B.Sc., BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

Curriculum and Syllabus
(2023-2024)

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

DEPARTMENT OF BIOTECHNOLOGY

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)
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FACULTY OF ARTS, SCIENC, COMMERCE AND MANAGEMENT
UNDERGRADUATE PROGRAMMES
REGULAR 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.

S. No.	PROGRAMME	DISCIPLINE
1.	B.Com.	Commerce
2.	B.Com.	Computer Applications
3.	B.Com.	Professional Accounting
4.	B.Com.	Business Process Services
5.	B.Com.	Financial Analytics
6.	B.Com.	International Accounting and Finance
7.	B.Com.	Information Technology
8.	BBA	Business Administration
9.	B.Sc.	Biotechnology
10.	B.Sc.	Microbiology
11.	B.Sc.	Computer Science
12.	B.Sc.	Information Technology
13.	B.Sc.	Computer Technology
14.	B.Sc.	Computer Science (Cognitive Systems)
15.	B.Sc.	Computer Science (Artificial Intelligence and Data Science)
16.	BCA	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 Tamil Nadu 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	Min. No. of Semesters	Max. No. of Semesters
B.Sc., B.Com., BCA and BBA	I	2	4
	II	4	8
	III	6	12
	IV	4	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:

S.No	Name of the Offering Department	Name of the Course
1.	Biotechnology	Environmental Studies
2.	Commerce	Indian Knowledge System
3.	Biochemistry	Health and Wellness
4.	Computer Science	Cyber Security
5.	Artificial Intelligence and Data Science	Fundamentals of Artificial Intelligence
		Fundamentals Of Data Science
		Internet Programming
		Robotics And Automation
6.	Biomedical Engineering	Human Anatomy and Physiology
		Artificial Organs and Implants
7.	Bio Technology	Bioreactor Design
		Food Processing and Preservation
		Basic Bioinformatics

		Fundamentals Of Nano Biotechnology
8.	Civil Engineering	Housing, Plan and Management
		Building Services
		Repair and rehabilitation of structures
		Computer-Aided Civil Engineering Drawing
		Contracts Management
		Air and Noise Pollution andControl
9.	Computer Science and Design	Introduction To 3d Modelling and Animation
		Digital photography
		Mobile Application Development
10.	Computer Science and Engineering	Internet of Things
		Machine Learning
		Blockchain Technologies
11.	Electronics and Communication Engineering	Neural Networks and Its Applications
		Principles of Modern Communication System
12.	Food Technology	Processing Of Food Materials
		Nutrition And Dietetics
		Ready To eat foods
		Agricultural Waste And Byproducts Utilization
		Design Of Food process equipment
13.	Mechanical Engineering	Computer Aided Design
		Industrial Safety and Environment
		Non-Destructive testing
14.	Electrical and Electronics Engineering	Electric Hybrid Vehicle
		Renewable 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 100 marks, 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 advice 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 Course Coordinator. 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 Committee Meeting 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 work class, 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

S. No.	Category	Maximum Marks
1.	Assignment	5
2.	Attendance	5
3	Seminar	5
4.	Test – I (1 ½ units- Unit I and II)	8
5	Test – II (1 ½ units Unit II and III)	8
6	Test III (2 units Unit IV and V)	9
Continuous Internal Assessment: Total		40

Practical Courses

S. 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	50 marks
Duration	2 Hours
Part – A	Objective type (20 x1=20)
Part - B	Short Answer Type (3 x2 = 6)
Part - C	3 Eight mark questions 'either – or' choice (3 x 8 = 24 Marks)

13.5 Attendance

Marks Distribution for Attendance

S. No.	Attendance (%)	Maximum Marks
1	91 and above	5
2	81 - 90	4
3	76 - 80	3
4	Less than or equal to 75	0

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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	60 marks for ESE.
Duration	3 hours (½ Hr for Part – A Online & 2 ½ Hours for Part – B and C)
Part - A	20 Questions of 1 mark each (20 * 1 = 20 Marks) Question No. 1 to 20 Online Multiple Choice Questions
Part- B	5 Questions of 2 marks each (5 * 2 = 10 Marks) Covering all the five units of the syllabus Question No. 21 to 25
Part- C	5 six marks 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	91 - 100	10	OUTSTANDING
A+	81- 90	9	EXCELLENT
A	71-80	8	VERY GOOD
B+	66- 70	7	GOOD
B	61 – 65	6	ABOVE AVERAGE
C	55 - 60	5	AVERAGE
D	50 - 54	4	PASS
RA	<50	-	REAPPEARANCE
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:

i. The list of courses enrolled during the semester and the grade scored.

ii. 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.

