சிறப்பு புடியருள பத்துப்பாட்டும் -

விளம்பக்ககள்.

கவிவத- ஈகரபுதமிழன்பன் - இன்மைரு சுதந்திரம்
சிறுகவத - கு. அழகியிசுமி - இருவர் கண்ட ஓகரகைவு
கட்டுவர - ஓளவவதுவரசுமி - ஏட்டில் இல்லை
இக்கியம்

பவடப்பினைக்கியப் பயிற்சிகள் - மரபுக்கவிவத, புதுக்கவிவத, சிறுகவத, கட்டுவர
பவடப்பாக்க உத்திகள் -பயிற்சிகள்

அகு - 4

(8 மணிநேரம்)

சிறுகவத - நதாற்றமும் வளர்ச்சியும்

கலிங்கத்துப்பரணி - கதவசுரம், உடலின்கமல், மநடுங்குதிவர மிவசக்கைவண,
விருந்தினரும் வறியவரும், தவரமகள் தன்மகமுநன்றன்,
மபுருதடக்வகவமளங்கக, மவயில்துவர.

அருள்தரும் பூங்ககுவதயன்வை அந்தாதி - 11புடல்கள்

1. பகவன்மபயவர, 2.மமல்லியல்கமவை,3.வலின் குரங்கு, 4.தவகள இவள், 5.சுரக்கும்
- திருவருட, 6.வதிவய் வரிவளபயில்,7.உவறவன், 8.பசுவசப்கபு,
- 9.வித்தகம், 10.துவணயய், 11.கைந்தார்.

கவிவத - கவிஞர்தாமவர

- மதுவைந்துகபுகைன்

சிறுகவத - அம்வப

- ஜ-

வல்லுறுகள் கட்டுவர- முவைவர் ப. தமிழரசி -

மநுய்யல்,

மசுல்லின் மசல்வர் ரு.பி.கசதுப்பிள்வள - கௌத்திகவடனும் கங்வககவடனும்

மமழிமபயர்ப்புப் பயிற்சிகள் : தமிழ்-ஆங்கிை மமழிமபயர்ப்புப் பயிற்சிகள் -2.

அகு -5

(8 மணிநேரம்)

நுட்டுப்புற இைக்கியங்கள்

- அறிமுகம்

கவிவத - பூரட்சிக்கவிஞர் பூரதிதுசன் - தமிழினம்

இை்வம கவிவத - கவிஞர் அறிவுமதி - ேட்புக்காலம்

சிறுகவத - நுஞ்சில்நுடன்

- இந்நுட்டு மனெர்

கீழடி

- வவவக நதிக்கவரயில் சங்ககூை நகரநுகூிகம்

மமழிமபயர்ப்புப் பயிற்சிகள் : ஆங்கிைம் - தமிழ் மமழிமபயர்ப்புப் பயிற்சிகள்-2.

Part I TAMIL 2023. Even Sem Science Karpagam Academy of Higher Education, Coimbatore – 21.

பூர்வவ நூல்கள்

1. கற்பகச் கசுவை - தமிழ்ப்ப்புட நூல், இைக்கிய மநறிகள், தமிழ்த்துவற மவளியீடு, கற்பகம் உயர்கல்விக்கழகம், ககூயம்புத்தூர் - 21.

2. தமிழ் இைக்கிய வரைறு, முவைவர் க.ககூ. கவங்கடரூமன், கவையக மவளியீடு, நுமக்கல்.

இவணயதளம்

1. www.tvu.org.in

2. www.maduraitamilproject.com

இதழ்கள்

1. International Research Journal of Indian Literature, irjil.in

2. International Tamil Research Journal, iorpress.in

வினாத்துள் கட்டவமப்பு

இவடக்கதுன வினாத்துள்

மமத்த மதிப்பமபண்கள் 50

பகுதி – அ (ஒரு மதிப்பமபண் வினாக்கள்) $20 \times 1 = 20$ (சுரியுண் விவடயிவதைத் கதுளம்மதடுதம்மதமுதலுதல்) பகுதி – ஆ (இரு மதிப்பமபண் வினாக்கள்) $3 \times 2 = 6$ (அவைத்து வினாக்களுக்கும் விவடயளித்தல்) பகுதி – இ (ஆறுமதிப்பமபண் வினாக்கள்) $6 \times 4 = 24$ (அவைத்து வினாக்களுக்கும் விவடயளித்தல்)
பருவக்கதுன வினாத்துள் - மமத்த மதிப்பமபண்கள் 60

பகுதி – அ (ஒரு மதிப்பமபண் வினாக்கள்) $20 \times 1 = 20$ (சுரியுண் விவடயிவதைத் கதுளம்மதடுதம்மதமுதலுதல்) பகுதி – ஆ (இரு மதிப்பமபண் வினாக்கள்) $5 \times 2 = 10$ (அவைத்து வினாக்களுக்கும் விவடயளித்தல்) பகுதி – இ (ஆறுமதிப்பமபண் வினாக்கள்) $5 \times 6 = 30$ (அல்லைது வவகயில் கதுளம்மதடுத்து எழுதுதல்)

Instruction Hours / week: L: 3 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

Course Objectives

- To refresh the grammar knowledge of the students to improvise their language.
- To make the students to speak and write errors free English.
- To make the students understand different kinds of communication.
- To help the students develop their listening, speaking, reading and writing skills.
- Introducing literary works to the students to enhance their analytical and aesthetic skills.

Course Outcomes

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Strengthen the foundation of the language to elevate the command of standard grammar. | Remember |
| CO2 | Formulate and communicate persuasive arguments for specific business outcome. | Apply |
| CO3 | Utilize fundamentals of language for reading, writing and effective communication. | Apply |
| CO4 | Standardize and demonstrate understanding of LSRW skills. | Understand |
| CO5 | Introduce literature to enhance the moral and aesthetic values. | Evaluate |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO2 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO3 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO4 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO5 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO6 | L | L | L | L | S | L | L | L | L | L | L | L |

S-Strong; M-Medium; L-Low

| | | |
|-------------------|---|------------------|
| UNIT-I | | (6 Hours) |
| Listening | : Listening for Pleasure (Poetry) | |
| Speaking | : Developing speaking skills | |
| Reading | : Reading strategies | |
| Writing | : Developing a story with pictures | |
| Literature | : Refuge Mother and Child by Chinua Achebe | |
| Grammar | : Voice | |
| UNIT- II | | (6 Hours) |
| Listening | : Listening for Pleasure (Story) | |
| Speaking | : Oral presentation | |
| Reading | : Reading Passages | |
| Writing | : Essay writing | |
| Literature | : Prose: Dimensions of Creativity by A.P.J. Abdul Kalam | |
| Grammar | : Subject, verb, agreement | |
| UNIT-III | | (6 Hours) |
| Listening | : Dictation | |
| Speaking | : Public speaking and secrets of good delivery | |
| Reading | : Note Making | |
| Writing | : Writing agendas, memos and minutes | |
| Literature | : River by A.K. Ramanujan | |
| Grammar | : Degrees of comparison | |
| UNIT- IV | | (6 Hours) |
| Listening | : Listening to instructions and announcements | |
| Speaking | : Debating | |
| Reading | : Silent reading and methods of reading | |
| Writing | : Writing Notices | |
| Literature | : Two Gentlemen of Verona by A.J. Cronin | |
| Grammar | : Phrases and clauses | |
| UNIT-V | | (6 Hours) |
| Listening | : Testing listening | |
| Speaking | : Situational Conversation | |
| Reading | : Developing reading activities | |
| Writing | : E - Mail Writing | |
| Literature | : The Postmaster by Rabindranath Tagore | |
| Grammar | : Direct and indirect speech | |

Books for References

Oxford Handbook of Writing: St. Martins Handbook of Writing 2013 Cambridge University Press
 Sound Business, Julian Treasure 2012 Oxford University Press
 Hornby, A.S.(1975) The Guide to patterns and usage in English: oxford university Press. Ellis,
 R.(1990) Instructed second language acquisition. Oxford: oxford university Press.

23MBU201

MICROBIAL PHYSIOLOGY AND METABOLISM

Semester – II
(6H–5C)

Instruction Hours / week: L: 5 T: 1 P:0 Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To provide brief description on the microbial metabolism and its pathways
- To explain the various aerobic and an aerobic process through which the organisms obtain and utilize the energy for their growth and to produce industrially important products.
- To explain photosynthesis and photosynthetic bacteria
- To study the structure, function, growth, and regulatory mechanisms of microorganisms.
- To learn about the metabolic diversity exhibited by microorganisms.
- To explain the networks that supports the survival and growth of the microorganism.

COURSE OUTCOME

Upon the completion this course student will acquire

| Cos | Course Outcomes | Blooms Level |
|-----|---|---------------|
| CO1 | The students will be able to understand and predict the various metabolic reactions in microbial cell. | understanding |
| CO2 | This will make them predict the intermediate products which can be employed in industrial production processes. | applying |
| CO3 | Students will understand the microbial growth, nutrition and environmental factors. | understanding |
| CO4 | Students will be able to assess the prokaryotes by observing the biochemical reaction. | Evaluating |
| CO5 | This course will support them to understand the concepts of microbial physiology | understanding |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | L | L | M | M | M | M | M | M | M |
| CO2 | L | L | M | L | L | M | M | M | M | M | L | L |
| CO3 | M | L | M | L | L | L | M | S | S | M | L | L |
| CO4 | M | L | M | M | M | M | M | S | L | M | L | L |
| CO5 | M | M | M | M | M | M | M | S | L | M | L | M |

S- Strong; M-Medium; L-Low

Unit I- Microbial nutrition**(10 Hours)**

Microbial nutrition– Nutritional groups of microorganisms, (Carbon, energy and electron source), Nutrient requirements: Macro and micronutrients with their physiological functions. Uptake of nutrients by cell – Passive, Facilitated diffusion, Active transport- Uniport, Symport, Antiport. Group translocation and Iron uptake.

Unit II- Microbial growth and concept of Fermentation**(10 Hours)**

Growth; bacterial cell division, Growth curve - Different phases of growth curve - generation time, growth rate and growth kinetics. Methods of measuring microbial growth. Batch, fed-batch, Continuous and Synchronous culture, Diauxic growth, Influence of environmental factors on growth (Temperature, pH, solute, water activity, oxygen and pressure). Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

Unit III- Carbohydrate metabolism**(10 Hours)**

Carbohydrate metabolism – EMP, ED, Pentose phosphate pathway, TCA cycle, Aerobic respiration, oxidative phosphorylation, electron transport chain (Prokaryotic and Eukaryotic), substrate level phosphorylation. Uncouplers, inhibitors and ionophores. Chemical coupling, conformational coupling and chemiosmotic hypotheses.

Unit IV- Nitrogen metabolism**(10 Hours)**

Nitrogen Fixation – Nitrogen fixers, Physiology of nitrogen cycle and mechanism of nitrogen fixation- Symbiotic and non symbiotic Assimilatory and dissimilatory nitrate reduction, biological nitrogen fixation. Anaerobic respiration with special reference to dissimilatory nitrate reduction – Denitrification: nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction.

Unit V- Phototrophic metabolism**(10 Hours)**

Phototrophic metabolism- Historical account of photosynthesis, diversity of phototrophic bacteria, Photosynthesis – bacteria and cyanobacteria: anoxygenic (Purple, green bacteria) and oxygenic (cyanobacterial) photosynthesis. Photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation.

SUGGESTED READINGS

1. Madigan, M.T., Kelly, S.B., Daniel, H.B, Mathew, S and David, A.S (2017). Brock Biology of Micro-organisms. 15th edition. Parker J. Prentice Hall International, Inc.
2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2019). Prescott's Microbiology. 11th 12th edition. McGraw Hill.
3. Talaro., Kathleen, P.T., Chess., and Berry, C., (2018). Foundations in Microbiology, 10th Ed., McGrawHill.
4. Benson's Microbiological Applications Laboratory Manual Complete Version, 2015, 13th Edition, McGrawHill.
5. Kathleen Park Talaro and Barry Chess, 2018. Foundations in Microbiology: Basic Principles, 10th Edition, McGrawHill
6. Moat, A.G., and Foster, J.W. (2002). Microbial Physiology. 4th edition. John Wiley & Sons. Reddy, S.R., and Reddy, M. (2007). Microbial Physiology. Scientific Publishers India

23MBU202

Semester – II
BIOCHEMISTRY II

(6H–5C)

Instruction Hours / week: L: 5 T: 1 P:0 Marks: Internal: 40 External: 60 Total:100**End Semester Exam: 3Hour****COURSE OBJECTIVES**

- To provide the informative understanding on Advances in Biochemistry and its applications.
- To study the various metabolic pathways and energy generation.
- To understand the free energy and electron carriers
- To gain knowledge on carbohydrate, lipid and protein metabolism
- To provide an understanding of the principle concept of biochemical compounds
- To gain information and detailed understanding of biological oxidation

COURSE OUTCOME (CO'S)

Upon completion of this course students will be able to

| Cos | Course Outcomes | Blooms Level |
|------------|--|---------------------|
| CO1 | Understand the metabolic pathways of carbohydrates, proteins, Lipids and Nucleic acid that improve their skills. | Apply |
| CO2 | This course will provide clear understanding about the fattyacid oxidation. | Understand |
| CO3 | Students will analyze structural functional relationships of genes and proteins from bacteria to eukaryotes. | Apply |
| CO4 | Students able to demonstrate the carbohydrate, protein and nucleic acid | Apply |
| CO5 | Students able to understand the metabolism of carbohydrate, protein and lipid. | Understand |
| CO6 | Students can understand the energy generation. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|
| CO1 | M | S | M | L | L | M | M | M | M | M | M | M |
| CO2 | L | L | M | L | L | M | M | M | M | M | L | L |
| CO3 | M | L | M | L | L | L | M | S | S | M | L | L |
| CO4 | M | L | M | M | M | M | M | S | L | M | L | L |
| CO5 | M | M | M | M | M | M | M | S | L | M | L | M |

S-Strong; M-Medium; L-Low

Unit I- Introduction to metabolism**(10 Hours)**

Anabolism and catabolism - Definition. Bioenergetics - Thermodynamics principles, Concepts of free energy, Standard free energy, Mitochondrial Electron Transport Chain: electron carriers, chemiosmotic theory and ATP production, High Energy phosphate compounds, Inhibitors of electron transport chain and Redox potential and uncouplers of oxidative phosphorylation.

Unit II- Carbohydrate metabolism**(10 Hours)**

Glycolysis, TCA cycle, Glycogenesis, Glycogenolysis, HMP shunt, Gluconeogenesis, Glucuronic acid pathway. Regulation of glycogen metabolism. Oxidative Phosphorylation.

Unit III- Lipid metabolism**(10 Hours)**

Fatty acid oxidation – α , β , ω oxidation. Biosynthesis of saturated and unsaturated fatty acids. Metabolism of cholesterol, triglycerides and ketone bodies.

Unit IV- Protein metabolism**(10 Hours)**

Synthesis of Aliphatic and aromatic amino acids. Degradation of proteins: Deamination, Transamination and Decarboxylation, Urea cycle. Synthesis of ketogenic and glucogenic amino acid.

Unit V- Nucleic acid metabolism and Biological oxidation**(10 Hours)**

Biosynthesis and degradation of purine and pyrimidine nucleotides. Interconversion of nucleotides.

SUGGESTED READINGS

1. Fundamentals of Biochemistry, J.L. Jain, S.Chand publications, 2004.
2. Lehninger's Principles of Biochemistry (2000) by Nelson, David L. and Cox, M.M. Macmillan /Worth, NY.
3. Harper's Biochemistry Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, 24th edition, Prentice Hall International. Inc.
4. Principles of Biochemistry, Geoffrey L. Zubay, 3rd edition William W. Parson, Dennis E. Vance, W.C. Brown Publishers, 1995.
5. Principles of Biochemistry, David L. Nelson, Michael M. Cox, Lehninger, 4th edition, W.H. Freeman and company.
6. Biochemistry, Lubert Stryer, 4th edition, W.H. Freeman & Co, 1995.
7. Fundamentals of Biochemistry (1999) by Donald Voet, Judith G. Voet and Charlotte W Pratt, John Wiley & Sons, NY.
8. Molecular Biochemistry II "Nucleotides: Their Synthesis and Degradation". 2014.

Instruction Hours / week: L: 0 T:0 P:4 Marks: Internal: 40 External: 60 Total:100**End Semester Exam: 9 Hour****COURSE OBJECTIVES**

- To enhance the students' knowledge on various aspects of microbial physiology like growth, extremophiles studies and chemical characterization of microbes.
- To improve their skills in handling of microorganisms
- To analyze the growth condition of the bacteria.
- To facilitate the students to deal with the bacterial strain
- To demonstrate the fermentation technique
- To demonstrate the generation time and thermal death time of bacteria

COURSE OUTCOME (CO'S)

Upon completion of this course students will be able to

| Cos | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | The students will be able to analyze the bacterial growth and growth condition | Understand |
| CO2 | Able to identify the various factors for optimal growth of E.coli. | Apply |
| CO3 | Understand the basic microbial structure and functions of various physiological groups of prokaryotes | Understand |
| CO4 | Able to apply various culture media in the proper physical condition for fermentation | Analyze |
| CO5 | Able to explain the microbial metabolism and their physiological interaction for cellular function. | Apply |
| CO6 | The students will be able to analyze the bacterial growth and growth condition | Remember |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | S | S | S | M | M | M | M | M | M |
| CO2 | S | S | M | S | S | S | M | M | M | M | S | S |
| CO3 | S | S | M | S | S | S | M | S | S | M | S | S |
| CO4 | S | S | M | M | M | M | M | S | S | M | S | S |
| CO5 | M | M | M | M | M | M | M | S | S | M | S | S |

S-Strong; M-Medium; L-Low.

EXPERIMENTS (40 Hours)

1. Study and plot the growth curve of *E. coli* by turbidimetric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E.coli*
4. Effect of pH on growth of *E.coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of NaCl on growth of *E.coli*
7. Biochemical Characterization:
8. IMViC test
9. TSI Test
10. Nitrate reduction Test
11. Urease production Test
12. Catalase Test
13. Oxidase Test
14. Carbohydrate fermentation Test
15. Demonstration of alcoholic fermentation
16. Demonstration of the thermal death time and decimal reduction time of *E.coli*.
17. Lecithinase and gelatin liquefaction activity.

SUGGESTED READINGS

1. Madigan, M.T., Kelly, S.B., Daniel, H.B, Mathew, S and David, A.S (2017). Brock Biology of Micro-organisms. 15th edition. Parker J. Prentice Hall International, Inc.
2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2019). Prescott's Microbiology. 11th edition. McGraw Hill.
3. Talaro., Kathleen, P.T., Chess., and Berry, C., (2018). Foundations in Microbiology, 10th Ed., McGrawHill.
4. Benson's Microbiological Applications Laboratory Manual-Complete Version, 2015, 13th Edition, McGrawHill.
5. Reddy, S.R., and Reddy, S.M. (2007). Microbial Physiology. Scientific Publishers India

Instruction Hours / week: L: 0 T: 0 P:3 Marks: Internal: 40 External: 60 Total:100
End Semester Exam: 6 Hour**COURSE OBJECTIVES**

- To familiarize the students with some basic analytical techniques in Biochemistry that improve their skills associated with laboratory techniques
- To gain knowledge with these techniques used for purification
- To know principle behind the compound purification
- To measure the protein using standard method
- To analyze the lipid using routine test
- To determine the physical factors and substrate concentration of protein

COURSE OUTCOME (CO'S)**Upon completion of this course students will be able to**

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Understand the metabolic pathways of carbohydrates, proteins, Lipids and Nucleic acid that improve their skills. | Apply |
| CO2 | This course will provide clear understanding about the Biological oxidation. | Understand |
| CO3 | Students will analyze structural functional relationships of genes and proteins from bacteria to eukaryotes. | Apply |
| CO4 | Students able to demonstrate the carbohydrate, protein and nucleic acid | Apply |
| CO5 | Students able to comment on metabolism of carbohydrate, protein and lipid. | Understand |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | M | M | M | M | M | M | M | M |
| CO2 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO3 | M | M | M | M | M | M | M | S | S | M | M | M |
| CO4 | S | S | M | M | M | M | M | S | S | M | M | M |
| CO5 | M | M | M | M | M | M | M | S | S | M | S | S |

S-Strong; M-Medium; L-Low.

EXPERIMENTS

(30 Hours)

1. Separation of sugar by paper chromatography
2. Separation of amino acid by thin layer chromatography
3. Separation of plant pigments by thin layer / column chromatography
4. Estimation of carbohydrate by anthrone method
5. Estimation of Protein by Lowry's method
6. Estimation of Cholesterol by Zak's method
7. Estimation of Phosphorus by Fiske Subbarow method
8. Estimation of starch.
9. Extraction and estimation of chlorophyll in plant tissue

SUGGESTED READING

1. Biochemical Methods 1992, by S. Sadasivam and A. Manickam, Second Edition, New Age International Publishers, New Delhi
2. Laboratory Manual in Biochemistry, 1981. J. Jayaraman, New Age International publishers, New Delhi.
3. Laboratory Manual for Practical Biochemistry (2013), Shivaraja Shankara Ym 2nd Edition. Jaypee Publishers.
4. A Laboratory Manual of Plant, Physiology, Biochemistry and Ecology 2012. Akhtar Inam. ISBN: 9788177544589 Agrobios Publisher, India.