GPA of a Semester = (Sum of the product of the GP by the corresponding credits of the courses offered in that Semester) / (Sum of the credits of the courses of that Semester)

i.e. **GPA** of a Semester = $\frac{\sum_i CiGPi}{\sum_i Ci}$

CGPA of the entire programme = (Sum of the product of the GPs by the corresponding credits of the courses offered for the entire programme) / (Sum of the credits of the courses of the entire programme)

i.e. **CGPA** of the entire programme = $\frac{\sum_n \sum_i CniGPni}{\sum_n \sum_i Cni}$

where,

Ci is the credit fixed for the course 'i' in any semester
GPi 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 3^{rd} or 5^{th} or 7^{th} semester with an appropriate Undergraduate Certificate or Undergraduate Diploma or Undergraduate Degree certificates respectively.

Karpagam Innovation and Incubation Council (KIIC)

(A Section 8 Company)

Based on the 2019 National Innovation and Startup Policy and the 2019–2023 Tamil Nadu 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.

Sl. No.	Description/Startup phases	In place of the Subject / Course title	Grades/Credits /Marks
1	**Idea stage/Problem Identification**	**Seminar**	**Same Marks/Credits can be 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

S.No.	Programme	Subject	Eligibility
1.	B. Sc.	Biotechnology	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern taking Biology or Botany or Zoology or chemistry as subjects at the Higher Secondary level.
2.	B. Sc.	Computer Science	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State 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.
3.	B. Sc.	Microbiology	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern taking Biology or Botany Zoology or chemistry as subjects at the Higher Secondary level.
4.	B. Sc.	Information Technology	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State 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.
5.	B. Sc.	Computer Technology	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State 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.
6.	B.Sc.	Computer Science(Cognitive Systems)	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State 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.

7.	B.Sc.	Computer Science (Artificial Intelligence and Data Science)	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State 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.
8.	BCA	Computer Application	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State 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.
9.	B. Com.	Commerce	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern Commerce as a subject under the academic or vocational stream at the Higher Secondary level
10.	B.Com (CA)	Commerce with Computer Applications	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern Commerce as a subject under the academic or vocational stream at the Higher Secondary level
11.	B. Com. (PA)	Commerce with Professional Accounting	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern Commerce as a subject under the academic or vocational stream at the Higher Secondary level
12.	B. Com. (BPS)	Commerce with Business Process Services	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern Commerce as a subject under the academic or vocational stream at the Higher Secondary level
13.	B.B.A.	Business Administration	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern Commerce as a subject under the academic or vocational stream at the Higher Secondary level
14.	B. Com	Financial Analytics	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern Commerce as a subject under the academic or vocational stream at the Higher Secondary level

15.	B. Com	International Accounting and Finance	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern Commerce as a subject under the academic or vocational stream at the Higher Secondary level
16.	B.Com	Information Technology	Candidates who have passed Higher Secondary Education (XII) or any equivalent Examination conducted by a State Government or a University or Board under the 10+2 pattern Commerce as a subject under the academic or vocational stream at the Higher Secondary level