Instruction Hours / week: L: 2 T: 0 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES:**

- To make the students
- To understand the Indian knowledge systems about origin, evolution and ontological approach
- To comprehend the Indian knowledge approaches with respect to time and language
- To obtain key knowledge on life and mind of Indian knowledge system
- To acquire key information on torchbearers of Indian knowledge system
- To attain strong knowledge on the role of Women in ancient and modern India

COURSE OUTCOMES:**Learners should be able to**

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Understand the rich heritage that resides in our traditions. | Understand |
| CO2 | Comprehend the Indian knowledge | Understand |
| CO3 | Understand the importance of philosophical concepts | Understand |
| CO4 | Understand the origin of Indic thought and practices | Understand |
| CO5 | Understand role of Women in ancient and modern India. | Understand |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | M | M | M | M | M | M | M | M |
| CO2 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO3 | M | M | M | M | M | M | M | S | S | M | M | M |
| CO4 | S | S | M | M | M | M | M | S | S | M | M | M |
| CO5 | M | M | M | M | M | M | M | S | S | M | S | S |

S-Strong; M-Medium; L-Low

UNIT I**(4 Hours)**

Tradition - Conception and Constitution of Knowledge in Indian Tradition, The Oral Tradition, Knowledge Maintenance and Renewal Mechanisms, Nature and Character of Knowledge, Models and Methods of Indian Knowledge Systems, Nature and Conception of Reality, Means of Knowledge of Reality –Uniqueness of Indian Ontology and Epistemology.

UNIT II**(4 Hours)**

Time and Language - Time – Concept of Kala, Cycles of Time, Measurement of Time, Knowledge of Time – the Science of Light. Language – Philosophy of Word and Meaning, The Sphota Doctrine, Sadhu and Asadhu words, Levels of Speech, Silence as the eternal language.

UNIT III**(4 Hours)**

Environment and Management - Environment – Concept of Nature in Indian Tradition, Panchbhutas – Elements of Nature, Concept of Rta, Sacred Environment, Panchvati. Management – Indian conception of Economy and Management, Insights from Arthashastra, Management by Consciousness.

UNIT IV**(4 Hours)**

Life and Mind - The Science of Life – History and Basic Principles of Ayurveda, Prana, Ojas and Tejas, Health, Balance and Routine in Ayurveda. The Science of Mind – Origin, Nature and Evolution of Yoga, Types and Schools of Yoga, Yoga Darshana.

UNIT V**(4 Hours)**

Torchbearers - Ancient – Sankara, Nanak, Tulsi, Caitanya. Modern – Dayananda, Ramakrishna, Sri Aurobindo, Ananda Coomaraswamy. Women's Empowerment in India: Ancient Period to Modern Time Period.

SUGGESTED READINGS:

B. Mahadevan, Vinayak Rajat Bhat, and Nagendra Pavana R.N. (2022). Introduction to Indian Knowledge System: Concepts and Applications (1st ed.). PHI Publishers, New Delhi, India.

WEBSITES

<https://iks.iitgn.ac.in/wp-content/uploads/2016/01/Indian-Knowledge-Systems-Kapil-Kapoor.pdf>

<https://www.sanskritimagazine.com/india/traditional-knowledge-systems-of-india/>

23LSU301

LANGUAGE III

Semester - III
(4H-4C)

Instruction Hours / week: L: 4 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

கலை, அறிவியல், வணிகவியல் மற்றும் மனவியல்
லமயியல் புவம்

மமாழிகள் Fலற – தமிழ்
ப்பிரிவுதாள் - 3, 4 - H, 4 - C
(2024- 2025 Odd Semester)

பாடத்திட்ட பயன் விளைவு

ளுக்கு அறிமுகப்படுத்துதல்

1. வரண்ாற்றிற்கு முற்பட்ட
தமிழகத்தலத மாணவாக

2. பழந்தமிழாப் பண் ஂத வாழ்க்கலக முலறலய ள் அறிய ஊக்குவித்தை
பாடு சாரந மாணவாக

3. தமிழ்மமாழியின் பலழலமயும், திராவிட மமாழிகளின் தமிழ்மமாழியின்
தனிச்சிறப்பயும் மாணவரகளாகக் அறிமுகப்பட்டுத் தை ஂ.

4. ளின் வாழ்வியல், தமிழர்கலகைகள், ஆற்றங்கலரபத்
தமிழர்க் பண் பாடுகள் கூறித்த ள் அறியச் சய்தை.
மாண
வரக

5. இந்தியக் கூடியுரிலமப் பணி மூதான மபாட்டித்
மதானுகளின் விருப்பப் பாடமாக இடம்மபறுகின்ற தமிழ்
நாகரிகமும் பண் பாடும் கூறித்த மூலமயான அறிமுகம்
மபற்றிருத்தை.

பாடத்திட்டப் பபாந் நாகக்கம்

1. இந்தியக் கூடியுரிலமப்பணி மூதான மபாட்டித்
மதரனுகளின், விருப்பப்பாடமாக இடம்மபறுகின்ற, 'தமிழ்
இக்கியவரைறு' குறித்த முலமயான அறிமுகம்
மபற்றிருத்தை.

2. கண்மவட்டியல், வடியியல் மற்றும் ஂத ஆவணத்
ஓலசைச மதாண்லியல் சாரந

மதலுக்குரிய ஆய்வு மனப்பான் லமயுடன், இக்கியங்கலள அணுகுதை.

3. தமிழின் வளரச்சித் Fலறயாகிய, 'அறிவியல் தமிழ்'; 'இலணயதமிழ்'
கூறித்த பண் மநாகக்

அணுகுமுலறயிண்ான ஆய்வுசசிந்தலன மமம்பாடு.

4. மவலவைவாய்ப்புக்குரிய சுயதிறன் மமம்பாடமுடன்,
பலடப்பாக்கத்திறன் மமம்பாடுமபற்றிருத்தை.

5. சமுதாய மற்றும் வாழ்வியை மதிப்புகளப் மபணுவதற்குக் கருவியாக
இகக்கியங்கலள நாடுகின்ற . மமாழிமபயப்புத் பலசாரந்த
மனப்பான்லம வளரசுவலைவாய்
புத்திறன் மபற்றிருத்தை

தாள்கள் வரிலசயும் மதரனசம் மசயண்
திட்டமும்

பகுதி-I தமிழ்
இளநிலை கலைத் துறைப் பட்ட
வகுப்புகளுக்குரிய பருவம் தாள் கற்பிக்கும்
மநரம்/வாரம்

மதரணுமணிகள்
மதிப்பீடு அக/எழுத்து
மமாத் தம்
மதிப்பீடு மூன்று 3
4 3 40 / 60 100 4

களை, அறிவியல், வணிகவியல் மற்றும் நுட்ப நுட்ப
ளமயியல் புணர்

பமாழிகை - I - தமிழ்
பிரிவு தமிழ் இணை
வரைவு- தாள் 3, (2024- 2025
Odd Semester)

அக:1 சங்க இணை

(9 Hours)

தமிழ் இணை வரலாறு-அறிமுகம்-முச்சங்க வரலாறு-பாடலும்
மதாலகயுமாகிய சங்க

இணைத் மதாபு-அறிமுகம் -எட்டுமதாலகயிண் அகத்திலண-புறத்திலண-
புறப்பாட்டிண் அலமந்த ஆற்றுப்பலட இணையங்கள்-
புறப்பாட்டிண் அகமும் புறமும்-
பு ளும் பாடல்களும்- ள்.
வைர மபண் பாற் புவைரக
க

அக: 2 அற இணையும் காப்பியமும்

(9 Hours)

திருக்குறள்-அலமப்பு-இணையச் சிறப்பு-உகப் மபாபலமத் தன் லம-மபாபுட்

சிறப்பு-இணையச் சிறப்பு-நாடியார் முதைக குமரகுருபரரின் நீ திமநறிவிளக்கம்
ஈறாக அலமந்த நீ தி இணையங்கள் -நீ தி நுண் களிண் அகமும்
புறமும் -தமிழ் இணைய வரலாறுயிண் ஐம் மபருங் காப்பியங் களும் ,
ஐஞ்சிறு காப்பியங்களும்- சிமும்பும் மணிமகலையும் -
இரடலடககாப்பியங்கள்- கம்
பராமாயணம்-மபரியபுராணம்-சீறாபபுராணம்-மதம்பாவணி-
இராவண காவியம்.

அக:3 திருமுறைகளும் திவ்யப்பிரபந்தமும்

(8 Hours)

தமிழகத்திண் பக்தி இயக்கத்தின் மதாற்றமும் வளரசியும்-பண்
னிரு

திருமுலறகளும்,பதிநான் கு
களும்-திவ்யப்பிரபந்தமும்,
லவணவ இைக்கியங்களும்.

சித்தாந்த சாத்திரங்
இராமாஈஜ நுற்றந்தாதி முதைான

ைஅகு: 4 சிற்றிைக்கியங்களும் இக்காை இைக்கியங்களும் (10 Hours)

குற்றாைக்குறவஞ்சி, முக்கூடற்பள்ளு, மஈலர மீனாடசியம் லம பிள்ளத்தமிழ்,
மஈலரமசாக்கநாதர் தமிழ்விடு ஈஈ, அழகர் கிள்ளவிடு ஈஈ முதைான சிற்றிைக்கிய
வரிலச-தமிழிண் பஈஈஈக்கவிலத இயக்கங்களின் மதாற்றமும் வளரசசியும்-
தமிழ்ப் பஈஈஈக்கவிலத

வடிலங் கள்-தமிழின் நாடக இைக்கியங் கள்- மமனாண் மணீயம்
– தமிழின் உலரநலட

1. International Research Journal of Indian Literature, irjil.in
2. International Tamil Research Journal, iorpress.in

Instruction Hours / week: L: 3 T: 0 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****Course Objectives**

- To enable students, learn correct pronunciation, spelling, meaning and usage of English Vocabularies.
- To give English language skill practice to students to enhance their English proficiency.
- To expose students to native speakers' spoken language to enable students to recognize native speakers' accent and language usage.
- To help students to become autonomous and self-directed English language learners.
- To produce entrepreneurs among students by making them English language trainers and take communicative English to schools and colleges around.

Course Outcomes

At the end of this course, students will be able to

| Cos | Course Outcomes | Blooms Level |
|------------|--|---------------------|
| CO1 | Demonstrate the skill to write in English without grammatical error. | Apply |
| CO2 | Practice listening effectively to communication in English. | Apply |
| CO3 | Develop the ability to speak English language with the right way of pronunciation. | Understand |
| CO4 | Express the viewpoints with confidence in English. | Analyze |
| CO5 | Express values and skills gained through effective communication to other disciplines. | Analyze |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|
| CO1 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO2 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO3 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO4 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO5 | L | L | L | L | S | L | L | L | L | L | L | L |

S-Strong; M-Medium; L-Low

UNIT-I

(7 Hours)

Listening: Listening Comprehension-Listening for Specific Information- Interpreting Charts and Diagrams

UNIT- II

(7 Hours)

Speaking: Essentials of effective Communication- **Telephone Skills:** Understanding Telephone Conversation-Handling Calls-Leaving Messages-Making Requests-Giving Instructions and Orders.

UNIT-III

(7 Hours)

Reading: Reading with a purpose-Skimming and Scanning-Locating Main Points-Reading Critically-Sequencing of Sentences-Reading Comprehension

UNIT- IV

(7 Hours)

Writing: Descriptive and Narrative-Safety Instructions- Suggestions-Expansion of Abbreviations-Spellings Rules Translation- Translating Short Sentences and Passages from English to Tamil

UNIT-V

(8 Hours)

Vocabulary: Synonyms-Antonyms-Prefixes-Suffixes- Idioms- Different Types of English-Homonyms and Homophones (British and American)

Books for References

- 1.Oxford Handbook of Writing: St. Martins Handbook of Writing 2013 Cambridge University Press
Wren & Martin, 2008, *High School English Grammar & Composition*, S.Chand & Company Ltd, Board of Editors,
- 2.Krashen, Stephen D (1982) Principles and practice in second language acquisition. New York: Pergamon Press.

Instruction Hours / week: L: 4 T: 1 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3 Hours****COURSE OBJECTIVES**

- To study general aspects of viruses, classification, replication, interactions and immunity to viruses
- To explain the students about the virus classification based on host, genome, mode of replication and structure or shape
- To examine interaction between virus and host in infection process
- To study the disease caused by virus transformation and sub viral particles
- To study the vaccine development, antiviral drug and interferons in therapy

COURSE OUTCOMES

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Understanding of types of virus that infect plant, microbes and animals | Apply |
| CO2 | Clear understanding of virus entry, gene expression and regulation | Apply |
| CO3 | Comprehend the intricate interaction between viruses and host cells | Understand |
| CO4 | Understanding of disease caused by virus and sub viral infection | Apply |
| CO5 | Explain vaccine development and mechanisms of antiviral drugs, interferons and immunotherapy | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | M | M | M | M | M | M | M | M |
| CO2 | M | M | S | S | M | M | M | M | M | M | S | S |
| CO3 | M | M | S | S | M | M | M | S | S | M | M | M |
| CO4 | S | S | S | S | M | M | M | S | S | M | M | M |
| CO5 | M | M | M | M | M | M | M | S | S | M | S | S |

S-Strong; M-Medium; L-Low

Unit I- History of viruses, virus multiplication and replication (9 Hours)

History of viruses. Properties of virus. Origin of virus. Structure, Classification, nomenclature of viruses. Viral replication strategies as per Baltimore classification. DNA virus, RNA virus and retrovirus replication.

Unit II- Bacteriophages (9 Hours)

Diversity, classification, one step multiplication curve, lytic and lysogenic life cycle of lambda phage, Genome of lambda phage, F2 phage, Ff phage concept of early and late proteins, regulation of transcription in lambda phage.

Unit III- Transmission of virus, genome organization of virus (9 Hours)

Modes of viral transmission in plant and animals. Viral genome size and organization. Salient features of viral nucleic acid (unusual bases, overlapping genes, splicing genes, terminal redundancy, cohesive ends, capping and tailing).

Unit IV- Viral infection diagnosis and prevention (9 Hours)

Oncogenic viruses and its types, General characters, epidemiology, pathogenicity, disease caused mechanism. Prevention and control of viral diseases. Laboratory diagnosis of emerging respiratory virus. Concept of viroids, virusoids, satellite viruses, Virophage and Prions.

Unit V- Antiviral compounds (12 Hours)

Antiviral compounds and their mode of action. Interferon and their mode of action. Viral vaccines and vaccine development. Use of viral vectors, gene cloning, expression in development of viral vaccines, Applications of gene therapy and phage display in disease control.

SUGGESTED READINGS

1. Dimmock, N.J., Easton, A.L., Leppard, K.N. (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J., and Saunders, V. (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint, S.J., Enquist, L.W., Krug, R.M., Racaniello, V.R., Skalka, A.M. (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy, J.A., Conrat, H.F., Owens, R.A. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner, E.K., Hewlett, M.J. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayud, M.V. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Ananthanarayanan R and CK Jayaram Panicker, (2017). Textbook of Microbiology 10th Ed. Orient Longman.

Instruction Hours / week: L: 4 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES:

- To focus on the basic principles of genetics incorporating the concepts of classical molecular and population genetics.
- To discuss about the microbial genes, genomes, and expression is essential for understanding the biology and evolution of microorganism and their interaction with the environment.
- To Understanding the central dogma of biology
- To understand the Transcription and Translation Process.
- To give a strong charity about genetics principle and genetic engineering.
- To give a vast knowledge about the transposable elements and their importance.

COURSE OUTCOMES:

At the end of this course, students will be able to

| Cos | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | This course will provide candidates with basic awareness and outline of Molecular Biology with unique reference to microbial genome. | Apply |
| CO2 | Students will be able to describe the nature of molecular world and its application in modern Microbiological sectors. | Apply |
| CO3 | Students will be able to understand the process of Mutation and mutagenesis. | Understand |
| CO4 | This paper provided the knowledge about the central dogma of biology. | Apply |
| CO5 | This course provided the concepts of genetic recombination techniques. | Apply |
| CO6 | Students will gain the awareness about the transposons and it applications | Understand |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | M | M | M | M | S | M | M | S | S | S | S |
| CO2 | M | M | M | M | M | S | M | M | S | S | S | S |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | S |
| CO4 | M | M | M | M | S | M | M | M | M | M | M | S |
| CO5 | S | M | M | M | M | M | M | M | M | M | M | S |
| CO6 | S | M | M | M | M | M | M | M | M | M | M | S |

S-Strong; M-Medium; L-Low

Unit I- History of genetics**(9 Hours)**

Concept of Genetics, Mendelian principles, DNA as a genetic material, Experimental evidence Chromosomal theory of inheritance. DNA structure, models of DNA, RNA structure and types. DNA replication in Prokaryotes, and eukaryotes Proof reading, Enzymes involved in replication.

Unit II- Plasmids**(9 Hours)**

Types of plasmids- replication, partitioning, host range, plasmid-incompatibility, amplification, pBR322 plasmid, pUC18 plasmids and its application as a vector. curing and application. Cosmid- types of cosmids with examples. Cloning vectors and expression vectors.

Unit III- Genetic code**(9 Hours)**

Central dogma of biology-transcription, translation, RNA editing, t-RNA charging, m RNA splicing, peptidyl transferase. Aminoacyl t-RNA. Genetic code- Operon concept-Lactose, tryptophan. Genetic recombination in bacteria- Conjugation, Transformation-Transduction and its types. Gene Mapping techniques-gene and chromosome walking.

Unit IV- Mutations**(9 Hours)**

Mutations and mutagenesis, types of mutations and mutagens. Identification of mutants- Ames test, Luria Delbruck experiments. DNA repair mechanisms and its types.

Unit V- Transposons**(12 Hours)**

Transposons-definition, types of Transposons, mechanism of transposition and application. Mu transposon elements and eukaryotic transposable elements and applications. Transposons in antibiotic resistance.

SUGGESTED READINGS

1. Klug, W.S., Cummings, M.R., Spencer, C., Palladino, M. (2011). Concepts of Genetics, 10th edition, Benjamin Cummings.
2. Krebs, J., Goldstein, E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd edition, Jones and Bartlett Learning.
3. Pierce, B.A. (2011) Genetics: A Conceptual Approach, 4th edition, Macmillan Higher Education Learning.
4. Watson, J.D., Baker, T.A., Bell, S.P., et al. (2008) Molecular Biology of the Gene, 6th edition, Benjamin Cummings.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. 8th edition, Wiley-India.
6. Molecular genetics 3RD edition by David P. Clark, Michelle R. McGehee, and Nanette J. Pazdernik. 2018.

23MBU303A

MICROBIAL BIOTECHNOLOGY

Semester –III
(3H–3C)

Instruction Hours / week: L: 3 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVE

- To make students understand the aspects of industrial, soil, environmental, agricultural microbiology.
- Gain knowledge about the Industrially important microorganisms & nutritional requirements.
- Know about the Commercialization methods of Microbial products.
- To understand the industrially important microorganisms' commercial value and importance of patent and IPR.
- Describe about different sewage treatment methods employed in waste water treatment.
- know the microorganisms responsible for water pollution.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | This paper imparts knowledge on applications of microorganisms in various fields and helps to gain employability in pharmaceutical industries | Understand |
| CO2 | Describe about different sewage treatment methods employed in waste water treatment. | Apply |
| CO3 | Learn about the global environmental problems. | Understand |
| CO4 | To provide a fundamental knowledge about the various scopes in environmental and industrial studies. | Analyze |
| CO5 | Learn about the applications of microbes in biotransformation, therapeutic and industrial biotechnology | Understand |
| CO6 | Describe aspects of genetically engineered microbes for industrial application | Remember |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO2 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO3 | S | S | S | S | M | M | M | M | M | M | M | S |
| CO4 | M | M | M | M | S | M | M | M | M | M | M | S |
| CO5 | S | M | M | M | M | M | M | M | M | M | M | S |
| CO6 | S | M | M | M | M | M | M | M | M | M | M | S |

S-Strong; M-Medium; L-Low

Unit I **(7 Hours)**

Microbial biotechnology and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), biostimulants environmental, and food technology. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications. Genetically engineered microbes for industrial application: Bacteria and yeast. Brief history of fermentation- Fermentation, general concepts and application of fermentation.

Unit II **(7 Hours)**

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics, Microbial biosensors. Gene transfer technique. Biotechnological application of microalgae- Food, Feed, colorant, fuel and aquaculture feed.

Unit III **(7 Hours)**

Microbial based transformation of steroids and sterols. Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute. Phage typing, gene therapy. Bio-transformation of antibiotics. Industrial production of organic acids & vitamins. Importance of microbes in industry-microbial biomass, microbial enzymes and microbial recombinant products.

Unit IV **(7 Hours)**

Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization. RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions. MDR, XDR and PDR resistance mechanism.

Unit V **(8 Hours)**

Basic cloning steps and product development. Bioethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Significance of Experimental plants. Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents. Microbial Valorization of Plastic Wastes.

SUGGESTED READINGS

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd edition, Cambridge University Press.
2. Swartz, J.R. (2001). Advances in *Escherichia coli* production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
3. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, McGraw Hill Publishers.
4. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications.
5. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
6. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.
7. Poonam Singh & Ashok Pandey, Biotechnology for agro-Industrial residues utilisation. (2019), Springer.
8. Satyanarayana T. and Johri B.N. (2015). Microbial diversity, Current Perspectives and Potential Applications, IK international.

Instruction Hours / week: L: 3 T: 0 P:0 Marks: Internal: 40 External: 60 Total:100
End Semester Exam: 3Hours**COURSE OBJECTIVES**

- To learn the basic handling of microorganisms.
- To understand the various biological containments.
- To emphasize on IPR issues and need for knowledge in patents in biotechnology.
- To gain knowledge on steps of a patenting process and the role of biosafety committee.
- To emphasize the components and design of laboratory.
- Provide learning opportunities to critically evaluate research methodology and findings

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Able to understand safety aspects in biological laboratory. | Understand |
| CO2 | To create awareness on the Intellectual property rights and patenting of biotechnological processes. | Apply |
| CO3 | To equip students with a basic understanding of the underlying principles of quantitative and qualitative patenting methods. | Understand |
| CO4 | Provide students with in-depth training on the conduct and management of patent filing from inception | Analyze |
| CO5 | Enable students to acquire expertise in the use and application of the methods of data collection and analysis. | Analyze |
| CO6 | Enable students to be reflexive about their role and others' roles as researchers. | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO2 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO3 | S | S | S | S | M | M | M | M | M | M | M | S |
| CO4 | M | M | M | M | S | M | M | M | M | M | M | S |
| CO5 | S | M | M | M | M | M | M | M | M | M | M | S |
| CO6 | S | M | M | M | M | M | M | M | M | M | M | S |

S-Strong; M-Medium; L-Low

Unit I Biosafety:**(7 Hours)**

Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms.

Unit II Biosafety Guidelines:**(7 Hours)**

Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

Unit III AERB/RSD/RES guidelines**(7 Hours)**

AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions. Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Berne conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

Unit IV Introduction to Intellectual Property**(7 Hours)**

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications-importance of IPR—patentable and nonpatentable—patenting life—legal protection of biotechnological inventions—World Intellectual Property Rights Organization (WIPO).

Unit V Grant of Patent**(8 Hours)**

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement -meaning, scope, litigation, case studies, Rights and Duties of patent owner.

SUGGESTED READINGS

1. Bare Act, (2007). Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh KK (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India.

Instruction Hours / week: L: 0 T: 0 P:4 Marks: Internal: 40 External: 60 Total:100
End Semester Exam: 6 Hours**COURSE OBJECTIVES**

- To study general aspects of viruses structure and classification
- To explain the students about the virus that infect animals, plants and bacteria.
- To study general aspects of viral morphology and classification.
- Cultivation of viruses and various methods of propagation of bacterial virus.
- To discuss the application of various immunological and molecular diagnostic tools.
- To study general aspects of viral particles.

COURSE OUTCOMES

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Upon paper completion, students will have skill-based knowledge on structure of plants, animal, bacteria viruses and genetics. | Apply |
| CO2 | This paper also enables the student on isolation, propagation of various viruses. | Apply |
| CO3 | It will help the students to understand the plant virus, animal virus and bacterial virus. | Understand |
| CO4 | Students can distinguish the viruses According to their characteristic features. Perform bacterial conjugation, transformation and transduction. | Apply |
| CO5 | It will explain the research activities involved in virology studies, genetics, and medical research. | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO2 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO3 | S | S | S | S | M | M | M | M | M | M | M | S |
| CO4 | M | M | M | M | S | M | M | M | M | M | M | S |
| CO5 | S | M | M | M | M | M | M | M | M | M | M | S |
| CO6 | S | M | M | M | M | M | M | M | M | M | M | S |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(48 Hours)

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs–Demonstration.
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs–Demonstration.
3. Study of the structure of important bacterial viruses (ϕ X174, T4, λ) using electron micrograph – Demonstration.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.
5. Isolation, purification and assay of virus - Demonstration.
6. Preparation of Master and Replica Plates.
7. Perform Bacterial Conjugation.
8. Perform bacterial transformation.
9. Perform transduction with bacteriophage.
10. Isolation of total DNA from environmental sample.
11. Quantification of DNA using agarose gel electrophoresis.
12. Studying isolation and propagation of animal viruses by chick embryo technique.
13. Types of animal cell culture and cell lines.
14. Study of cytopathic effects of viruses using photographs.
15. Perform local lesion technique for assaying plant viruses.
16. Immunization schedule, stability of vaccines.

SUGGESTED READING

1. Dimmock, N.J., Easton, A.L., Leppard, K.N. (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter, J., and Saunders, V. (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint, S.J., Enquist, L.W., Krug, R.M., Racaniello, V.R., Skalka, A.M. (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy, J.A., Conrat, H.F., Owens, R.A. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner, E.K., Hewlett, M.J. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu, M.V. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos, L. (1999) Plant viruses-A text book of plant virology by Backhuys Publishers.
9. Versteeg, J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.
10. Watson, J.D., Baker, T.A., Bell, S.P., et al. (2008) Molecular Biology of the Gene, 6th edition, Benjamin Cummings.
11. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. 8th edition, Wiley-India.

Instruction Hours / week: L: 0 T: 0 P:3 Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 6 Hours

COURSE OBJECTIVE

- To make students understand the aspects of industrial, soil, environmental, agricultural microbiology.
- To understand the methods for Production of industrially important compounds from fungal source.
- This paper is designed to provide an exposure to the students about the potential of fungi as food and in field of biotechnology as source of different enzymes, secondary metabolites, vitamins, polysaccharides, polyhydric alcohols, pigments and lipids.
- Develop an understanding of various aspects of bioprocess technology.
- Evaluate nanotechnology and microbial production of therapeutic compounds
- The laboratory training in addition to theory is included so that the students will acquire the skills to qualify for a broad range of positions in research, industry, consultancy, education and public administration, or for further education in a doctoral program

COURSE OUTCOMES

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Impart knowledge on applications of microorganisms in various fields | Understand |
| CO2 | Provides skill development on microbial products. | Apply |
| CO3 | To study the immobilization techniques and fungal pigment production. | Understand |
| CO4 | Develop a xylanase and lipase production technology. | Apply |
| CO5 | Demonstration of algal single cell proteins. | Apply |
| CO6 | State of art knowledge about various methodological and analytic approaches that are used within the specialization. | Understand |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO2 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO3 | S | S | S | S | M | M | M | M | M | M | M | S |
| CO4 | M | M | M | M | S | M | M | M | M | M | M | S |
| CO5 | S | M | M | M | M | M | M | M | M | M | M | S |
| CO6 | S | M | M | M | M | M | M | M | M | M | M | S |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(36 Hours)

1. Study yeast cell immobilization in calcium alginate gels and storage stability.
2. Study enzyme immobilization by sodium alginate method and storage stability.
3. Study of cell viability and enzyme estimation
4. Pigment production from fungi (*Trichoderma/Aspergillus/Penicillium*).
5. Isolation of *xylanase* or *lipase* producing bacteria.
6. Production of Microbial Biomass in bioreactor.
7. Study of algal Single Cell Proteins.

SUGGESTED READINGS

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd edition, Cambridge University Press.
2. Swartz, J.R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current
3. Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications.
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press.
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.
8. Corinne Whitby, Torban Lund Skovhus (2018). Applied Microbiology and molecular biology in oil field systems, Springer.
9. Head, Steven R., Ordoukhanian, Phillip, Salomon, Daniel R (2018) Next Generation Sequencing Methods and Protocol. Springer
10. Izard, Jacques., Rivera, Maria. (2014) Metagenomics for Microbiology. Elsevier B.Sc. Microbiology

23MBU312B BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS PRACTICAL**(3H–1C)****Instruction Hours / week: L: 0 T: 0 P:3****Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3 Hours****COURSE OBJECTIVES**

- To learn the basic handling of microorganisms.
- To understand the various biological containments.
- To emphasize on IPR issues and need for knowledge in patents in biotechnology.
- To gain knowledge on steps of a patenting process and the role of biosafety committee.
- To emphasize the components and design of laboratory.
- Provide learning opportunities to critically evaluate research methodology and findings

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Able to understand safety aspects in biological laboratory. | Understand |
| CO2 | To create awareness on the Intellectual property rights and patenting of biotechnological processes. | Apply |
| CO3 | To equip students with a basic understanding of the underlying principles of quantitative and qualitative patenting methods. | Understand |
| CO4 | Provide students with in-depth training on the conduct and management of patent filing from inception | Analyze |
| CO5 | Enable students to acquire expertise in the use and application of the methods of data collection and analysis. | Analyze |
| CO6 | Enable students to be reflexive about their role and others' roles as researchers. | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO2 | S | S | S | S | M | S | M | M | S | S | S | S |
| CO3 | S | S | S | S | M | M | M | M | M | M | M | S |
| CO4 | M | M | M | M | S | M | M | M | M | M | M | S |
| CO5 | S | M | M | M | M | M | M | M | M | M | M | S |
| CO6 | S | M | M | M | M | M | M | M | M | M | M | S |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(36 Hours)

1. Study of component and design of a BSL-III laboratory
2. Perform Standard Microbiological practices
3. Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents.
4. Decontamination in Microbiological Laboratory
5. Risk management methodology.
6. Filing applications for approval from biosafety committee
7. Filing primary applications for patents
8. Study on step by step patenting process
9. Principles of biomedical ethics.

SUGGESTED READINGS

1. Bare Act, 2007. Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh KK (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson.

Instruction Hours / week: L: 2 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To state the basic concepts of cybercrimes and classification.
- To provide an exposure to the spectrum of cyber offenses and attacks.
- To understand the social media overview and security.
- To gain knowledge about E-commerce and digital payments.
- To understand key terms and concepts in digital device security.
- To provide the learner will be able to examine tools and technologies for cybersecurity.

COURSE OUTCOMES (COS)

1. Students would be able to understand the concept of Cyber security and issues and challenges associated with it.
2. Students, at the end of this module, should be able to understand the cybercrimes, their nature, legal remedies and as to how report the crimes through available platforms and procedures.
3. Students should be able to appreciate various privacy and security concerns on online Social media and understand the reporting procedure of inappropriate content, underlying legal aspects and best practices for the use of Social media platforms.
4. Students would be able to understand the basic concepts related to E-Commerce and digital payments. They will become familiar with various digital payment modes and related cyber security aspects.
5. Students, after completion of this module will be able to understand the basic security aspects related to Computer and Mobiles. They will be able to use basic tools and technologies to protect their devices.

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | L | L | L | L | L | L | L | L | L | L | L | L |
| CO2 | L | L | L | L | L | L | L | L | L | L | L | L |
| CO3 | L | L | L | L | L | L | L | L | L | L | L | L |
| CO4 | L | L | L | L | L | L | L | L | L | L | L | L |
| CO5 | L | L | L | L | L | L | L | L | L | L | L | L |
| CO6 | L | L | L | L | L | L | L | L | L | L | L | L |

S-Strong; M-Medium; L-Low

Unit I - INTRODUCTION TO CYBERCRIME

(4 Hours)

Definition and Information Security-who are cybercriminals? - Classification of cybercrimes. Cybercrime:The legal perspectives- cybercrimes: An Indian Perspective - cybercrime and the Indian ITA2000: Hacking and the Indian law(s) - A Global Perspective on cybercrimes: cybercrime and the Extended Enterprise - cybercrime Era: Survival Mantra for the Netizens - Concluding Remarks and Way Forward to Further Chapters.

Unit II - CYBER OFFENSES

(4 Hours)

How Criminals Plan Them: Introduction: categories of Cybercrime -How criminals Plan the Attacks: Reconnaissance Passive Attacks Active Attacks Scanning and Scrutinizing Gathered Information Attack(Gaining and Maintaining the system Access) -social Engineering: Classification of Social Engineering – Cyber talking: Types of stalkers Cases Reported on Cyber stalking How stalking Works? real-life incident of Cyber stalking - Botnets: The Fuel for cybercrime: Botnet - Attack Vector-Cloud Computing: Why cloud computing? Types of Services Cybercrime and Cloud Computing.

Unit III – SOCIAL MEDIA OVERVIEW AND SECURITY

(4 Hours)

Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies

Unit IV - E - C O M M E R C E AND DIGITAL PAYMENTS

(5 Hours)

Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorized banking transactions. Relevant provisions of Payment Settlement Act, 2007

Unit V - DIGITAL DEVICES S E C U R I T Y, TOOLS AND TECHNOLOGIES FOR CYBER SECURITY

(7 Hours)

End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Anti-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.

Text Book

1. Nina Godbole & SUNIT Belapure. (2013). CYBER SECURITY. Wiley India Pvt. Ltd. New Delhi
2. Godbole, N. (2009). Information Systems Security: Metrics Frameworks and Best Practices. Wiley India. New Delhi

SUGGESTED READINGS

1. Cyber Crime Impact in the New Millennium, by R. C Mishra, Author Press. Edition 2010.
2. Cyber Security Understanding Cyber Crimes, Computer F o r e n s i c s and L e g a l Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011)

3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, CreateSpace Independent Publishing Platform. (Pearson , 13th November, 2001)
1. Electronic Commerce by Elias M. Awad, Prentice Hall of India Pvt Ltd.
2. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, Dominant Publishers.
3. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt. Ltd.

WEBSITES

1. www.Cybercrime.gov.in
2. <https://gac.gov.in/>
3. <https://www.india.gov.in/password-policy-ministry-electronics-and-information-technology?page=3>
4. <https://mahe.gov.in/mobile-app-policy/>
5. <https://www.dsci.in/>

JOURNALS

1. Noura Al-Suwaidi , Haitham Nobanee , & Fauzia Jabeen, **Estimating Causes of Cyber Crime: Evidence from Panel Data FGLS Estimator**, International Journal of Cyber Criminology Vol 12 Issue 2 July – December 2018.

INTERNSHIP

(2C)

Instruction Hours / week: L: 0 T: 0 P:0

23LSU401

தமிழ் தாள் 4

Semester -IV

(4H-4C)

Instruction Hours / week: L: 4 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

களம், அறிவியல், வணிகவியல் மற்றும் நுட்ப நுட்பம்
 எம்ப்ரியல் புமபமாழிகை Fளற – தமிழ் ப்பிரிவு
 தாண் 4,

4 - H, 4 - C

(2024 – 2025 Even Semester)

பாடத்திட்ட பயன் விளைவு

1. வரண்ஹற்றிற் கு முற் பட்ட தமிழகத்லத ளுக்கு அறிமுகப்படுத்Fதண்
 மாணவாக

2. பழந்தமிழா் ஂத வாழ்க்கலக ள் அறிய
 பண் பாடு சாரந ம஁லறலய
 ஊக்குவித்தை மாணவாக

3. தமிழ்மமாழியின் பலழலமயும், திராவிட மமாழிகளின்ஂதமிழ்மமாழியின்
 தனி றபல்பயும் ளுக்கு அறிமுகப்படுத்Fதை.
 சசி மாணவரக

4. ளின் வாழ்வியண், தமிழர் கலகைள், ஆற்றங்கலரப் பண்
 தமிழரக் பாடுகள் குறித்F ள் அறியச் மசய்தை.
 மாணவ
 ரக

5. இந்நியக் குடியுரிமப் பணி முதண்஁ன மபாட்டித் மதா஁களின்
 விர஁ப்பப் பாடமாக இடம் மபறுகின் ற தமிழ் நாகரிகமும் பண்
 பாடும் குறித்த முழுலமயான அறிமுகம் மபற்றிருத்தை.

பாடத்திட்டப் பபாF ந஁கக்கம்

1. இந்நியக் குடியுரிமப்பணி முதண்஁ன மபாட்டித் மதர஁களின்,
 விர஁ப்பப்பாடமாக இடம் மபறுகின் ற, 'தமிழ் ஁஁க்கியவரை஁' குறித்த
 முழுலமயான அறிமுகம் மபற்றிருத்தை.

2. கண்மவட்டியண், ஁ல஁ச்சுவட்டியியண் மற்றும் மதாண்
 லியண் சாரந்த ஆவணத்
 மதலுக்குரிய ஆய்வு மனப்பான் லமயுடன், ஁஁க்கியங்கலள அணுகுதை.

3. தமிழின் வளரச்சித்Fலறயாகிய,
 'அறிவியண்தமிழ்'; '஁லணயதமிழ்' குறித்த

பண் மநாகக் அண்஁கும஁லறயிண்஁ன ஆய்வுசசிநதலன் மமம்பாட஁.

4. மவலைவாய்ப்புக்குரிய சுயதிறன் மமம்பாட்டுடன், பலடப்பாக்கத்திறன்
 மமம்பாடும் மபற்றிருத்தை.

5. சமுதாய மற்றும் வாழ்வியல் மதிப்புகளில் மபணுவதற்குக் கருவியாக
இணைக்கியுள்ள நாகரிகத்தின் மனப்பான்மை வளரச்சி. மமாழிமயபபுத்
ஈலறசாரந்த மவலவைவாய்புத்திறன் மபறறிர்ுத்த ணை

தாண்ைக் வரிளசயும் நதர்வுச் பசயை திட்டமும்

பகுதி-I தமிழ்

இளநிலை அறிவியலைப் பட்ட வகுப்புகளுக்கெரியுபரவம் தாள்
கற்பிக்கும் மநரம்/வாரம்

மதரணுமணிகள் மதிபம்பண்

அக/எழுத்

மமாத்தம் மதிப்பீடு

நான் கு 4 4 3 40 / 60 100 4

களை, அறிவியலை, வணிகவியலை மற் றும் நமைண் ளமயியலை
புமை

பமாழிகை F ளற - தமிழ்ப் பிரிவு தமிழர்)ாகரிகமும் பண்

பாடும் - தாண் 4 (2024 - 2025 Even Semester)

அகு - I வரைாற்றுக்கு முற்பட்ட தமிழகமும் சங்ககாை வரைாறும் (8 Hours)

வரைாறும் நிைஅலமப்பும் - வரைாற்றின் மசைவாக்கு - பைமவறு காைங்களிை வரைாறு
உண் டாக்கிய ப் பிரிவுகள் - பலழய கற்காைம் - புதிய கற்காைம் -

நாட

இரும்புக்காைம்.

அகு - 2 தமிழின் பதான் ளம

(8 Hours)

தமிழ் மதான்றிய இடம் - குமரிக்கண் டத் தமிழ் நாடுகள் - தமிழ்
எண் Fம் மபயர வரைாறு - திராவிட மமாழிக்குடும் பம் - தமிழ் மமாழிச் சிறப்பு -
தமிழுக்குத் தமிழ் நாட்டவர் மசய்ய மவண் டியலவ - தமிழுக்கு மவளிநாட்டிற்
மசய்ய மவண் டியலவ.

அகு - 3 தமிழர் வாழ்வியை

(8 Hours)

ஐவலக நிைங்கள் - களவு வாழ்க்கை - கற்பு வாழ்க்கை - அரசர் கடலம் - கைவிநிலை
- மதாழிண் நிலை - ஆடவர் நிலை - மபண் டிர்நிலை.

அகு - 4 கட்டடக்களையும் தமிழர் பண் பாடும்

(8 Hours)

கட்டடக்கலை மதாற்றுவாய் - முதற்கலை - கட்டடக்கலையின் பலழலம் - புதிய
கற்காைம் - சங்ககாைம் - மகாயிண்கள் - அரண் மலனகள் -
மகாட்லடகள் - வீடுகள் -

நீ ப்ாசனக் கட்டடக்கலை - தமிழர் கட்டடக்

றப்பு.

ரப கலையின் தனிச்சி

அகு - 5 ஆற்றங் களர)ாகரிகம்

(8 Hours)

ஆறும் நாகரிகமும் - ஆறுகளின் மதாற்றமும் நீ ளமும் - காவிரிக்கலர நாகரிகம் -

இைக்கியச் சிறப்பு - கலைச்சிறப்ப

லவலகக்கலர நாகரிகம் - இைக்கியச் சிறப்ப

கலைச்சிறப்ப , மநாய்யண்கலர நாகரிகம்.

பார்ளவ நூை்ைக்

1. முலனவர் அரங்க இராமலிங்கம் (பதிப்பாசிரியர்), தமிழர் நாகரிகமும் தமிழ் மமாலிவரையும் (மதாசுதி -1, 6, 2, 5, 10), வாத்தமானன் பதிப்பகம் , தியாகராயநகர்,

மசன் லன்-17.

2. மக.மக.பிள் லள, தமிழக வரண்ாறு மக்ஞா ம் பண் பாடும், உைகத்தமிழ்

ஆராய்ச்சிநிறுவனம் தரமணி, மசன்லன-13.

3. நா.வானமாமலை, தமிழா்வரணும் பண் பாடும், நியுமசஞ்சுரி
புகஹவுஸ் ,
மசன்லன -98.

இளனயதைம்

1. www.tvu.org.in
2. www.maduraitamilproject.com

இதழ்கை

1. International Research Journal of Indian Literature, irjil.in
2. International Tamil Research Journal, iorpress.in

23ENU401

English IV

(3H–3C)

Instruction Hours / week: L: 3 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To provide the students with an ability to build and enrich their communication skills.
- To help them think and write imaginatively and critically.
- To improve the communicative ability.
- To strengthen their professional skills.
- To expose the students to various spoken skills.

COURSE OUTCOMES

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Make the students proficient communicators in English. | Apply |
| CO2 | Develop learners' ability to understand English in a wide range of contexts. | Understand |
| CO3 | Understand the nuances of listening, speaking and reading English. | Understand |
| CO4 | Prepare the learners to face situations with confidence and to seek employment in the modern globalized world. | Apply |
| CO5 | Build the students' ability to listen and to speak English better. | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO2 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO3 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO4 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO5 | L | L | L | L | S | L | L | L | L | L | L | L |
| CO6 | L | L | L | L | S | L | L | L | L | L | L | L |

S-Strong; M-Medium; L-Low

UNIT-I (6 Hours)

Concept of Communication- Barriers to Communication- Body Language-Personality Development-Etiquette and Manners-Soft Skills

UNIT- II (6 Hours)

Listening Comprehension-Reading Comprehension-Paragraph Writing-Precis Writing-Collocation

UNIT-III (6 Hours)

Writing-Writing Resume and Covering Letter- Types of Letter Writing-Writing MoU-DictoComposition--Term Paper-Book Reviews

UNIT- IV (6 Hours)

Speaking-Interview Skills-Preparing Welcome address and Vote of Thanks-Compering -

UNIT-V (6 Hours)

Punctuation Marks- Figures of Speech

Books for References:

1. Oxford Handbook of Writing: St. Martins Handbook of Writing 2013 Cambridge University Press
2. Wren & Martin, 2008, *High School English Grammar & Composition*, S.Chand & Company Ltd, Board of Editors,
3. Krashen, Stephen D (1982) *Principles and practice in second language acquisition*. New York: Pergamon Press.

23MBU401

IMMUNOLOGY

Semester –IV
(5H–5C)

Instruction Hours / week: L: 5 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To strengthen the knowledge of students in immunodiagnostics.
- To learn the latest trends in immunology.
- To analyze rapid diagnosis and Immune reaction.
- To provide overview of immune system, antigen antibody structure and interactions.
- To develop understanding of innate and adaptive immunity along with major cells and molecules involved.
- To integrate immunology with health and enrich the knowledge for autoimmune disorders, hypersensitivity reaction

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Introducing the employment aspect of immunology and to study various types of immune systems, their classification, structure and mechanism of immune activation. | Understand |
| CO2 | Upon completion, students will gain knowledge of immune system, cells involved along with complement system and autoimmunity | Apply |
| CO3 | Develop understanding about immune system, antigen antibody interactions. | Understand |
| CO4 | Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components. | Analyze |
| CO5 | Students can able to perform basic immunological assays. | Understand |
| CO6 | It will distinguish fundamental knowledge on immunology and its advancement | Remember |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | S | S | S | S | S | S | S | M | S | M | S | M |
| CO2 | S | M | S | S | M | S | M | S | M | S | M | S |
| CO3 | S | M | S | S | M | S | M | S | M | S | M | S |
| CO4 | S | M | S | S | M | S | M | S | M | S | M | S |
| CO5 | S | M | S | S | M | S | M | S | M | S | M | S |
| CO6 | S | S | S | S | S | M | S | M | S | M | S | M |

S-Strong; M-Medium; L-Low

UNIT I

(12 Hours)

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology – Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa. Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

Unit II

(12 Hours)

Antigens – Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants. Antigenicity, Immunogenicity and Factors influencing Immunogenicity. Antibodies – Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); Monoclonal and Chimeric antibodies.

Unit III

(10 Hours)

MHC – Organization of MHC locus; Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways). Complement system – Components of the Complement system; Activation pathways (Classical, Alternative); Biological consequences of complement Activation

Unit IV

(14 Hours)

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance. Types of Autoimmunity and Hypersensitivity with examples; Immuno deficiencies – Animal models (Nude and SCID mice), DiGeorge syndrome, Chediak-Higashi syndrome. Transplantation immunology, Graft versus host reaction, Graft rejection.

Unit V

(12 Hours)

Types of tumors, tumor Antigens, causes and therapy for cancers. Types of vaccine and their vaccination schedule in Practice. Principles of precipitation, agglutination, complement fixation, Immunodiffusion, Immuno-electrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy. Immunological biosensors.

SUGGESTED READINGS

1. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition. W.H. Freeman and Company, New York.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
4. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition, Saunders Publication, Philadelphia.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinburgh.

23MBU402

MEDICAL MICROBIOLOGY

Semester –IV
(5H–4C)

Instruction Hours / week: L: 4 T: 1 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- The aim of Medical Microbiology course is to introduce basic principles and applications of various clinical diseases and their epidemiology.
- Students can be able to characterize, isolate and identify different microbes under a wide range of host-pathogen interaction.
- It includes a detailed study of etiology, clinical systems and laboratory diagnosis of disease-causing Microorganisms.
- The content of the course will be including many etiological agents responsible for global infectious diseases.
- To provide the clear knowledge about the pathogen identification from the patient.
- The course creates the conceptual basis for understanding pathogenic microorganisms and particularly addresses the fundamental mechanisms of their pathogenicity.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | It will provide opportunities for a student to develop diagnostic skills in microbiology, including the practical application and interpretation of laboratory tests for the diagnosis of infectious diseases. | Understand |
| CO2 | It will develop the student's knowledge on medically important microorganism's morphology with the main focuses being the characterization based on physiological factors. | Apply |
| CO3 | It will give improved knowledge on current antimicrobial chemotherapy, antibiotics towards target sites, drug resistance mechanisms and spectrum evaluation methods in the clinical settings. | Understand |
| CO4 | Student can be able to safeguard the society. | Analyze |
| CO5 | Able to work for advanced clinical diagnostics practices. | Understand |
| CO6 | It will render the prophylaxis measures and strategies of deadly microorganisms upon the completion of this study. | Remember |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | S | S | M | S | M | S | M |
| CO2 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO3 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO4 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO5 | M | M | S | S | M | S | M | S | M | S | M | S |
| CO6 | S | S | S | S | S | M | S | M | S | M | S | M |

S-Strong; M-Medium; L-Low

Unit I: Introduction to Medical Microbiology

(9 Hours)

Normal micro flora of the human body: skin, throat, gastrointestinal tract, urogenital tract. Definitions – Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity. Transmission of infection, Carriers and their types, Opportunistic infections, Nosocomial infections. Collection, transport and processing of clinical samples – Blood, Sputum, Stool, Urine and CSF.

Unit II: Medical Bacteriology

(9 Hours)

List of diseases of various organ systems and their causative agents. Respiratory pathogens: *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*. Gastrointestinal pathogen *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori*. Others: *Staphylococcus aureus*, *Bacillus anthracis*, *Clostridium tetani*, *Treponema pallidum* *Klebsiella pneumonia*

Unit III Virology

(9 Hours)

Study of following diseases – Causative agents, Mode of transmissions, Pathogenicity, Symptoms and prophylaxis of Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of Adeno virus, swine flu, Ebola, Chikungunya, Japanese Encephalitis, Coronavirus (COVID-19) and omicron virus.

Unit IV: Medical Mycology and Parasitology

(10 Hours)

Study of mycoses- transmission, symptoms and prevention. Cutaneous mycoses: *Tinea pedis* (Athlete's foot). Systemic mycoses: *Histoplasmosis*. Opportunistic mycoses: *Candidiasis*. The detailed study of following diseases– Causative agents, Mode of transmissions, Pathogenicity, Symptoms and prophylaxis of *Amoebiasis*, *Giardiasis*, *Elephantiasis*, *Taeniasis*, *Malaria*, *Kala-azar*.

Unit V: Antimicrobial agents

(10 Hours)

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Antibiotic resistance - MDR, XDR, MRSA, NDM-1 and PDR resistance mechanisms. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Molecular Diagnosis of infectious diseases. Artificial Intelligence.

SUGGESTED READINGS

1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 27th edition. McGraw Hill Publication.
2. Greenwood D, Slack R, Barer M, and Irving W. (2018). Medical Microbiology, 19th Edition. Churchill Livingstone.
3. Ananthanarayan R. and Paniker C.K.J. (2022) Textbook of Microbiology. 12th edition, University Press Publication.
4. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
5. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

Semester –IV
23MBU403A

MOLECULAR BIOLOGY

(3H–3C)

Instruction Hours / week: L: 3 T: 0 P:0

Marks: Internal: 40 External: 60

Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To provide an experience for the students in an interdisciplinary research program connecting animalgenomics with animal reproduction and biotechnology.
- To impart information on the historical developments in Molecular Biology
- An in-depth study on structure and organization of chromosome and mutagenesis.
- To expose the students on the basic understanding of various techniques used in molecular studies.
- To gather information to know mechanism of DNA replication.
- To gain the knowledge of translational machinery in prokaryotes and eukaryotes

COURSE OUTCOME (CO'S)

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Explores technologies using molecular biology and cell biology | Apply |
| CO2 | Understand the genetic make up and Manipulate the genomes of animals for ways to improve the livestock for food production and biomedical purpose | Understand |
| CO3 | Develop the skills in molecular biology. | Apply |
| CO4 | Executing concept of RNA splicing and mRNA and its significance. | Apply |
| CO5 | Students able to be inferring various model of DNA replication | Apply |
| CO6 | Students able to contrast translational machinery | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | S | S | M | S | M | S | M |
| CO2 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO3 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO4 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO5 | M | M | S | S | M | S | M | S | M | S | M | S |
| CO6 | S | S | S | S | S | M | S | M | S | M | S | M |

S-Strong; M-Medium; L-Low

Unit I DNA Structure**(6 Hours)**

DNA Structure: Miescher to Watson and Crick - historical perspective, DNA Structure, Salient features of double helix, Chargaff's rule, Types of DNA, Conformations of nucleic acids, Stability of nucleic acid structure, Types of genetic material, Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure, Organelle DNA—mitochondria and chloroplast DNA.

Unit II DNA Replication**(6 Hours)**

DNA replication, prokaryotic and Eukaryotic replication, Mechanism of DNA replication: Enzymes and proteins involved in DNA replication—DNA polymerases, DNA ligase, primase, telomerase— for replication of linear ends. DNA topology –linking number, proof reading mechanism.

Unit III DNA Transcription**(6 Hours)**

Transcription and transcriptional control in prokaryotes and eukaryotes, initiation, elongation, termination, promoter sequences, TATA box, Hogness Box, CAAT box, Enhancers, upstream activating sequences, Post-transcriptional modification, splicing, spliceosomes, nuclear transport of mRNA.

Unit IV DNA Translation**(6 Hours)**

Translational machinery, charging of tRNA, amino acyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptide s in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote and post translational modifications. Regulation of gene expression in prokaryotes lacoperon and trp operon.

Unit V Molecular Biology Techniques**(6 Hours)**

Extraction of DNA, Extraction of RNA, Isolation of plasmid, DNA purification and estimation, PCR, Gelelectrophoresis, Blotting techniques, SDS-PAGE. Expression Cloning, DNA microarray.

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009). The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.
2. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons Inc.
4. Sambrook J and Russell DW (2001). Molecular Cloning: A Laboratory Manual 4th Edition, Cold Spring Harbour Laboratory press.
5. Krebs J, Goldstein E, Kilpatrick KS (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
6. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.

Semester –IV23MBU403B
ANIMAL TISSUE CULTURE

PLANT TISSUE AND
(3H–3C)

Instruction Hours / week: L: 3 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To provides detailed idea about laboratory organization in plants, basic techniques in tissue culture, genetic transformations in plants, plant genetic engineering and industrialproducts.
- To learn the basic tools in recombinant technology
- To understand the various concepts of cloning vectors and cloning strategies
- To emphasize the knowledge in biotechnology and techniques.
- To familiarize the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.
- A sound knowledge on procedural repertoire allows students to innovatively apply these in basic andapplied fields of biological research.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Provides detailed idea about laboratory organization for conservation of plants in laboratory condition through tissue culture techniques. | Understand |
| CO2 | To provide idea about genetic transformations in plants, plant genetic engineering and plant based industrial products production. | Apply |
| CO3 | Provide fundamental knowledge for the development of genetically modified crop including expression of genes related to water deficit tolerance, pest resistance, insect resistance and coldresistance. | Understand |
| CO4 | Explain the general principles of generating transgenic plants, animals and microbes. | Analyze |
| CO5 | Technical know-how on versatile techniques in recombinant DNA technology. | Understand |
| CO6 | An understanding on application of genetic engineering techniques in basic and applied experimental biology | Remember |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | S | S | M | S | M | S | M |
| CO2 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO3 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO4 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO5 | M | M | S | S | M | S | M | S | M | S | M | S |
| CO6 | S | S | S | S | S | M | S | M | S | M | S | M |

S-Strong; M-Medium; L-Low

UNIT-I

(6 Hours)

Principles of Plant Breeding: Important conventional methods of breeding – self, cross pollinated and vegetatively propagated crops. Non-conventional methods. Polyploidy, Genetic variability. Genome organization in plants – mitochondria and chloroplast. Cytoplasmic malesterility.

UNIT-II

(6 Hours)

Tissue culture media – composition and preparation, Callus and suspension culture, somaclonal variation, micropropagation, organogenesis, somatic embryogenesis, Embryo culture and embryo rescue. Haploidy; protoplast fusion and somatic hybridization; cybrids; anther, pollen and ovary culture for production of haploid plants and homozygous lines. Plant hardening transfer to soil, green house technology.

UNIT-III

(6 Hours)

Chloroplast, Mitochondria, and Nucleus Strategies in bioconversion. Production of pharmaceutical compounds. Mass cultivation of plant cells. Secondary metabolite Production from Suspension Culture, Bioreactors – Photo bioreactor. Production of secondary metabolite in plants, stages of secondary metabolite production, uses of tissue culture techniques in secondary metabolites.

UNIT-IV

(6 Hours)

Methodology; Plant transformation with Ti plasmid of *Agrobacterium tumefaciens*; Ti plasmid derived vector systems, Ri plasmids; Physical methods of transferring genes to plants – Microprojectile bombardment, Electroporation; Manipulation of gene expression in plants; Production of marker free transgenic plants.

UNIT-V

(6 Hours)

Productivity and performance: herbicide resistance, insect resistance, virus resistance, fungal resistance, nematode resistance, Induction of abiotic stress and cold stress. Delay in fruit ripening, LEA protein, plantibodies, edible vaccines - primary and secondary metabolite modification, biopolymers, plant-based enzyme engineering.

SUGGESTED READINGS

1. Slater, A., Scott, N.W., & Fowler, M. R. (2008). Plant Biotechnology. Oxford: Oxford University Press.
2. Ignacimuthu, S. (2004). Plant Biotechnology. New Delhi: Oxford and IBH Publishing House.
3. Chawla, H.S. (2002). Introduction to Plant Biotechnology. New Delhi: Oxford and IBHP Publishing Co. Pvt. Ltd.
4. Kumar, U. (2008). Plant Biotechnology and biodiversity conservation. Jodhpur: Agrobios.
5. Stewart, N.C. (2008). Plant Biotechnology and Genetics. New Jersey: John Wiley & Sons, Inc.
6. Halford, N., & Halford, N. G. (2006). Plant Biotechnology: Current and Future Applications of Genetically Modified Crops. New Jersey: John Wiley & Sons.

Instruction Hours / week: L: 0 T: 0 P:4

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 6 Hour

COURSE OBJECTIVES

- To introduce the knowledge of the medically important microorganisms, microbial morphology with the main focuses being the characterization, isolation and identification of different microorganism.
- The aim of Medical Microbiology course is to introduce basic principles and application relevance of clinical disease for students who are in preparation for physicians.
- The content of rigorous course includes many etiological agents responsible for global infectious diseases.
- To strengthen the knowledge of students in immunodiagnostics on skill basis.
- To integrate immunology with health and enrich the knowledge for autoimmune disorders, hypersensitivity reaction.
- It will develop the basic skills on handling clinical pathogens.

COURSE OUTCOME

At the end of this course, students will be able to

| Cos | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | It will also provide opportunities for a student to develop diagnostic skills in microbiology, including the practical application and interpretation of laboratory tests for the diagnosis of infectious diseases. | Understand |
| CO2 | Comprehend the various methods for identification of unknown microorganisms. | Apply |
| CO3 | Develop understanding about immune system, antigen antibody interactions. | Understand |
| CO4 | Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components. | Analyze |
| CO5 | After course completion, students can apply the knowledge in further studies and higher education. | Understand |
| CO6 | Knows the concepts of advanced immunological assays | Remember |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | S | S | M | S | M | S | M |
| CO2 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO3 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO4 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO5 | M | M | S | S | M | S | M | S | M | S | M | S |
| CO6 | S | S | S | S | S | M | S | M | S | M | S | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(40 Hours)

1. Identification of human blood groups - ABO Blood grouping, Rh Typing.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum and plasma from the blood sample.
5. WIDAL test, RPR and CRP.
6. Perform immunodiffusion by Ouchterlony method.
7. Perform DOT-ELISA.
8. Perform immune electrophoresis.

SUGGESTED READINGS

1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A and Mietzner, T.A (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
2. Greenwood D, Slack R, Barer M and Irving W. (2012). Medical Microbiology, 18th Edition. Churchill Livingstone.
3. Ryan KJ and Ray CG. (2014). Sherris Medical Microbiology, 6th Edition. McGraw-Hill Professional.
4. Ananthanarayan R. and Paniker C.K.J (2009) Textbook of Microbiology 8th edition, University Press Publication.
5. Peakman M and Vergani D (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinburgh.
6. Richard C and Geffrey S. (2009). Immunology 6th edition. Wiley Blackwell Publication.

Instruction Hours / week: L: 0 T: 0 P:4**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 9 Hours****COURSE OBJECTIVES**

- To introduce the knowledge of the medically important microorganisms, microbial morphology with the main focuses being the characterization, isolation and identification of different microorganism.
- The aim of Medical Microbiology course is to introduce basic principles and application relevance of clinical disease for students who are in preparation for physicians.
- The content of rigorous course includes many etiological agents responsible for global infectious diseases.
- It covers all biology of bacteria, viruses and other pathogens related with infectious diseases in humans.
- The course will provide the conceptual basis for understanding pathogenic microorganisms and particularly address the fundamental mechanisms of their pathogenicity.
- It will develop the basic skills on handling clinical pathogens

COURSE OUTCOME**At the end of this course, students will be able to**

| Cos | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | It provides the entrepreneurial ability to characterize, isolate and identify different microbes. | Understand |
| CO2 | It includes a detailed study of characterization, etiology, pathogenicity, clinical systems, and laboratory diagnosis of disease-causing Microorganisms. | Apply |
| CO3 | It will also provide opportunities for a student to develop diagnostic skills in microbiology, including the practical application and interpretation of laboratory tests for the diagnosis of infectious diseases. | Understand |
| CO4 | Comprehend the various methods for identification of unknown microorganisms. | Analyze |
| CO5 | Recall the relationship of this infection to symptoms, relapse and the accompanying pathology. | Understand |
| CO6 | Explain the methods of microorganisms control, e.g. chemotherapy & vaccines. Solve problems in the context of this understanding. • Demonstrate practical skills in fundamental microbiological techniques | Remember |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | S | S | M | S | M | S | M |
| CO2 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO3 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO4 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO5 | M | M | S | S | M | S | M | S | M | S | M | S |
| CO6 | S | S | S | S | S | M | S | M | S | M | S | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(40 Hours)

1. Identify bacteria (any three of *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, MacConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS, Salmonella Shigella/BSA Agar.
3. Study of bacterial flora of skin by swab method.
4. Antibacterial sensitivity assay by Kirby - Bauer method.
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms).
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

SUGGESTED READINGS

1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
2. Greenwood D, Slack R, Barer M, and Irving W. (2012). Medical Microbiology, 18th Edition. Churchill Livingstone.
3. Ryan KJ and Ray CG. (2014). Sherris Medical Microbiology, 6th Edition. McGraw-Hill Professional.
4. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
6. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education

Instruction Hours / week: L: 5 T: 0 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours**

- To encompasses the employability skill by the use of microorganisms in the production of food or industrial products.
- The aim of the course is to give the students broad theoretical and practical skills in industrial microbiology.
- This course covers the principles of various processes associated with the production and recovery of different bio-products derived from microorganisms.
- The students will be able to discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites.
- It will make the students to explore their practical skills in entrepreneurial development.
- It will deliver the large scale production of microbial products techniques in advanced level.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Provides knowledge in the large scale production of industrial product, providing the trends to cater the needs of industry. | Understand |
| CO2 | This will help the students to enhance their employment knowledge on microbiology based commercial products. | Apply |
| CO3 | The aim of the course is to give the students broad theoretical and practical skills in industrial microbiology. | Understand |
| CO4 | This course covers the principles of various processes associated with the production | Analyze |
| CO5 | Students are able recover the different bio-products from microorganisms. | Understand |
| CO6 | The students will be able to discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites. | Remember |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | S | S | M | S | M | S | M |
| CO2 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO3 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO4 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO5 | M | M | S | S | M | S | M | S | M | S | M | S |
| CO6 | S | S | S | S | S | M | S | M | S | M | S | M |

S-Strong; M-Medium; L-Low

Unit I: Screening of Industrial Important Microbes**(12 Hours)**

Exploitation of microbes and their products. Sources of industrially important microbes and methods for their isolation, primary and secondary screening methods. Strain improvement method (protoplast fusion, mutation and recombinant DNA technology). Preservation and maintenance of industrial strains. Cell growth kinetics- Kinetics of Substrate utilization.

Unit II: Upstream Process**(12 Hours)**

Media formulation. Types of fermentation processes – Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch and continuous fermentations. Design of laboratory bioreactor. Types of bioreactors – Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters.

Unit III: Downstream Process**(12 Hours)**

Downstream processing-techniques and methods: Stages in downstream processing. Separation of cells– filtration and centrifugation. Cell disruption– physical, chemical and enzymatic methods. Product separation- solvent extraction and precipitation. Lyophilization and spraydrying, freeze drying and vacuum drying. Immobilization, Methods of immobilization, advantages and applications of immobilization.

Unit IV: Instrumentation**(10 Hours)**

Principle, Instrumentation and application of spectrophotometer, colorimeter and turbidometer. MALDI-TOF, FTIR, MS, Nuclear Magnetic Resonance, ESR. Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column Chromatography - packing types (IEC, AC, SEC), fraction collection. Nano LC, CGMS, LCMS, HPLC and Gel filtration chromatography.

Unit V: Microbial production of industrial products**(14 Hours)**

Citric acid, Ethanol, Penicillin, Bacitracin, Chlormphenicol, monoclonal antibodies, Glutamic acid, Vitamin B12, Enzymes (DHA, amylase, protease, lipase, chitinase) Wine, Beer, probiotics (*Lacto bacillus*, *Bacillus* and yeast) Development of designer microbes for food, energy and health care products.

SUGGESTED READINGS

1. NdukaOkafor, Benedict C. Okeke (2017) Modern Industrial Microbiology and Biotechnology, 2nd Edition, CRC Press.
2. Stanbury PF, Whitaker A and Hall SJ. (2016). Principles of Fermentation Technology. 3rd edition, Elsevier Science Ltd.
3. Crueger W and Crueger A. (2017). Biotechnology: A textbook of Industrial Microbiology. 3rd edition. Panima Publishing Co. New Delhi.
4. Geoffrey M Gadd, Sima Sariaslani (2015) Advances in Applied Microbiology, CRC Press.
5. Mansi El-Mansi (2012) Fermentation Microbiology and Biotechnology, CRC Press.
6. E M T El-Mansi, Jens Nielsen, David Mousdale (2019). Fermentation Microbiology and Biotechnology, Fourth Edition, CRC Press
7. NdukaOkafor, Benedict C. Okeke (2022). Modern Industrial Microbiology and Biotechnology 2nd Edition. CRC Press.
8. David B. Wilson, Hermann Sahm, Klaus-Peter Stahmann, Mattheos Koffas (2019). Industrial Microbiology 1st Edition. Wiley-VCH.
9. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press

Instruction Hours / week: L: 5 T: 0 P:0 Marks: Internal: 40 External: 60 Total:100**End Semester Exam: 3Hours****COURSE OBJECTIVES**

- To develop an attitude of concern for the environment.
- To know the social issues of the environment.
- To understand the core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
- To know about the various renewable and nonrenewable resources of the region.
- The students will develop set of skills to recognize the ecological problems and critical evaluation of the human impacts on pollution, climate changes and as well as environmental protection.
- Familiarize students with general principles and subject knowledge in the field of environment microbiology.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|------------|--|---------------------|
| CO1 | Make appropriate judgments and decisions for the protection and improvement of the earth. | Understand |
| CO2 | Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems. | Apply |
| CO3 | Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes. | Understand |
| CO4 | Students will get the basic knowledge how to prepare and perform sampling and microbial analyses to determine the abundance, growth rate and microbial community composition together with the basic environmental parameters. | Analyze |
| CO5 | Clarify application of microorganisms in varied fields of environmental microbiology like bioremediation, biofertilizers and waste water treatment. | Understand |
| CO6 | Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability. | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|
| CO1 | M | S | M | M | S | S | S | M | S | M | S | M |
| CO2 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO3 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO4 | M | M | M | M | M | S | M | S | M | S | M | S |
| CO5 | M | M | S | S | M | S | M | S | M | S | M | S |
| CO6 | S | S | S | S | S | M | S | M | S | M | S | M |

S-Strong; M-Medium; L-Low

Unit I: Microbes in Environment**(12 Hours)**

Terrestrial Environment- soil profile and soil microflora. Biogenesis and Abiogenesis in environment
Aquatic Environment- Microflora of fresh water and marine habitat. Atmosphere- Aeromicrobes and dispersal of microbes. Development of microbial communities. Environmental monitoring through microorganisms, monitoring of water and soil.

Unit II: Microbial role and diagnosis**(12 Hours)**

Physiological ecology of micro-organisms. C, N, P nutrient cycle, Treatment and safety of drinking (potable) water, membrane filter technique, Microbial interaction. Bio-films-surface colonization, Biofilm structure, Biofouling and Biotechnological applications. Xenobiotics. Artificial Intelligence in Environmental sustainability.

Unit III Waste Management**(12 Hours)**

Solid waste management- sources and types, methods of disposal (composting sanitary landfill), Liquid Waste Management – Composition and strength of sewage (BOD and COD), Primary, Secondary (Oxidation ponds, trickling filter and activated sludge process) and tertiary sewage treatment.

Unit IV: Air Pollution**(10 Hours)**

Introduction, Microbial Contamination of Air, Sources of Contamination, Enumeration and Isolation of Bacteria in Air, Air samplers and sampling techniques, Effects and control measures of air pollution.

Unit V: Biogas and biodegradation technology**(14 Hours)**

Biogas Technology- Plant design, construction, operation. Biogas from organic wastes. GMO impact and their important - Use in environmental management recycling technology. Principles and biodegrading of common pesticides, organic (Hydrocarbons and Oil spills) and inorganic (Heavy Metal), Biosurfactants. Biotransformation, bio-conservation, bioremediation, microbial remediation.

SUGGESTED READING

1. Singh, M.P., Singh, B.S., and Dey, S.S., (2004). Conservation of Biodiversity and Natural Resources. Daya Publishing House, Delhi.
2. Uberoi, N.K., (2010). Environmental Studies, Excel Books Publications, New Delhi, India.
3. Tripathy, S.N., and Panda, S., (2011). Fundamentals of Environmental Studies; 3rd Edition, Vrianda Publications Private Ltd., New Delhi.
4. Kumar, A., (2004). A Textbook of Environmental Science; APH Publishing Corporation, New Delhi.
5. Verma, P.S., Agarwal, V.K., (2001). Environmental Biology (Principles of Ecology); S. Chand and Company Ltd., New Delhi.
6. Kaushik, A., Kaushik, C.P., (2006). Perspectives in Environmental Studies, New Age International Pvt. Ltd. Publications, New Delhi.
7. Maier RM, Pepper IL, Gerba CP (2019). Environmental microbiology, Elsevier
8. Environmental Biotechnology: Principles and Applications by Bruce E Rittmann and Perry L McCarty, McGraw-Hill International (2020) 2nd edition
9. Ljungdahl LG, Adams MW, Barton LL, Ferry JG, Johnson MK (2003). Biochemistry and Physiology of Anaerobic Bacteria, Springer.
8. Madigan MT, Martinko JM, Dunlap PV, Clark DP (2012).

Instruction Hours / week: L: 5 T: 0 P:0 Marks: Internal: 40 External: 60 Total:100**End Semester Exam: 3Hours****COURSE OBJECTIVES**

- To learn the basic tools in recombinant technology
- To understand the various concepts of cloning vectors and cloning strategies
- To emphasize the knowledge in biotechnology and techniques.
- To familiarize the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.
- A sound knowledge on procedural repertoire allows students to innovatively apply these in basic and applied fields of biological research.
- This course offers theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants

COURSE OUTCOME

- ☐ At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Imparts the entrepreneurial concepts of rDNA technology and their applications and Acquire knowledge on the applications of genetic engineering. | Understand |
| CO2 | Understand the difference between old biotechnology and modern biotechnology. | Apply |
| CO3 | Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic sciences. | Understand |
| CO4 | Explain the general principles of generating transgenic plants, animals and microbes. | Analyze |
| CO5 | Technical know-how on versatile techniques in recombinant DNA technology. | Understand |
| CO6 | An understanding on application of genetic engineering techniques in basic and applied experimental biology | Remember |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | M | S | M | S |
| CO2 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | M | S | S | M | M | M | S | S | M | M | M |
| CO6 | S | S | S | S | S | S | S | S | S | S | S | S |

S-Strong; M-Medium; L-Low

Unit I**(12 Hours)**

Milestones in genetic engineering and Biotechnology cloning Tools - Restriction modification systems - Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications – DNA polymerases, DNA ligases, Topoisomerase, gyrase, Terminal deoxynucleotidyl transferase, kinases and phosphatases.

Unit II**(12 Hours)**

Cloning Vectors: - Definition and Properties Plasmid vectors – pBR 322 and pUC Vector, Bacteriophage – lambda (λ) and M13 based vectors Cosmids, BACs, YACs. Use of linkers and adaptors. Expression vectors- *E. coli* lac and T7 promoter - based vectors, yeast – YIp, Yep and YCp vectors, Baculovirus based vectors, mammalian – SV- 40- based expression vectors

Unit III**(12 Hours)**

Transformation of DNA – Chemical method, Electroporation. Gene delivery – Micro injection, electroporation, biolistic method (gene gun), liposome and viral – mediated delivery, *Agrobacterium*-mediated delivery DNA, RNA and Protein analysis – Agarose gel electrophoresis, Blotting techniques - Southern, Northern, Western blotting, dot blot, SDS - PAGE.

Unit IV**(10 Hours)**

PCR – Basics of PCR, RT - PCR, Real - Time PCR (Quantitative), Multiplex PCR, Sybr Green PCR, Sanger's method of DNA Sequencing, traditional and automated sequencing. Primer walking and shotgun sequencing, Methylation sequencing and RNA sequencing. Microarrays – DNA and Protein microarray.

Unit V**(14 Hours)**

Construction of Genomic and cDNA libraries, screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping. Products of recombinant DNA technology – Products of human therapeutic interest - insulin, hGH. Bt transgenic-cotton, brinjal, recombinant vaccines, protein engineering and site directed mutagenesis. Gene therapy, Replacement and augmentation, gene correction, gene editing, gene silencing, siRNA, miRNA, Antisense RNA, CRISPR/Cas9.

SUGGESTED READINGS

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
3. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
4. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education.
5. Brown TA. (2007). Genomes-3. Garland Science Publishers
6. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Instruction Hours / week: L: 4 T: 1 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- To detail the importance of computer in field of life sciences.
- To obtain good understanding about the interpretation of biological data base.
- To uptake knowledge in latest tools and technology.
- Aimed to provide an overview of various bioinformatics tools, databases available and sequence analysis
- Provide knowledge on database concept, management, retrieval along with utilization in gene and protein analysis.
- To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Provides computational skill on search engines and various software tools involved in bioinformatics | Understand |
| CO2 | It will impart computational based techniques which includes genomics and proteomics in Bioinformatics. | Apply |
| CO3 | Retrieve information from available databases and use them for microbial identifications and drug designing | Understand |
| CO4 | Gain ability to modify gene and protein structures in simulated systems. | Analyze |
| CO5 | Introduction to the basics of sequence alignment and analysis. | Understand |
| CO6 | Describe about the different types of Biological databases | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | L | M | M | M | M | M |
| CO3 | M | M | M | M | M | M | L | M | M | M | L | M |
| CO4 | M | M | M | M | M | M | L | M | M | M | L | M |
| CO5 | M | M | S | S | M | M | M | M | M | S | S | M |
| CO6 | S | S | S | S | S | S | S | S | S | S | S | S |

S-Strong; M-Medium; L-Low

Unit I**(9 Hours)**

History of computers, Basics of Computer and operating systems, Data Representation, Data Abstraction, Concepts of flowcharting and algorithm development. Database, Database Management system, RDBMS - Definition of relational database. Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer.

Unit II**(9 Hours)**

Biological databases – nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB, SWISS- Prot, Specialized Databases. Gene prediction tools, ORF Prediction tool.

Unit III**(9 Hours)**

Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood. Introduction to Genomics, Proteomics, Transcriptomics, Systems biology and Infectomics.

Unit IV**(9 Hours)**

Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes Genome, transcriptome, proteome, 2-D gel electrophoresis, MaldiTof spectroscopy. Major features of completed genomes: E.coli, S.cerevisiae, Arabidopsis, Human. Genomic database SGD, TIGR.

Unit V**(12 Hours)**

Hierarchy of protein structure - primary, secondary and tertiary structures, modeling. Structural Classes, Motifs, Folds and Domains. Protein structure prediction in presence and absence of structure template Energy minimizations and evaluation by Ramachandran plot Protein structure and rational drug design. Recent software and tools.

SUGGESTED READINGS

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing.
2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications.
3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student Edition.
4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication.
5. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell

23MBU504B METAGENOMICS AND FORENSIC MICROBIOLOGYSemester –V
(5H–4C)**Instruction Hours / week: L: 4 T: 1 P:0 Marks: Internal: 40 External: 60**
Total:100**End Semester Exam: 3Hours****COURSE OBJECTIVES**

- The course aims to appraise the students to basic and high throughput techniques in Genomics and Proteomics and their applications.
- Get introduced to the field of chemical synthesis of DNA.
- Sequencing of DNA and its applications in human health.
- The course presents methods and experimental tools used in modern genomics with emphasis on prokaryotes and eukaryotes.
- The course also deals with the genome structure, stability, organization, and its expression.
- The course includes among others model systems, genetics behind complex diseases.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Infer the basic concepts of genomics, transcriptomics and proteomics. | Understand |
| CO2 | List and discuss the use of genomics and proteomics in human health. | Apply |
| CO3 | Suggest and outline solution to theoretical and experimental problems in metagenomics and forensic Microbiology | Understand |
| CO4 | Understand various steps involved in protein engineering. | Analyze |
| CO5 | Understand methods for sequencing of DNA | Understand |
| CO6 | Identification of disease genes and different types of mutations. | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | M | S | M | M | S | M |
| CO2 | M | M | L | M | M | M | M | M | L | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | M | S | S | M | M | M | M | S | S | M | M |
| CO6 | S | S | S | S | S | S | S | S | S | S | S | S |

S-Strong; M-Medium; L-Low

UNIT I Introduction about metagenomics

(12 Hours)

Need of Metagenomics, Omics: Stream of omics- Proteomics, Genomics, Metabolomics, Lipidomics and Epigenomics. Role of omics in Microbiology, Application of Metagenomics.

UNIT II Metagenomic Techniques

(12 Hours)

Introduction – Shot gun sequencing Vs 16S sequencing. Metagenomics Technique: Sample processing, Metagenomic DNA extraction, NGS (Next generation sequencing), Binning, Annotation, Data analysis.

UNIT III Genomics

(12 Hours)

Genome projects: The Human genome project, Structural genomics: Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole –genome shotgun sequencing. Determining the functions of individual genes and by studying the activity of a protein coded of an unknown gene. Synthetic genomes and their applications.

UNIT IV Molecular and Epidemiological tools

(10 Hours)

Nucleic amplification and molecular epidemiological techniques are essential tools in clinical microbiology for identifying pathogens. Typing tools for Phylogenetic study.

UNIT V Protein arrays

(14 Hours)

Basic principles. Computational methods for identification of polypeptides from mass spectrometry. Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools. Protein-protein interactions: databases such as DIP, PPI server and tools for analysis of protein- protein interactions.

SUGGESTED READINGS

1. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
2. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific
3. Graur, D and W H Li, 2000. Fundamentals of molecular evolution. Sinauer Associates.
4. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. 2004. Genetics from Genes to Genomes. McGraw Hill.
5. Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
6. Primrose, S. B., and R. M. Twyman. 2006. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA.
7. Discovering Genomics, Proteomics and Bioinformatics 2nd edition - by A. Malcolm Campbell and Laurie J. Heyer by Cold Spring Harbor Laboratory Press 2006.
8. Principles of Genome Analysis and Genomics (3rd Ed.) by Primrose, S.B. and Twyman, R.M., Blackwell Publishing Company, Oxford, UK. 2003
9. Introduction to Proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., Humana Press Inc., New Jersey, USA. 2002
10. Bioinformatics and Functional Genomics by Pevsner, J., John Wiley and Sons, New Jersey, USA. 2003
11. Bioinformatics: Sequence and Genome Analysis by Mount, D., Cold Spring Harbor Laboratory Press, New York. 2004

23MBU511 INDUSTRIAL MICROBIOLOGY AND BIOTECHNIQUES PRACTICAL**(4H–2C)****Instruction Hours / week: L: 0 T: 0 P:4****Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 9 Hours****COURSE OBJECTIVES**

- To encompasses the use of microorganisms in the manufacture of food or industrial products on the basis of employment.
- Get equipped with a theoretical and practical understanding of industrial microbiology
- Appreciate how microbiology is applied in manufacture of industrial products
- Know how to source for microorganisms of industrial importance from the environment
- Know about design of bioreactors, factors affecting growth and production, heat transfer, oxygen transfer
- To understand working of different laboratory equipment used in microbiological laboratories

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Provides knowledge in the large-scale production of industrial product, and teaches the modern employment trends to cater the needs of industry. | Understand |
| CO2 | Students will differentiate the types of fermentation processes | Apply |
| CO3 | Understand the biochemistry of various fermentations | Understand |
| CO4 | Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms | Analyze |
| CO5 | Comprehend the techniques and the underlying principles in downstream processing | Understand |
| CO6 | Students can able to explore the practical skills in research activities. | Remember |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | M | S | M | M | S | M |
| CO2 | M | M | L | M | M | M | M | M | L | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | M | S | S | M | M | M | M | S | S | M | M |
| CO6 | S | S | S | S | S | S | S | S | S | S | S | S |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(48 Hours)

1. Study of different parts of fermenter
2. Microbial fermentation – Production and estimation of enzyme – Amylase and Protease
3. Microbial fermentation – Production and estimation of organic acid- Citric acid
4. Assess quality of probiotics in tablets and nutritional supplements, stability of vials at different time.
5. Perform Cell growth kinetics.
6. Separation of mixtures by paper/thin layer chromatography.
7. Demonstration of column chromatography packing.
8. Separation of protein mixtures by SDS- Poly Acrylamide Gel Electrophoresis (SDS - PAGE).
9. Separation of components of a given mixture using a laboratory scale centrifuge.

SUGGESTED READINGS

1. NdukaOkafor, Benedict C. Okeke (2017) Modern Industrial Microbiology and Biotechnology, 2nd Edition, CRCPress.
2. StanburyPF,WhitakerAandHallSJ.(2006).PrinciplesofFermentationTechnology.2ndedition,ElsevierScience Ltd.
3. CruegerWandCruegerA.(2017).Biotechnology:AtextbookofIndustrialMicrobiology.3rdedition.Panima PublishingCo.NewDelhi.
4. GeoffreyMGadd,SimaSariaslani(2015)AdvancesinAppliedMicrobiology,CRCPress.
5. E.MTEL-Mansi,JensNielsen,DavidMousdale(2009)FermentationMicrobiologyand Biotechnology, FourthEdition, CRCPress.
6. KarpG.(2010)CellandMolecularBiology:ConceptsandExperiments.6thedition.JohnWiley&Sons.Inc.
7. Nigam A and AyyagariA. (2007). Lab Manual in Biochemistry, Immunologyand Biotechnology.Tata McGraw Hill

23MBU512

ENVIRONMENTAL MICROBIOLOGY AND R-DNA PRACTICAL (4H–2C)

Instruction Hours / week: L: 0 T: 0 P:4 Marks: Internal: 40 External: 60 Total:100**End Semester Exam: 6 Hours****COURSE OBJECTIVES**

- To educate students about Environmental monitoring and environmental aspects of microbes.
- To impart a skill-based knowledge on Microbes and environment and ecological importance.
- Appreciate the diversity of microorganism and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats
- Learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment
- and also learn different methods for their detection and characterization
- To provide an experience for the students in an interdisciplinary research program connecting animal genomics with animal reproduction and biotechnology.
- The course will facilitate in understanding of molecular biology by examining common processes and principles in genes to illustrate complexity.

COURSE OUTCOME

At the end of this course, students will be able to

| Cos | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Provides a comprehensive overview of biogeochemical processes relevant to environmental scientists and engineers mediated by microorganisms. | Understand |
| CO2 | Understand various plant microbes' interactions especially rhizosphere and their applications especially the biofertilizers and their production techniques | Apply |
| CO3 | Understand the basic principles of environment microbiology | Understand |
| CO4 | Explores technologies using molecular biology, cell and tissue culture to manipulate the genomes of animals for ways. | Analyze |
| CO5 | Develop the skills in molecular biology. | Understand |
| CO6 | Students are capable of explaining process involved in genetic changes and mutations | Remember |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | S | M |
| CO2 | M | M | L | M | M | M | M | M | M | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | M | S | S | M | M | M | M | M | S | M | M |
| CO6 | S | S | S | M | M | M | M | M | M | S | S | S |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(48 Hours)

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
3. Analysis of potable water- MPN method.
4. Determination of BOD and COD of wastewater sample.
5. Isolation of phosphate solubilizing bacteria from soil and study.
6. Resolution and visualization of proteins by SDS – Poly acrylamide Gel Electrophoresis (SDS-PAGE).
7. Competent cell preparation
8. Bacterial transformation
9. Isolation of genomic DNA from *E. coli*.
10. Isolation of plasmid from *E. coli*.

SUGGESTED READINGS

1. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
2. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York.
3. Atlas RM and Bartha R (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
4. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
5. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
6. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
7. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/Benjamin Cummings.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Heidelberg.

B.Sc. Microbiology

2023-2024
Semester –V

23MBU591

INTERNSHIP

(2C)

Instruction Hours / week: L: 0 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

23MBU601

FOOD AND DAIRY MICROBIOLOGY

Semester –VI
(5H–5C)

Instruction Hours / week: L:5 T: 0 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To understand the manufacturing process of textile fibers and yarns.
- The course aims to provide instruction in the general principles of food microbiology.
- The course covers the biology and epidemiology of food borne microorganisms of public health significance, including bacteria, yeasts, fungi, protozoa and viruses,
- Understand food spoilage microorganisms.
- Understand the microbiology of food preservation and food commodities; fermented and microbial foods;
- Understand the principles and methods for the microbiological examination of foods;
- To study the micro biological quality control, and quality schemes.

COURSE OUTCOME

At the end of this course, students will be able to

| Cos | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Understand the principles of microorganisms during various food-processing and preservation steps. | Understand |
| CO2 | Comprehend the interactions between microorganisms and the food environment, and factors influencing their growth and survival. | Apply |
| CO3 | Understand the significance and activities of microorganisms in food. | Understand |
| CO4 | Recognize the characteristics of food-borne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification. | Analyze |
| CO5 | Analyze the importance of microbiological quality control programme's in food production. Discuss the microbiology of different types of food commodities | Understand |
| CO6 | Describe the rationale for the use of standard methods and procedures for the microbiological analysis of food. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | M | S | M | M | S | M |
| CO2 | M | M | L | M | M | M | M | M | L | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | M | S | M | M | S | M |
| CO6 | M | M | L | M | M | M | M | M | L | M | M | M |

S-Strong; M-Medium; L-Low

Unit I**(10 Hours)**

Food and microorganisms – Important microorganisms in food (bacteria, molds and yeast). Sources of contamination of food. Intrinsic and extrinsic factors that affect growth and survival of microbes in foods. Microbial spoilage of various foods–Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods and sea food.

Unit II**(10 Hours)**

General principles of food preservation. Physical methods of food preservation: asepsis, removal of microorganism, drying, temperature (low, high), radiation, Chemical methods of food preservation, food additives, flavoring agents and enzyme preparation.

Unit III**(10 Hours)**

Fermented dairy products: yogurt, acidophilus milk, kumiss, kefir and cheese. Other fermented foods: Idly, sauerkraut, soy sauce and tampeh. Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market. Beneficial uses of microorganisms in food industry.

Unit IV**(8 Hours)**

Causative agents, foods involved, symptoms and preventive measures of the following diseases, Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins. Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*, fungal diseases (Mycotoxins, Aflatoxins, *Alternaria* toxins).

Unit V**(12Hours)**

Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology. HACCP, FSSAI (ISO9001:2008) Indices of food sanitary quality (record maintenance and standards) sanitizers. Quality control of milk – MBRT, Litmus Milk – Alkaline phosphatase tests. Biosensors in food processing.

SUGGESTED READINGS

1. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
2. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersburg, MD.
3. Frazier W.C. and Westhoff D.C. (2008) Food Microbiology, 4th Edn. Tata McGraw Hill Publishing Co., New Delhi.
4. Bamforth C.W. (2005) Food, Fermentation and Microorganisms, Blackwell Science.
5. Doyle M.P. and Buchanan R.L. (Ed.) (2013) Food Microbiology: Fundamentals and Frontiers, 4th Edn. ASM press.
6. Jay J.M., Loessner M.J. and Golden D.A. (2005) Modern Food Microbiology, 11th Edn. Springer Publishers.
7. Robinson R.K. (2018) Dairy Microbiology: Milk and Milk Products, 6rd Edn. Wiley Publishers.
8. James M Jay (2003). Modern Food Microbiology. Fourth edition, CBS Publishers, New Delhi.

23MBU602 MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (5H-5C)**Instruction Hours / week: L: 5 T: 0 P:0****Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- The goal of sustainable agriculture is to meet society's food and textile needs in the present without compromising the ability of future generations to meet their own needs.
- Able to evaluate the application of ecological principles and concepts in sustainable agriculture system.
- To know the role of microbes which make crop output more and increase the fertility of crops.
- To know the specific reference to agriculture and biotechnological terms
- To know the physiological processes that advocating microbial development and evolution
- To make them to understand issues related to plant nutrition, quality improvement, environmental adaptation, transgenic crops and their use in agriculture

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Develops the programmatic activities in sustainable agriculture and food systems | Understand |
| CO2 | Able to relate their knowledge about ecology to its relevance in sustainable agriculture | Apply |
| CO3 | Provides detailed idea about biofertilizer production and develop entrepreneur skill related to agriculture field. | Understand |
| CO4 | Understand on soil characteristics and biogeochemical cycling. | Analyze |
| CO5 | Students able to the uses of microorganisms as bio control agents. | Understand |
| CO6 | Understand transgenic crops and their use in agriculture. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | M | S | M | M | S | M |
| CO2 | M | M | L | M | M | M | M | M | L | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | M | S | M | M | S | M |
| CO6 | M | M | L | M | M | M | M | M | L | M | M | M |

S-Strong; M-Medium; L-Low

Unit I**(10 Hours)**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Role of microbes in soil fertility, Factors influencing the microbial density in the soil Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica and potassium

Unit II**(10 Hours)**

Role of microbes in production and control of carbon dioxide, methane, nitrous oxide and nitric oxide, Microbial interactions- Mutualism, Proto cooperation, Commensalism, Neutralism, Competition, Amensalism, Parasitism, Predation, Syntrophism,

Unit III**(10 Hours)**

Biocontrol mechanisms and ways- direct antagonism, indirect antagonism and mixed path antagonism Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds. Recycling of agriculture waste, Bioconversion of organic wastes-sugarcane wastes. Role of microbes in composting process –coir-pith composition-composting, principles and applications.

Unit IV**(8 Hours)**

Plant growth promoting bacteria, biofertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia, VAM, potash solubilizer), Non-Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs, Marine resource biofertilizers, vermicomposting.

Unit V**(12 Hours)**

Biotech feed, Silage, Bio manure, biogas, biofuels – advantages and processing parameters, Advantages, social and environmental aspects, GM crops, Bt crops, golden rice, transgenic animals.

SUGGESTED READINGS

1. Stephen Burchett, Sarah Burchett (2018) Plant Pathology, 1st Edition, Garland Science.
2. Ching T. Hou, Jei-Fu Shaw (2019) Biocatalysis and Agricultural Biotechnology, 1st Edition, CRC Press.
3. Parmjit S. Panesar, Satwinder S. Marwaha (2017) Biotechnology in Agriculture and Food Processing: Opportunities and Challenges, 1st Edition, CRC Press.
4. Noureddine Benkeblia (2019) Sustainable Agriculture and New Biotechnologies, 1st Edition CRC Press.
5. Sangita Sahni, Bishun Deo Prasad, Prasant Kumar (2017) Plant Biotechnology, Volume 2: Transgenics, Stress Management, and Biosafety Issues, 1st Edition, Apple Academic Press.
6. Pradeep Kumar, PhD., Jayanta Kumar Patra, Pranjal Chandra (2018) Advances in Microbial Biotechnology: Current Trends and Future Prospects, 1st Edition, Apple Academic Press.
7. Allen I. Laskin (2017) Microbial Ecology, 1st Edition, CRC Press.
8. Tanya E. Cheeke, David C. Coleman, Diana H. Wall (2012) Microbial Ecology in Sustainable Agroecosystems, 1st Edition, CRC Press.
9. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology, 4th Edition, ASM Press.

23MBU603A

BIOPHARMACY

(5H–5C)

Instruction Hours / week: L: 5 T: 0 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- An introduction to know about the biological substance which has the medicinal value.
- It aids to improve the biopharmaceutical components and technical knowledge.
- To study the origin, types and action of drugs; legislations on them.
- To acquire knowledge on the action and effects of drugs on human health.
- To know the various physical, physicochemical properties and principle involved in formulations
- It provides the basic concept about the technique involved in the field of biopharmacy.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | This course deals with the various physical and physicochemical properties | Understand |
| CO2 | Students will understand the principle involved in formulations | Apply |
| CO3 | Understand various physicochemical properties of drug molecules in the designing the dosage form | Understand |
| CO4 | The sources of impurities and methods to determine the impurities in inorganic drugs and pharmaceuticals. | Analyze |
| CO5 | Understand the medicinal and pharmaceutical importance of inorganic compounds. | Understand |
| CO6 | Students will understand the various processes involved in pharmaceutical manufacturing process. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | M | S | M | S |
| CO2 | M | M | L | M | M | M | M | L | M | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | M | S | M | S |
| CO6 | M | M | L | M | M | M | M | L | M | M | M | M |

S-Strong; M-Medium; L-Low

UNIT – I Phytochemistry**(10 Hours)**

Biosynthesis of primary and secondary metabolites - alkaloids, terpenoids, glycosides, Phenolic compounds and coumarins. Classification and sources of alkaloids. Major classes in phenolic compounds – carotenoids, flavonoids, tannins and phenolic acids. Classification of terpenoids.

UNIT – II Extraction Techniques**(10 Hours)**

General extraction and isolation techniques for compounds from plants. Techniques involved in extraction of phytochemicals – Percolation, Soxhlet extraction, Supercritical Fluid extraction, Pilot scale extraction, reflux and other methods.

UNIT – III Isolation and purification techniques**(10 Hours)**

Thin layer and Column chromatography, Liquid Chromatography, Gas chromatography, Affinity chromatography and super critical fluid chromatography. Chemical fingerprinting – HPLC and HPTLC, Mass Spectroscopy.

UNIT – IV Biotechnology of medicinal plants**(8 Hours)**

Production of secondary metabolites from cultured plant cells, elicitation, immobilization and biotransformation. Medicinal plants – Plant DNA isolation.

UNIT – V Bioactive studies**(12 Hours)**

Anticancer, antidiabetic, anti-inflammatory, hepatoprotectives, antimicrobials from medicinal plants. Antioxidants of plant origin – Reactive Oxygen Species (ROS), antioxidant polyphenols.

REFERENCES

1. Harborne, J.B., 1998. Phytochemical methods to modern techniques of plant analysis. Chapman & Hall, London.
2. Trease G.E. and M.C. Evans, 1979. Textbook of Pharmacognosy 12th Edition. Balliere-Tindal, London.
3. Irfan A. Khan and Atitya Khanum, (Eds.) 2004. Role of Biotechnology in medicinal and Aromatic plants, Vols. I-X. Ukaaz Publications, Hyderabad.

COURSE OBJECTIVES

- This course has been intended to provide knowledge about the Bio nanomaterials synthesis and its advancement.
- To foundational knowledge of the Nanoscience and related fields.
- To make the students acquire an understanding the Nanoscience and Applications
- To help them understand in broad outline of Nanoscience and Nanotechnology.
- Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment
- Apply their learned knowledge to develop Nanomaterial's.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Students get an idea about application of nanotechnology in biology. | Understand |
| CO2 | It provides analytical knowledge of trends and developments in the field of nanotechnology | Apply |
| CO3 | Acquire knowledge in nanotechnology and how it will support the employment greatly. | Understand |
| CO4 | Students able to construct hierarchy strategy in machine. | Analyze |
| CO5 | Able to describe self-application and machine phase biotechnology | Understand |
| CO6 | Students have an enhanced knowledge and understanding of chemical transformation and biomolecular sensing | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | M | S | M | S |
| CO2 | M | M | L | M | M | M | M | L | M | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | M | S | M | S |
| CO6 | M | M | L | M | M | M | M | L | M | M | M | M |

S-Strong; M-Medium; L-Low

UNIT – I Nano particles**(10 Hours)**

Biotechnology to Bionanotechnology: Bio nanomachines – Modern bionano materials – protein, nucleic acid, lipids used for carrying information – polysaccharides use in special structural roles – Present status of bionanotechnology.

UNIT – II Bionanomachines**(10 Hours)**

Molecular design for nanotechnology: Recombinant DNA technology – X-ray crystallography, NMR spectroscopy and electron microscopy, use in nanotechnology – Computer modeling to bionanomachines and computer assisted molecular design.

UNIT – III Natural bio nanotechnology designing**(10 Hours)**

Structural principles of Bionanotechnology: Natural bio nanotechnology design for specific environment– Biomolecular structure as low materials – Hierarchical strategy in construction of nanomachines – protein folding – self organization – molecular recognition – flexibility.

UNIT – IV Principles of Nanotechnology**(8 Hours)**

Functional principles of Bionanotechnology: Information driven nano assembly – chemical transformation – bio molecular sensing – self application – machine phase bio nanotechnology.

UNIT – V Ethics of Nanotechnology**(12 Hours)**

Future of Bio nanotechnology: Problems in bionanotechnology – Abide finger problem – Sticky finger problem – role of enzyme to solve these problems – Core studies – nanotube synthesis, nano scale assembler, nanosurveillance – ethical consideration – respect for life, potential dangers, fuel.

SUGGESTED READINGS

1. David, S. (2004). Goodsell. Bionanotechnology. Wiley-Blackwell.
2. Gonsalves, K., Halberstadt, C., Laurencin, C.T., (2007). Biomedical Nanostructures. Wiley-Blackwell.
3. Sabliov, C., Hongda, A., Yada, R., (2015). Nanotechnology and Functional Foods. Wiley-BlackwellPublishers
4. Rakesh Kumar, and Tiwari, K., (2013). A Textbook of Nanoscience. Publisher: S.K. Kataria& Sons.
5. Goosell, D.S. (2004). Bionanotechnology: Lessons from nature. John Wiley & Sons Inc. publication.
6. Goodsell, D.S. (1996). Biomolecules and Nanotechnology. Ancient Scientist, 88, 230 – 237.
7. Blundell, T.L., and Johnson, L.N., (1976). Protein crystallography. New York.
8. Eisenberg, D., and Crothers, D., (1979). Physical Chemistry with Applications to the Life Sciences. Benjamin Cummings, Menlo Park, California.
9. Ausubel, F.M., Breut, R., Kingston, R.E., Moore, D.D., Siedman, J.G., Smith, J.A., and Struhl K., (1999). Short protocols in Molecular Biology. (4th ed.). Wiley, New York.

Instruction Hours / week: L: 0 T: 0 P:4 Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To encode the importance of the role of microorganisms in food industries both in beneficial and harmful ways.
- To obtain a good entrepreneurial understanding of food and dairy products and become qualified as microbiologist in food and dairy industries.
- Understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods
- To know the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage
- Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods.
- To Learn various methods for their isolation, detection and identification of microorganisms in food and employ in industries.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Provides necessary entrepreneurial information on the food, dairy Microbiology in safety and quality perspective. | Understand |
| CO2 | It will help to study the importance in the prevention of contamination that might be caused by the microorganisms. | Apply |
| CO3 | To Learn various methods for their isolation, detection and identification of microorganisms in food and employ in industries | Understand |
| CO4 | Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation | Analyze |
| CO5 | Students can able to understand of the basis of food safety regulations and Discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food | Understand |
| CO6 | Acquire, discover, and apply the theories and principles of food microbiology in practical, real-world situations and problems. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | M | S | M | S |
| CO2 | M | M | L | M | M | M | M | L | M | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | M | S | M | S |
| CO6 | M | M | L | M | M | M | M | L | M | M | M | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(40 Hours)

1. Methylene Blue Dye Reduction Test and Resazurin test for testing the Raw milk quality
2. Standard plate count of milk sample.
3. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
4. Isolation of food borne bacteria from food products.
5. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
6. Production of yogurt.
7. Isolation of microorganisms from curd (*Lactobacillus* observation).
8. Visit to microbiology based Food and dairy industry and observe the unit operation procedures.

SUGGESTED READINGS

1. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
2. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersburg, MD.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
4. Diane Roberts (2013). Practical Food Microbiology, Third Edition, Print ISBN:9781405100755, Blackwell Publishing Ltd.

**23MBU612 MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT PRACTICAL
(4H–2C)**

Instruction Hours / week: L: 0 T: 0 P:4**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 6 Hours****COURSE OBJECTIVES**

- Able to relate their knowledge about ecology to its relevance in sustainable agriculture
- Able to evaluate the application of ecological principles and concepts in sustainable agriculture system.
- To know the role of microbes which make crop output more and increase the fertility of crops.
- To analyses the degrading microorganisms by various techniques.
- Able to design biogas plant.
- To obtain knowledge in entrepreneur in agricultural area.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Able to relate their knowledge about ecology to its relevance in sustainable agriculture | Understand |
| CO2 | Provides detailed idea about biofertilizer production and develop entrepreneur skill related to agriculture field. | Apply |
| CO3 | Able to device biogas plant | Understand |
| CO4 | Students will be annotating various zone in soil profile | Analyze |
| CO5 | Students will be isolate various degrading microorganisms for agricultural use. | Understand |
| CO6 | Understand the role of soil microbes in crop production. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(40 Hours)

1. Study of soil profile
2. Study the microflora of different types of soils
3. Preparation of compost
4. *Rhizobium* and *Azotobacter* as soil inoculants characteristics
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms, urea decomposers and nitrate utilizers
7. Screening of bacterial isolates for PHB production by using “Sudan black B” method
8. Estimation of soil microbial activity- CO₂ evolution method

SUGGESTED READINGS

1. Stephen Burchett, Sarah Burchett (2018) Plant Pathology, 1st Edition, Garland Science.
2. Ching T. Hou, Jei-Fu Shaw (2019) Biocatalysis and Agricultural Biotechnology, 1st Edition, CRC Press.
3. Parmjit S. Panesar, Satwinder S. Marwaha (2017) Biotechnology in Agriculture and Food Processing: Opportunities and Challenges, 1st Edition, CRC Press.
4. Nouredine Benkeblia (2019) Sustainable Agriculture and New Biotechnologies, 1st Edition, CRC Press.
5. Sangita Sahni, Bishun Deo Prasad, Prasant Kumar (2017) Plant Biotechnology, Volume 2: Transgenics, Stress Management, and Biosafety Issues, 1st Edition, Apple Academic Press.
6. Pradeep Kumar, PhD., Jayanta Kumar Patra, Pranjal Chandra (2018) Advances in Microbial Biotechnology: Current Trends and Future Prospects, 1st Edition, Apple Academic Press.
7. Allen I. Laskin (2017) Microbial Ecology, 1st Edition, CRC Press.
8. Tanya E. Cheeke, David C. Coleman, Diana H. Wall (2012) Microbial Ecology in Sustainable Agro ecosystems, 1st Edition, CRC Press.
9. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology, 4th Edition, ASM Press.

B.Sc. Microbiology

2023-2024
Semester –VI

23MBU691

PROJECT

(7H-4C)

Instruction Hours / week: L:0 T: 0 P:7

Marks: Internal: 80 External: 120 Total:200

23MBU701

TEXTILE MICROBIOLOGY

(6H–5C)

Instruction Hours / week: L: 5 T: 1 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To understand the manufacturing process of textile fibers and yarns.
- To gain knowledge about the fabric weaving methods.
- To understand microbial enzyme technology in textile field.
- To know about the innumerable applications of enzymes in textile processing.
- The students will develop set of skills to recognize and to gain knowledge in antimicrobial finishes.
- To familiarize students with general principles and subject knowledge in the field of textile microbiology.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Classify fibers and explain fiber properties | Understand |
| CO2 | Analyze the advantages of enzyme based detergents and explain the enzyme immobilization methods | Apply |
| CO3 | The aim of the course is to give the students broad theoretical and practical skills in textile microbiology. | Understand |
| CO4 | This course covers the principles of various processes associated with the textile manufacturing | Analyze |
| CO5 | Outline the microbial applications in textile field | Understand |
| CO6 | Justify eco-friendly textile processing with enzymes | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

Unit I: Introduction to fiber Science**(12 Hours)**

Classification of textile fibres according to their nature and origin, manufacturing process of end uses of various fibers. Essential and desirable properties of textile fibres. Natural fibres: Vegetable fibers (bast, leaf and seed fibres), animal fibers (wool and silk) and mineral fibers (glass, asbestos and metallic fibres). classification, distinctive properties and end uses. Man-made fibres- Rayon & Bamboo.

Unit II: Extraction and Fabrication of Natural Fibers and Biomaterials**(12 Hours)**

Introduction, Need, and Classification of retting – Mechanical, running water, pool retting, and dew retting, stagnant retting and enzymatic retting. Yarn making and fabrication weaving, knitting and non woven. Biomaterials utilized in medical textiles – an overview. Definition and classification of biomaterials, Structure of biomaterials, Mechanical properties - Elastic behavior, Stress and Strain, Tension and Compression, Shear, Isotropy -Fatigue- Toughness - Effect of Fabrication on Strength.

Unit III: Enzymes in textile industry**(12 Hours)**

Enzymes in textile processing- cellulosic fibres- desizing, scouring, bleaching, biopolishing, flax retting, denim fading. Protein fibres degumming, wool depriming, shrink proofing. Enzymes in treatment of textile dye effluent.

Unit IV: Enzyme based eco-friendly detergents**(10 Hours)**

Introduction, disadvantages of conventional detergents, role of enzymes in detergents. Immobilized enzymes- preparation and industrial applications. Enzymes as fermentation products- amylases, proteases, pectinases and cellulases.

Unit V: Microbial applications in textile field**(14 Hours)**

Microbial Pigments - Extraction of bacterial and fungal pigments. Application of microbes - decolourization of textile dye effluent, Extraction and softening of fibres. Antimicrobial Finish- Impact of microbial growth on textiles and Need for antimicrobial finish. Antimicrobial agents- Mode of action, types, characteristics. Commercially available antimicrobial agents. Assessment of antimicrobial activity: Antimicrobial finishing methods on fabrics.

SUGGESTED READING

1. Deepali Rastogi and Sheetal Chopra, (2017). Textile Science, Orient Black Swan Private Limited, Hyderabad.
2. Seema Sekhri, (2011). Textbook of Fabric Science: Fundamentals to Finishing, PHI Learning Pvt Limited, New Delhi.
3. Trever Palmer, (2004). Enzymes, Biochemistry, Biotechnology Clinical Chemistry: Affiliated East-West Press Ltd., New Delhi.
4. Satyanarayana. U and Chakrapani. U, (2006). Biochemistry, Third Edition, Arunabha Sen Books and Allied P Ltd., Kolkata.
5. V Nierstrasz ACavaco-Paulo, (2010). Advances in Textile Biotechnology, Woodhead Publishing Ltd., U.K.
6. Purohit. S, S, (2008). Microbiology Fundamentals and Applications, 7 Th Edition, AGROBIOS, India.

23MBU702

POULTRY AND VETERINARY MICROBIOLOGY

(6H-5C)

Instruction Hours / week: L:5 T: 1 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To understand the role of microorganisms in animal health.
- Identify a variety of types of pathogenic microorganisms and the diseases they produce in the host.
- Perform basic microbiological techniques used in the laboratory setting of a veterinary hospital.
- Identify organisms from unknown samples using a variety of tests.
- To understand animal disease and gives a brilliant grounding in immunology, molecular biology, microbiology and epidemiology.
- The infectious disease cycle of the pathogens enables to solve the epidemics. The territory covered by infections and the immune response.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Students will be able to understand the importance of commercialization in veterinary industry | Understand |
| CO2 | Students will be able to develop, investigation, pharmacy and vaccine production is offering various career opportunities for the Veterinary professionals | Apply |
| CO3 | Candidate able to explain the host response to infection. | Understand |
| CO4 | Students will be able to analyze the morphology and crystallographic structure of animal virus. | Analyze |
| CO5 | Students will be able to predict cytotoxic changes in animal due to virus infection. | Understand |
| CO6 | Demonstrate an understanding at an advanced level of microbial virulence mechanisms | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

UNIT I: Introduction to Veterinary Microbiology (12 Hours)

Introduction- etiology, pathogenesis, laboratory diagnosis and treatment of infection in the individual. Epizootiology - prevention and control of infection in the community.

UNIT II: Veterinary Bacteriology & Mycology (12 Hours)

Study of pathogenic bacteria and fungi in relation to their morphology, isolation, growth, colonial, biochemical characteristics, Pathogenicity and diagnosis of bacterial and fungal diseases: Bacteria - Staphylococcus, Streptococcus, Bacillus, Clostridium, Mycobacterium, Enterobacteriaceae, Campylobacter, Brucella, Pasteurella, Listeria, Actinomyces, Mycoplasma, Rickettsia, Chlamydia. Fungi - Dermatophytes, Candida, Aspergillus, Zygomycetes, Mycotic mastitis and Mycotoxicosis.

UNIT III: Cell interaction and cell damage (12 Hours)

Virus –cell interactions, types of interactions, Cytocidal changes in virus infected cells, mechanisms of cell damage., Inclusion bodies, ultrastructural changes in virus infected cells, interferons. Viral persistence, viral strategies to evade host defense mechanisms, persistent infection and chronic damage to tissues and organs, infection induced damage to immune system, autoimmune disease, hypersensitivity.

UNIT IV: Veterinary Parasitology (10 Hours)

Principles of Taxonomy, Physiology and Parasite Identification. Animal Parasitic diseases - Parasite morphology, parasite life cycles, host pathology, epidemiology of infections, treatment and control of infections- Platyhelminthes, Nematelminthes and Acanthocephala.

UNIT V: Livestock Management (14 Hours)

Animal nutrition- Energy sources. Dairy production and Management. Taxonomy, anatomy and biology of commercially important fishes. Most common cattle, sheep, goat, poultry and pig diseases. Types of vaccines-Live, Inactivated, Recombinant, synthetic peptide, genetically modified vaccines etc.

SUGGESTED READING:

1. Glen Sonder J & Karen W Post 2005. Veterinary Microbiology: Bacterial and Fungal Agents of Animal Diseases. ColdSpringHarbor Lab. Press.
2. Prescott LM, Harley JP & Klen DA. 2005. Microbiology. Wm. C. Brown Publications.
3. Tortora GJ, Funke BR & Case CL. 2004. Microbiology: An Introduction. Benjamin/Cummins Publications.
4. Publications.
5. C.L. Gyles, J. .F Prescott, J.G. Songer, C.O. Thoen. Pathogenesis of Bacterial Infections in Animals. 2004 Wiley
6. Fenner.S, 2016. Veterinary virology (5 th Edition). Academic Press.

Instruction Hours / week: L:4 T: 1 P:0 Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To know the significance of Drug Design and Discovery
- To know the course, introduce the basic principles of modern drug design, discovery and development.
- To know the different source of drug with specific focus on microbial source
- To understand the drug manufacturing process.
- To identify the Lead compound series
- To know the biosimilars and pharmaceuticals of microbial origin.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|------------|--|---------------------|
| CO1 | The course will impart knowledge on detection, selection, and validation of new antibacterial targets, | Understand |
| CO2 | Candidates able to involve in the vaccines | Apply |
| CO3 | The use of gene technology in pharmaceutical industry | Understand |
| CO4 | Students could understand the significance of tolerability, side effects at different doses | Analyze |
| CO5 | Can contribute to the upstream process | Understand |
| CO6 | Gain the knowledge on the drug development process and engineering technology in drug development | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

UNIT-I Introduction to drug design**(12 Hours)**

Introduction- History of drug design, Current approaches and philosophies in drug design, Molecular mechanisms of diseases and drug action with examples. Pharmaceutical products, Pharmaceuticals of microbial origin (macrolides, ansamycins, Peptide and other antibiotics) animal origin (sex hormones androgens), plant origin (Alkaloids Atropine and scopolamine)

UNIT-II Microbial drugs**(12 Hours)**

Sources of Drugs- Microbial drugs, E. coli as a source of recombinant therapeutic proteins. Expression of recombinant proteins in yeasts, animal cell culture systems. Transgenic animals, Transgenic plants and Insect cell-based systems. Rational drug design and Combinatorial approaches to drug discovery, Antibody Drug Conjugates.

UNIT-III Drug production**(12 Hours)**

Drug development process- Impact of genomics and related technologies upon drug discovery: Gene chips, Proteomics, Structural genomics and Pharmacogenetics, Model systems in the development of drugs, Nanoscaffolds for Drug Delivery. Drug manufacturing process- Guides to good manufacturing practice, Production of final product - Cell banking systems, Upstream processing, Microbial cell fermentation, Mammalian cell culture systems, Downstream processing, Final product formulation, Freezedrying, Labelling and packing

UNIT-IV Vaccines and adjuvant**(10 Hours)**

Traditional vaccine preparations, attenuated, dead or inactivated bacteria, Attenuated and inactivated viral vaccines, Toxoids, antigen-based and other vaccine preparations. Impact of genetic engineering on vaccine technology. Peptide vaccines Vaccine vectors. Development of an AIDS vaccine, Difficulties associated with vaccine development, AIDS vaccines in clinical trials, Cancer vaccines, Recombinant veterinary vaccines. Adjuvant technology: Adjuvant mode of action, Mineral-based adjuvants, Oil-based emulsion adjuvants Bacteria/bacterial products as adjuvants, Biosimilars.

UNIT-V Applications of drugs**(14 Hours)**

Nucleic acid as drugs- Gene therapy: Basic approach to gene therapy, Vectors used in gene therapy - Retroviral vectors, Additional viral-based vectors, Manufacture of viral vectors, Non-viral vectors. Gene therapy and genetic disease, cancer, Gene therapy and AIDS. Gene based vaccines, Repurposing of drugs.

SUGGESTED READING

1. Kristian Stromgaar, Povl Krogsgaard-Larsen and Ulf Madsen (2017). Textbook of Drug Design and Discovery, Fifth Edition, CRC press, 2017.
2. Thomas J. Dougherty and Steven J. Projan. Microbial Genomics and Drug Discovery, Taylor and Francis, 2003
3. Kenneth M. Merz, Dagmar Ringe and Charles H. Reynolds. Drug Design: Structure- and Ligand-Based Approaches, Cambridge University press, 2010.
4. Kristian Stromgaar, Povl Krogsgaard-Larsen and Ulf Madsen (2017). Textbook of Drug Design and Discovery, Fifth Edition, CRC press, 2017
5. David B. Weiner and William V. Williams. Biological Approaches to Rational Drug Design (Handbooks in Pharmacology and Toxicology) CRC press, 1994
6. Gary Wlash (2004). Biopharmaceuticals, Biochemistry and Biotechnology. 2nd edition. Wiley publisher.

23MBU703B BIOPRODUCT DEVELOPMENT AND ENTERPRENEURIAL MICROBIOLOGY
(5H-4C)

Instruction Hours / week: L: 4T: 1 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- To detail the entrepreneurship in field of life sciences.
- To obtain good understanding about the interpretation of biological products.
- To uptake knowledge in latest tools and technology.
- Aimed to provide an overview of various microbial bioproducts.
- Provide knowledge on manufacturing and production of bioproducts.
- To get introduced to the entrepreneurship skill in microbiology.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Describe and apply several entrepreneurial ideas and business theories in practical framework | Understand |
| CO2 | Clarify the metabolic pathways and control mechanisms of commercially important metabolites | Apply |
| CO3 | Commentate single cell proteins and express the importance of mushroom cultivation and probiotics | Understand |
| CO4 | Express the mass production of microbial inoculants used as Biofertilisers and Bioinsecticides in response with field application and crop response | Analyze |
| CO5 | Analyze the application and commercial production of Monoclonal antibodies, Cytokines, TPH and teaching kits | Understand |
| CO6 | Decode the significance of industrial production of Biofuels and Point out the role of Bioplastics and Biopigments | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

Unit I**(12 Hours)**

Entrepreneurship: Notions and theories of Entrepreneurship, Entrepreneurial traits and motivation- Nature and importance of Entrepreneurs, - Financial Analysis Investment process, Break even analysis, Profitability analysis, Budget and planning process. Government schemes for commercialization of technology - Funding and support mechanisms for entrepreneurship. Professional ethics in entrepreneurship.

Unit II**(12 Hours)**

Production of microbial metabolites and Single cell proteins: Metabolic pathways and control mechanisms of primary and secondary metabolites; Commercially important metabolites: Primary – ethanol, citric acid; Secondary – β exotoxin; Single Cell Protein: Algae (*Spirulina maxima*, *Chlorella pyrenoidosa*) and Yeast (*Candida tropicalis*) as SCP, Mushroom Cultivation and Probiotics.

Unit III**(12 Hours)**

Biofertilizers and Biopesticides: Production of *Rhizobium*, *Azotobacter*, *Azospirillum*, *Phosphobacterium*, BGA (*Anabena*, *Nostoc*); Packing, Quality assurance, Field Application and Crop Response. Bioinsecticide: Mass Production, field Application, and Crop Response of Bacteria (*Bacillus thuringiensis*, *Bacillus papillae*, *Pseudomonas fluorescens*), Fungi (*Verticillium lecanii*, *Coelomyces*) and Viruses (Baculo viruses, NPV, Granulosis virus).

Unit IV**(10 Hours)**

Commercial Products: Production and Application of TPA, HGH, Cytokines and Monoclonal Antibodies; Production of enzymes – Cellulase, Protease, Amylase and lipase Production of teaching kits-DNA isolation, widal. Biochemistry, Industrial Production and Application of biogas, bio-diesel, hydrogen fuel, gasoline; Bioplastics - PHB, PHA; Biopigments – Lycopene, Betacarotene, and its applications.

Unit V**(14 Hours)**

Government regulatory practices and policies: Regulatory aspects of quality control. Sterilization control and sterility testing- Chemical and biological indicators. Regulatory authorities for introduction of medicines in market – Role of Food and Drug Administration, FDA guidelines for drugs / biologicals, Validation(GMP, GLP, GCP, etc.). Clinical studies: Phase I, phase II, phase III and phase IV of clinical trials – Objectives,Conduct of trials, Outcome of trials.

SUGGESTED READINGS

1. Stanbury, P.F, and Whitekar. A. (1999), Principles of Fermentation Technology, 2nd Edition. Butterworth-Heinemann: Oxford.
2. Stockholm, K.T.H., Sven-Olof Enfors, and Lena Haggstrom. (2000), Bioprocess Technology: Fundamentals and Applications, Royal Institute of Technology: Sweden.
3. Ashton Acton, Q., (2012). Biological Pigments– Advances in Research and Application. Scholarly Editions: Atlanta, Georgia.
4. Crueger, W, and Crueger. A. (2000), Biotechnology: A Text Book of Industrial microbiology, 2nd Edition, Sinauer Associates :Sunderland.Mass.
5. Hugo, W.B. and Russel, A.D. (2003), Pharmaceutical Microbiology, 6th Edition. Blackwell Scientific Publications: U K.

23MBU704A

INHERITANCE BIOLOGY

(5H-4C)

Instruction Hours / week: L: 4 T: 1 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- To make students understand the principles of Genetics and inheritance biology.
- To study cell structure and functions of organelle.
- Exposure on transportations through cell membrane.
- To focus on different receptors and model of signaling.
- To introduce the concept of cell signaling.
- To know the inherited characters and response.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | This paper imparts knowledge on the different aspects of genetics and pedigree analysis. | Understand |
| CO2 | Basic concept of cell structure, membrane, cellular functions of different types of cell, modes of cellular signaling and signal amplification. | Apply |
| CO3 | Students undertaking this practical shall be able to describe the steps involved in the basic Microbial Genetics | Understand |
| CO4 | Effectively understand the implication of mutation and its characteristics. | Analyze |
| CO5 | Further, the experiments would allow students to recall and relate the Information gained from Microbial Genetics theory paper and skills associated with it | Understand |
| CO6 | Students undertaking this course will be able to describe the nature of molecular world and its application in modern Microbiological and biotechnological sectors | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

Unit I – Introduction to Genetics**(12 Hours)**

Historical developments: Model organisms in genetic analyses and experimentation: *Escherichia coli*, *Saccharomyces cerevisiae*, *Neurospora crassa*, *Caenorhabditis elegans*, *Drosophila melanogaster*, *Arabidopsis thaliana*.

Unit II – Mendelian Principles**(12 Hours)**

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity.

Unit III – Linkage and Crossing over & Recombination**(12 Hours)**

Linkage and recombination of genes, Cytological basis of crossing over, crossing over at four-strand stage, Molecular mechanism of crossing over, mapping Homologous and non-homologous recombination, including transposition, site-specific recombination.

Unit IV – Extra-Chromosomal Inheritance & Human genetics**(8 Hours)**

Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in *Chlamydomonas*, mitochondrial, mutations in *Saccharomyces*, Maternal effects – Shell coiling in *Limnaea peregra*, Infectious heredity - Kappa particles in *Paramecium*. Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit V – Characteristics of Chromosomes**(14 Hours)**

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome.

SUGGESTED READINGS

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education.
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings.
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H. Freeman and Co., New York.
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers.
7. Russell PJ. (2009). i Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings.

23MBU704B

BIostatISTICS AND RESEARCH METHODOLOGY

(5H–4C)

Instruction Hours / week: L: 4 T: 1 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- About collection, interpretation and presentation of statistical data
- The analytics of data, probability, and hypothesis testing of samples
- The essential role of statistics in present, future use and applications of Biology.
- Analytical techniques to generate results
- Comparison of different groups.
- To know the significant among the groups.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Apply basic statistical concepts commonly used in health and medical sciences | Understand |
| CO2 | Use basic analytical techniques to generate results | Apply |
| CO3 | Interpret results of commonly used statistical analyses in written summaries. | Understand |
| CO4 | Demonstrate statistical reasoning skills correctly and contextually and this course will support the employment in various bioscience sector. | Analyze |
| CO5 | The analytics of data, probability, and hypothesis testing of samples | Understand |
| CO6 | The essential role of statistics in present, future use and applications of Biology | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

UNIT I - Introduction of Biostatistics and Correlation (12 Hours)

Introduction to Biostatistics, Basic Measures - Central Tendency and Dispersion, Variables in Bioscience, Correlation – Meaning and definition - Scatter diagram –Karl Pearson's Correlation Coefficient. Rank Correlation. Regression: Regression in two variables – Properties of Regression, uses of Regression

UNIT II - Test of Significance (12 Hours)

Sampling parameters- Difference between sample and Population, Censoring, difference between parametric and non-parametric statistics. Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom, Confidence Interval, Small sample test based on t-test, Large Sample Test based on Normal Distribution – Z – test and F test.

UNIT III Analysis of Variance (12 Hours)

Distribution - free test - Chi-square test; Basic Introduction to Multivariate statistics, etc. Test of significance: Tests based on Means only-Both Large sample and Small sample tests –Chi-square test –the goodness of fit. Analysis of Variance – one-way and two-way classification, CRD, RBD Designs.

UNIT IV-Research (10 Hours)

Research: Scope and significance – Types of Research – Research Process – Characteristics of good research – Problems in Research – Identifying research problems.

UNIT V - Sampling Design (14 Hours)

Research Designs – Features of good research designs. Sampling Design: Meaning – Concepts – Steps in sampling – Criteria for good sample design. Scaling measurements - Types of scale, Types of sampling – random sampling and non-random sampling. Sampling Errors.

SUGGESTED READING

1. Jerrold H. Zar. (2003). Biostatistical Analysis. (4th ed.). Pearson Education(P) Ltd, New Delhi.
2. Kothari. C.R. (2004). Research Methodology – Methods and Techniques. (2nd ed.). New Age International Pvt. Ltd, New Delhi.

Instruction Hours / week: L: 0 T: 0 P:3 Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 9 Hours

COURSE OBJECTIVES

- The students will develop set of skills to recognize and to gain knowledge in antimicrobial finishes.
- To familiarize students with general principles and subject knowledge in the field of textile microbiology.
- To understand the manufacturing process of textile fibers.
- To gain knowledge about the fabric dyeing methods.
- To understand microbial enzyme technology in textile field.
- To know about the innumerable applications of microbes in textile processing.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Determine the efficacy of fabric dyeing. | Understand |
| CO2 | Analyze the advantages of microbial based textile dyeing. | Apply |
| CO3 | The aim of the course is to give the students broad theoretical and practical skills in textile microbiology. | Understand |
| CO4 | This course covers the principles of various processes associated with the textile manufacturing | Analyze |
| CO5 | Outline the microbial applications in textile field | Understand |
| CO6 | Justify eco-friendly textile processing with enzymes | Remember |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(36 Hours)

1. Antibacterial activity assessment of textile materials: Parallel Streak Method (AATCC 147).
2. Antibacterial Activity of Fabrics: Agar Plate Method (AATCC 90).
3. Antimicrobial activity assessment of Textiles against Fungi (AATCC 30).
4. Demonstration of fabric dyeing by pad dry cure method.
5. Study of coated fabrics in terms of air permeability, thickness, tensile strength, tear strength and fabricstiffness test.
6. Microbial Enumeration test in fabrics.
7. Determination of color strength and wash fastness test of coated fabrics.
8. Textile dye degradation using micro-organisms.

SUGGESTED READING

1. DeepaliRastogi and Sheetal Chopra,(2017). Textile Science, Orient Black Swan Private Limited, Hyderabad.
2. SeemaSekhri, (2011). Textbook of Fabric Science: Fundamentals to Finishing, PHI Learning Pvt Limited,New Delhi.
3. Trever Palmer,(2004). Enzymes, Biochemistry, Biotechnology Clinical Chemistry: Affiliated East-WestPress Ltd., New Delhi.
4. Satyanarayana.U and Chakrapani.U ,(2006). Biochemistry, Third Edition, ArunabhaSen Books and AlliedP Ltd., Kolkata.
5. V NierstraszACavaco-Paulo,(2010). Advances in Textile Biotechnology, Woodhead Publishing Ltd.,U.K.
6. Purohit.S,S, (2008). Microbiology Fundamentals and Applications, 7 Th Edition, AGROBIOS, India.

23MBU713A DRUG DESIGN AND DEVELOPMENT PRACTICAL**(3H–1C)****Instruction Hours / week: L: 0 T: 0 P:3 Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 6 Hours****COURSE OBJECTIVES**

- To know the significance of Drug Design and Discovery
- To know the course introduce the basic principles of modern drug design, discovery and development.
- To know the different source of drug with specific focus on microbial source
- To understand the drug manufacturing process.
- To identify the Lead compound series
- To know the biosimilars and pharmaceuticals of microbial origin

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | The course will impart knowledge on detection, selection, and validation of new antibacterial targets | Understand |
| CO2 | Candidates able to involve in the vaccines | Apply |
| CO3 | The use of gene technology in pharmaceutical industry | Understand |
| CO4 | Students could understand the significance of tolerability, side effects at different doses | Analyze |
| CO5 | Can contribute to the upstream process | Understand |
| CO6 | Gain the knowledge on the drug development process and engineering technology in drug development | Remember |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO4 | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(36 Hours)

1. Routes of drug administration to laboratory animals
2. To evaluate the analgesic potency of drug by tail flick method
3. Screening of anti-inflammatory drugs using hind paw method
4. Drug design and development and computer aided drug design
5. Study the effect of drugs on spontaneous motor activity (SMA) and evaluate their nature as CNS stimulants using drugs
6. Structure based drug design using freely available molecular modeling tools
7. Protein structure analysis
8. Ligand selectivity analysis
9. Molecular basis of drugs
10. Homology modeling
11. Pharmacophore design and search

SUGGESTED READING

1. Kristian Stromgaar, PovlKrogsgaard-Larsen and Ulf Madsen (2017). Textbook of Drug Design and Discovery, Fifth Edition, CRC press,2017.
2. Thomas J. Dougherty and Steven J. Projan. Microbial Genomics and Drug Discovery, Taylor and Francis,2003
3. Kenneth M. Merz, Dagmar Ringe and Charles H. Reynolds. Drug Design: Structure- and Ligand- Based Approaches, Cambridge University press,2010.
4. Kristian Stromgaar, PovlKrogsgaard-Larsen and Ulf Madsen (2017). Textbook of Drug Design and Discovery, Fifth Edition, CRC press,2017
5. David B. Weiner and William V. Williams. Biological Approaches to Rational Drug Design (Handbooks in Pharmacology and Toxicology) CRC press,1994
6. Gary Wlash (2004). Biopharmaceuticals, Biochemistry and Biotechnology. 2nd edition. Wiley publisher.

Instruction Hours / week: L: 0 T: 0 P:3 Marks: Internal: 40 External: 60 Total:100
End Semester Exam: 6 Hours
COURSE OBJECTIVES

- To detail the entrepreneurship in field of life sciences.
- To obtain good understanding about the interpretation of biological products.
- To uptake knowledge in latest tools and technology.
- Aimed to provide an overview of various microbial bioproducts.
- Provide knowledge on manufacturing and production of bioproducts.
- To get introduced to the entrepreneurship skill in microbiology.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Describe and apply several entrepreneurial ideas and business theories in practical framework | Understand |
| CO2 | Clarify the metabolic pathways and control mechanisms of commercially important metabolites | Apply |
| CO3 | Commentate single cell proteins and express the importance of mushroom cultivation and probiotics | Understand |
| CO4 | Express the mass production of microbial inoculants used as Biofertilisers and Bioinsecticides in response with field application and crop response | Analyze |
| CO5 | Analyze the application and commercial production of Monoclonal antibodies, Cytokines. TPH and teaching kids | Understand |
| CO6 | Decode the significance of industrial production of Biofuels and Point out the role of Bioplastics and Biopigments | Apply |

Mapping with Programme Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO4 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO5 | M | S | S | S | S | S | S | S | S | S | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(36 Hours)

1. Production of bioproducts- Biofertilizers.
2. Production of bioproducts- Probiotics.
3. Production of Antibiotics – (Any antibiotic Eg: Penicillin)
4. Organic Farming- Vermicompost.
5. Quality control in biofertilizers
6. Study on integrated farming system
7. Study of models of IFS for rainfed and irrigated farming system and conditions.
8. Government schemes - NPOF, NPOF, NHM, HMNEH, NPMSH&F and RKVY

REFERENCE BOOKS:

1. The One-Straw Revolution: An Introduction to Natural Farming, YRB Classics; Main edition (2 June 2009), Masanobu Fukuoka, Frances Moore Lappé Wendell Berry

1 Subba Rao, N. S. (2002). Soil Microbiology. 4th ed. Soil Microorganisms and Plant Growth. Oxford & IBHPublishing Co. Pvt. Ltd., New Delhi.

3. Dubey, R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.

Instruction Hours / week: L: 4 T: 1 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- This course encompasses the use of microorganisms in the manufacture of food or industrial products.
- The use of microorganisms for the production of food, either human or animal, the microorganisms used in bio processes may be natural isolates; laboratory selected mutants or genetically engineered organisms.
- To know the basics and concepts of various biotechnological related terms
- Elucidate the significance of transgenic plants as bioreactors for the production of enzymes.
- Address bioethical and biosafety issues related to plant transgenics
- Elucidate the molecular techniques involved in gene manipulation and rDNA technology

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | This course will enable the students to design the various microbial fermentation products and their production, purification for various applications | Understand |
| CO2 | To know the process protocol for the, synthesis and characterization of nanoparticles | Apply |
| CO3 | Explain the gene transfer methods for the production of transgenic animals | Understand |
| CO4 | Gain experimental knowledge to perform animal biotechnology related experiments | Analyze |
| CO5 | Explain the application of biotechnology in medical and its allied fields, gene therapy, genetic counseling | Understand |
| CO6 | Address the bioethical issues & concerned linked to medical biotechnology | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO4 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO5 | M | S | S | S | S | S | S | S | S | S | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

UNIT I – Fermenter**(10 Hours)**

Design of a basic fermenter, bioreactor configuration, design features, computer control of fermentation process, measurement and control of process. Types of Bioreactors and its functions.

UNIT II - Cultures in the fermenter**(10 Hours)**

Growth of cultures in the fermenter. Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity.

UNIT III - Physical factors and scale-up**(10 Hours)**

Transport phenomena in fermentation: Gas- liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, heat transfer, aeration/agitation, its importance. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors.

UNIT IV – Microbial Products and Downstream process**(8 Hours)**

Enzymes- Introduction, Enzyme Kinetics, Immobilized Enzyme system, large scale production, Vitamins(Vitamin C), Amino acids, Enzymes, Antibiotics, Organic acids, Vaccines, Cheese, and Exopolysaccharides. Biotransformation product (steroid). Down streaming process of microbial products (Peptides, Biopolymers, surfactants, Enzymes) - separation, centrifugation, filtration, extraction, purification, crystallization, crystal washing, drying of crystals, freeze-drying, spray drying.

UNIT V - Strain improvement & Preservation**(12 Hours)**

Isolation, selection and improvement of important strains and pathways –Mutation, Protoplast fusion, parasexual cycle and genetic engineering for strain improvements, product formation and inhibition pathways and their regulations; applications in medicine, agriculture and industry. Role of plant and animal cells in bioprocess. Industrially important microorganisms, preservation, national and international culture collection centers.

SUGGESTED READING

1. Shuler, M.L., Kargi F., and DeLisa, M. Bioprocess Engineering: Basic concepts, 3rd Edition, 2017, Prentice Hall, Engelwood Cliffs.
2. Peter Stanbury, Allan Whitaker., S, Stephen Hall. Principles of Fermentation Technology, 3rd Edition, 2016, Elsevier Science and technology.
3. Casida, L.E.J.R. Industrial Microbiology, 2 nd Edition, 2019, New Age International Private Limited
4. Richard H. Baltz., Arnold L. Demain., Julian E. Davies. Manual of Industrial Microbiology and Biotechnology, 3rd edition, 2010, American Society for Microbiology.
5. Michael J. Waites., Neil L. Morgan. Industrial Microbiology: An Introduction, 2001, Wiley-Blackwell
6. El-Mansi, E. M. T., Bryce, C. F. A., Arnold L. Demain., Allman, A.R. Fermentation Microbiology and Biotechnology, 3rd Edition, 2011, CRC Press.

23MBU802

MICROBIAL ENZYMOLOGY

(5H–4C)

Instruction Hours / week: L: 4 T: 1 P:0**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- The course presents methods and experimental tools used in enzymology with an emphasis on prokaryotes and eukaryotes.
- The theoretical grounds of methods and their applications in research will be discussed.
- The course also deals with enzyme structure, stability, organization, and expression.
- The courses include among others model systems, the enzymes behind complex diseases
- To know the production and purification of microbial enzymes.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | This course allows the candidate to recollect the basics of enzymes and apply cognitive thinking to the application-oriented sectors of enzymes. | Understand |
| CO2 | Students would be able to practically apply this knowledge in different sectors with possibilities ranging from the treatment of human diseases. | Apply |
| CO3 | The development of novel medicines for treatment. | Understand |
| CO4 | A thorough understanding of the process of translation and operons along with the recombination of DNA. | Analyze |
| CO5 | An in-depth study of enzyme analysis with enzyme techniques. | Understand |
| CO6 | Full understanding of all aspects of all important techniques used for the study of enzymes. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO4 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO5 | M | S | S | S | S | S | S | S | S | S | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

Unit I - Bio energetics:**(10 Hours)**

Enzyme nomenclature, classification, general properties of enzymes, factors affecting enzyme activity, activation energy, transition state, turnover number, enzyme co-factors. Enzyme kinetics; General kinetic principles; steady-state enzyme kinetics, Michaelis-Menten equation, importance of K_m and V_{max} .

Unit II-Enzyme regulation:**(10 Hours)**

Allosteric and cooperative effects, concerted model of Monod et al, and sequential model of Koshland et al, Principles of metabolic regulations; feedback regulations of multifunctional pathway.

Unit III Isolation and purification of enzymes:**(10 Hours)**

Enzyme extraction –soluble enzymes, membrane bound enzymes, purification-precipitation methods, concentration of biomolecules: salting with ammonium sulphate precipitation, dialysis, lyophilisation, chromatographic methods, total activity and specific activity.

Unit IV- Assay techniques for microbial enzymes:**(8 Hours)**

Amylases, proteases, cellulases, and lipases, Basic principles of cell and enzyme immobilization.

Unit V Uses of enzymes in analysis**(12 Hours)**

Enzyme electrodes. Enzyme as biosensor, potentiometric biosensor, industrial applications of enzymes. Commercial value: steroidal conversions, penicillin and antibiotic conversion, immunosensor. Recent advances and future prospects of enzyme engineering; artificial enzymes. Enzymes in organic solvents, enzyme targeting using liposomes, isoenzymes

SUGGESTED READING

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009). The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.
3. DeRobertis EDP and DeRobertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4TH Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.

23MBU803

MARINE MICROBIOLOGY

(5H-4C)

Instruction Hours / week: L: 4 T: 1 P:0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- To provide students with basic knowledge on the biology and ecology of marine microorganisms, and their ecological role.
- To know the basic biology of marine microorganisms and their activities
- To impart modern techniques for the characterization and study of marine microorganisms and microbial communities.
- To understanding the ecological role of marine microorganisms and marine microbial communities.
- To know the main techniques of modern use necessary for the characterization and study of marine microbes.
- To understand basic biological processes that occur in and between organisms in nature.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|---|--------------|
| CO1 | Capable of describing and explaining both biological interaction processes and their importance to ecosystems. | Understand |
| CO2 | To acquire knowledge of the most common research methods used to develop our knowledge of biological processes. | Apply |
| CO3 | learn to work independently in collecting and analysing scientific data, both in the field and in the laboratory. | Understand |
| CO4 | Understand the architecture of marine ecosystem and its essential role | Analyze |
| CO5 | Specify the biological significance of biomolecules in metabolism | Apply |
| CO6 | To understand computer applications and Bioinformatics. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO4 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO5 | M | S | S | S | S | S | S | S | S | S | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

UNIT I - Marine microorganisms (10 Hours)

Introduction of coastal, shallow and deep sea. Marine microorganisms- important and their significance. Marine micro and macro-organisms-Collection, enumeration, identification based on morphological, physiological and biochemical characteristics and preservation. International and national collection centres.

UNIT-II- Extremophiles and Marine bio-diversity (10 Hours)

Thermopiles, basophiles, halophiles, psychrophiles, alkaliphiles, oligotroph, toxitolerant, xerotolerant, endolith – Extremophiles and their environment. Coral reefs, Sea grass, Mangroves, Hydrothermal vents and water currents.

UNIT III- Marine food pathogens and microbial toxin (10 Hours)

Marine food pathogenic microorganisms, distribution, indicator organism's prevention and control. Microbiology of processed -finfish and shellfish products. Microbial diseases- diagnosis and control. Introduction, microbial toxin, algal blooms, types. Harmful effect- Human health, Economic impact and Environmental impact, Potential remedies.

UNIT IV – Xenobiotics and Marine nutrient cycles (8 Hours)

Microbiology of degradation of xenobiotic environment: Ecological considerations, decay behavior, degradative plasmids, hydrocarbons, oil pollution, surfactants, pesticides, plastics and heavy metals. Factors affecting bioremediation – role of microbes in the marine nutrient cycles.

UNIT V – Marine Microbes bioproducts (12 Hours)

Microalgae and seaweeds – Food products- Human food and animal feed, Biomedical Products- Antimicrobial, antioxidant, antiviral and anticancer activity. Aquaculture feed inoculants -Industrial Application-bioethanol production. Biopigment products - Phytoplanktons, Bioluminescence.

SUGGESTED READINGS

1. Colin Munn. (2011). Marine Microbiology: Ecology & Applications. (2nd ed.). Black Well Publishers.
2. David Sigeo. (2005). Freshwater Microbiology: Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment. (1st ed.). Black well Publishers.
3. Joanne, M.W., Linda, S., and Christopher, J.W., (2008). Prescott, Harley, and Klein's Microbiology. (7th Ed). McGraw-Hill Higher Education, United States.
4. Se-Kwon Kim. (2013). Bioactive compounds and biotechnological applications. CLS Publishers
5. Dube, H.C. (1994). A text book of fungi, bacteria and viruses. Vikas Publishing House, New Delhi.
6. Dale, J.W. (1994). Molecular genetics of Bacteria. John Wiley and Sons.
7. Pelczar, M., JR., Chan, E.C.S., and Noel, R. K., (2006). Microbiology. Tata McGraw, Hill. Co. (5th ed.). New Delhi.
8. Prescott, L.N., Harley, J.P. and Klein, D.A., (1999). Microbiology. W.C. Brown Publishers.
9. Stanier, R.Y., Ingham, J.L., Wheelis, M.L., and Painter, P.R., (1986). General Waste water engineering Treatment, Disposal and Reuse. Metcalf and Eddy. Inc., Tata Mc Graw Hill, New Delhi.
10. Rheinheimer, G., 1980 Aquatic Microbiology-an Ecological Approach. Blackwell Scientific Publications
11. Kirchman, L Microbial Ecology of the Oceans 2000 John Wiley and Sons. Hans G. Truper et. al 1991.

23MBU804 BIOMEDICAL RESEARCH AND ANIMAL MANAGEMENT**(5H-4C)****Instruction Hours / week: L: 4 T: 1 P:0****Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- Aimed to provide training on various methods of handling.
- Concerning the care and use of laboratory animals.
- Laboratory animal care provides the proper handling and care for various species of animals used in research, testing, and in education.
- It extensively deals with the amended act on the Animal Welfare.
- It deals with the concept, availability and use of research or testing methods that limit the use of animals or minimize animal distress.
- To study the preclinical studies.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Laboratory animal care provides the proper handling and care for various species of animals used in research, testing, and in education. | Understand |
| CO2 | It extensively deals with the amended act on the Animal Welfare and the concept, availability, and use of research or testing methods that limit the use of animals or minimize animal distress. | Apply |
| CO3 | This course content will enhance the employment in drug testing field. | Understand |
| CO4 | Validation for equipment, methods, cleaning and process | Analyze |
| CO5 | Students can develop their entrepreneurial skills in analysis of pens design and environment. | Apply |
| CO6 | Ethical knowledge for use of animals in research. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO4 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO5 | M | S | S | S | S | S | S | S | S | S | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low**UNIT – I - Responsibilities of institution and chief investigators****(10 Hours)**

General introduction - responsibilities of institution and chief investigators, Aspects of rabbit behavior relevant to housing, Rabbit Group housing in pens, advantages and disadvantages, Pens, design of pens environment, Rabbit care management – Regrouping, catching and identification in pens and cages, Rabbit care management – food, water, health and breeding in pens and cages, Cage design and environment, Environment enrichment for rabbits in pens and cages, Ethical guidelines for use of animals in research.

UNIT – II – Mice**(10 Hours)**

Introduction-behavior, anatomic and physiological features of mice in lab, Husbandry-Housing, nutrition and breeding requirements and management of lab mice, occupational health and zoonotic

diseases, treatment of disease in mice, regulatory agencies and compliance associates with management of lab mice, Restraining and sample collection methods from lab mice, Physical, examination of mice for disease conditions, anesthesia and analgesia -mice, Euthanasia in veterinary care.

UNIT – III – Rat

(10 Hours)

Introduction to anatomical and physiological features of laboratory rat, major color groups and varieties of rats, regulatory management housing of laboratory rats-equipment, feed formulation, ailments & disease management of laboratory rats, disease management and ailments of laboratory rats, restraining and sample collection in lab rats, anesthesia and analgesia of lab rats, breeding of laboratory rats.

UNIT – IV - Guinea pig

(8 Hours)

Introduction – history and classification of guinea pigs, varieties and characteristics of guinea pigs used in labs, characteristics and behaviors of the guinea pig used in labs, housing, nutrition and feeding of guinea pigs, care and handling of guinea pigs in lab, zoonoses of guinea pigs, reproduction and breeding managements in guinea pigs –gnotobiotic animals.

UNIT – V- Role in microbiology

(12 Hours)

Various routes of inoculation in mice & rats, various routes of inoculation in mice & rats, handling and routes of inoculation in rabbits, guinea pigs, laboratory use of animals –role in microbiology, antibody production in animals, disposal of animal house wastes, safety measures in animal house. National animal house Facilities in India.

SUGGESTED READINGS

1. The IACUC Handbook, 2nd ed., eds. Silverman, Murthy, Suckow. CRC Press, (2006).
2. Anesthesia and Analgesia in Laboratory Animals. American College of Laboratory Animal Medicine, second ed.), eds. Richard Fish, Peggy Danneman, Marilyn Brown, and Alicia Karas. Academic Press, (2008).
3. The Mouse in Biomedical Research, second ed.), eds. James G. Fox, Muriel T. Davisson, Fred W. Quimby, Stephen W. Barthold, Christian E. Newcomer and Abigail L. Smith. Elsevier, (2007).
4. The Laboratory Rat, (2nd ed.). American College of Laboratory Animal Medicine. eds. Suckow, Weisbroth and Franklin. Elsevier, (2006).
5. Handbook on Genetically Standardized Mice. (6th ed.). Ed. Joanne Curren, The Jackson Laboratory, Bar Harbor, Maine, (2009).
6. Laboratory Animal Medicine, (2nd ed.). American College of Laboratory Animal Medicine, eds. Fox, Anderson, Lowe, Quimby. Academic Press, (2002).
7. Percy, D.H., and Barthold, S.W., (2007). Pathology of Laboratory Rodents and Rabbits, (3rd ed.). Blackwell Publishing Company.
8. Nalinasundari, M.S., and Santhi, R., (2006). Entomology. MJP Publishers, Chennai.
9. Pelczar, Jr. M.J., Chan, E.C.S., and Kreig, N.R., (1993). Microbiology McGraw-Hill Inc. New York.
10. Warren, D. M. (2002). Small Animal Care and Management. (2nd ed.). Delmar – Thomson Learning, Columbia, NY.
11. Yadav, M. (2004). Applied Entomology. (1st ed.). Discovery Publishing House, New Delhi.

23MBU805 MEDICAL CODING AND PHARMACOVIGILANCE (5H-4C)**Instruction Hours / week: L: 4 T: 1 P:0 Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 3Hours****COURSE OBJECTIVES**

- This program will train students to properly locate, document, and validate appropriate diagnostic and procedure codes using the current ICD-9-CM/ICD-10-CM, CPT, and HCPCS coding manuals for professional services.
- The medical coder reviews the patient's file and translates everything from that file into universal codes required by insurance companies.
- To motivate public to participate in environment protection and improvement.
- To Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.
- Students will demonstrate understanding of appropriate workplace relationships by reading articles and responding to thought-provoking questions.
- This includes everything from diagnosis and treatment, to what supplies were used. The coder also indicates if there were any unusual circumstances during the visit or procedure.

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | Students will also gain knowledge of medical legal and ethical responsibilities, as well as anatomy and medical terminology. | Apply |
| CO2 | Students completing this program will be able to apply for employment opportunities in doctor's offices, clinics, nursing homes, hospitals, labs, public health facilities and insurance agencies. | Apply |
| CO3 | Students will be required to complete and turn in one Hybrid Assignment each week to show they are working at home. | Understand |
| CO4 | Students will show comprehension of anatomical and physiological information learned on multiple choice tests. | Apply |
| CO5 | Students will demonstrate understanding of correct coding guidelines by completing coding simulations and reviews | Understand |
| CO6 | Ethics in coding. | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO4 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO5 | M | S | S | S | S | S | S | S | S | S | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

Unit I – Introduction to US Healthcare**(10 Hours)**

Healthcare in India and US, Patient, Provider and Payers Relationship, Importance and significance of coding in today's world

Unit II - ICD-10-CM**(10 Hours)**

History, Volumes, Conventions, General Coding Guidelines, Chapter Specific Guidelines, Infections and Parasitic Diseases, Neoplasms, Endocrine, Nutritional and metabolic diseases and immunity disorders. Diseases of blood and blood forming organs. Mental disorders

Unit III - Introduction to Pharmacovigilance**(10 Hours)**

History and development of Pharmacovigilance, Importance of safety monitoring of Medicine. WHO international drug monitoring programme, Pharmacovigilance Program of India (PvPI).

Unit IV - Introduction to adverse drug reactions**(8 Hours)**

Definitions and classification of ADRs, Detection and reporting, Methods in Causality assessment, Severity and seriousness assessment, Predictability and preventability assessment Management of adverse drug reactions. Drug and disease classification Anatomical, therapeutic and chemical classification of drugs, International classification of diseases, daily defined doses International Non-proprietary Names for drugs.

Unit V - Pharmacovigilance methods**(12 Hours)**

Passive surveillance – Spontaneous reports and case series Stimulated reporting. Active surveillance – Sentinel sites, drug event monitoring and registries Comparative observational studies – Cross sectional study, case control study and cohort study. Targeted clinical investigations.

SUGGESTED READINGS

1. Textbook of Pharmacovigilance: Ensuring the Safe Use of Medicines. SK Gupta, Sushma Srivastava Jaypee Brothers Medical Publishers, 24-Dec-2018 - Medical - 638 pages
2. Current trends in pharmacovigilance. by Varun and Deepak Pragi. 1 January 2020.
3. The ICD-10 classification of mental & behavioural disorders: clinical descriptions and diagnostic guidelines paperback – 1 January 2002 by W.H.O (author).

Instruction Hours / week: L: 0 T: 0 P:4**Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 9 Hours****COURSE OBJECTIVES**

- This course encompasses the use of microorganisms in the manufacture of food or industrial products.
- The use of microorganisms for the production of food, either human or animal, the microorganisms used in bio processes may be natural isolates; laboratory selected mutants or genetically engineered organisms.
- To know the basics and concepts of various biotechnological related terms
- Elucidate the significance of transgenic plants as bioreactors for the production of enzymes.
- Address bioethical and biosafety issues related to plant transgenics
- Elucidate the molecular techniques involved in gene manipulation and rDNA technology

COURSE OUTCOME

At the end of this course, students will be able to

| COs | Course Outcomes | Blooms Level |
|-----|--|--------------|
| CO1 | This course will enable the students to design the various microbial fermentation products and their production, purification for various applications | Understand |
| CO2 | To know the process protocol for the, synthesis and characterization of nanoparticles | Apply |
| CO3 | Explain the gene transfer methods for the production of transgenic animals | Understand |
| CO4 | Gain experimental knowledge to perform animal biotechnology related experiments | Analyze |
| CO5 | Explain the application of biotechnology in medical and its allied fields, gene therapy, genetic counseling | Understand |
| CO6 | Address the bioethical issues & concerned linked to medical biotechnology | Apply |

Mapping with Programme Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1 | M | S | M | M | S | M | S | M | S | M | M | S |
| CO2 | M | M | L | M | M | M | M | M | M | L | M | M |
| CO3 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO4 | M | M | S | S | S | S | S | S | S | S | M | M |
| CO5 | M | S | S | S | S | S | S | S | S | S | M | S |
| CO6 | M | M | L | M | M | M | M | M | M | L | M | M |

S-Strong; M-Medium; L-Low

EXPERIMENTS

(40 Hours)

1. Microbial fermentation – Production and estimation (qualitative and quantitative) of enzyme- Amylase, Protease, lipase and asparaginase.
2. Microbial fermentation – Production and estimation (qualitative and quantitative) of Amino acid - Glutamic acid.
3. Microbial fermentation – Production and estimation (qualitative and quantitative) of Organic acid- Citric acid and DHA.
4. Microbial fermentation – Production and estimation (qualitative and quantitative) of Antibiotics - Penicillin, Bacitracin.
5. Microbial fermentation – Production and estimation (qualitative and quantitative) of Alcohol - Ethanol

SUGGESTED READINGS

1. Nduka Okafor, Benedict C. Okeke (2017) Modern Industrial Microbiology and Biotechnology, 2nd Edition, CRC Press.
2. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
3. Crueger W and Crueger A. (2017). Biotechnology: A textbook of Industrial Microbiology. 3rd edition. Panima Publishing Co. New Delhi.
4. Geoffrey M Gadd, Sima Sariaslani (2015) Advances in Applied Microbiology, CRC Press.
5. E. MTEI-Mansi, Jens Nielsen, David Mousdale (2009) Fermentation Microbiology and Biotechnology, Fourth Edition, CRC Press.
6. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc
7. Nigam A and Ayyagari A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill

B.Sc. Microbiology

2023-2024
Semester –VIII

23MBU891

RESEARCH PROJECT

(18H-12C)

Instruction Hours / week: L:0 T: 0 P:18 Marks: Internal: 120 External: 180 Total:300