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

Course code	Name of the course	Objectives and outcomes		Instruction hour / week			Credits	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	12
23ENU101	English I	I	a	3	-	-	3	40	60	100	MDC 1	18
23BTU101	Biochemistry and Metabolism	I	a	5	1	-	5	40	60	100	CC 1	20
23BTU102	Chemistry I	I	a	4	1	-	4	40	60	100	MC 1	22
23BTU111	Biochemistry and Metabolism Practical	I	b	-	-	4	2	40	60	100	SEC 1	24
23BTU112	Chemistry I Practical	I	a	-	-	4	2	40	60	100	MC 2	26
23VAC101	Value Added Courses Environmental Studies	II	d	2	-	-	2	40	60	100	VAC 1	28
	Activity: Library/Seminar	-	-	-	-	02	-	-	-	-	-	30
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
23BTU201	Cell Biology	I, II	a	5	1	-	5	40	60	100	CC 2	38
23BTU202	Chemistry II	I	a	5	1	-	5	40	60	100	MC 3	40
23BTU211	Cell Biology Practical	I, II	a	-	-	4	2	40	60	100	CC 3	42
23BTU212	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	-	-	-	-	-	48
Semester Total				**19**	**02**	**09**	**22**	**280**	**420**	**700**		
SEMESTER III												
23LSU301	Language - III	I	a	4	-	-	4	40	60	100	AEC 3	49
23ENU301	English - III	I	a	3	-	-	3	40	60	100	MDC 3	52
23BTU301	Molecular Biology	II, III	e, k	4	1	-	4	40	60	100	CC 4	54
23BTU302	General Microbiology	II, III	e	4	-	-	4	40	60	100	CC 5	56
23BTU303A/ 23BTU303 B	Bioinstrumentation and Biostatistics / Biophysics	II, III	g	3	-	-	3	40	60	100	MC 4	58 - 61

22BTU311	Molecular Biology practical	II, III	e, k	-	-	4	2	40	60	100	CC 6	62
23BTU312	General Microbiology Practical	II, III	f	-	-	3	1	40	60	100	MC 5	64
23VAC303	Value added course: Cyber security		d	2	-	-	2	40	60	100	VAC 3	66
23BTU391	Internship*			-	-	-	2	100	-	100	SEC 3	68
	Activity: Library/Seminar	-	-	-	-	02	-	-	-	-	-	69
Semester Total				**20**	**01**	**09**	**25**	**420**	**480**	**900**		
SEMESTER IV												
23LSU401	Language - IV	I	a	4	-	-	4	40	60	100	AEC 4	70
23ENU401	English - IV	I	a	3	-	-	3	40	60	100	SEC 4	73
23BTU401	Recombinant DNA Technology	II, III	e	5	-	-	5	40	60	100	CC 7	75
23BTU402	Genetics	II, III	c	4	1	-	4	40	60	100	CC 8	77
23BTU403A/ 23BTU403B	Basics of Forensic Science / Evolutionary Biology	II, III	g	3	-	-	3	40	60	100	MC 6	79 - 82
23BTU411	Recombinant DNA Technology and Genetics Practical	II, III	e, g	-	-	4	2	40	60	100	CC 9	83
23SEC412	Basics of Forensic Science / Evolutionary Biology Practical	II, III	c	-	-	4	2	40	60	100	SEC 5	85 - 88
	Activity: Library/Seminar					02						89
Semester Total				**19**	**01**	**10**	**23**	**280**	**420**	**700**		
SEMESTER V												
23BTU501	Plant Biotechnology	II, III	i	5	-	-	5	40	60	100	CC 10	90
23BTU502	Animal Biotechnology	II, III	i	5	-	-	5	40	60	100	CC 11	92
23BTU503	Immunology	II, III	g	5	-	-	5	40	60	100	CC 12	94
23BTU504A/ 23BTU504B	Microbial Biotechnology/ Marine Biotechnology	II, III	g	4	1	-	4	40	60	100	MC 7	96 - 99
23BTU511	Plant and Animal Biotechnology Practical	II, III	i	-	-	4	2	40	60	100	CC 13	100
23BTU512	Immunology Practical	II, III	j	-	-	4	2	40	60	100	CC 14	102
23BTU591	Internship*			-	-	-	2	100	-	100	SEC 6	104

	Activity: Library/Seminar					02						105
Semester Total				**19**	**01**	**10**	**25**	**340**	**360**	**700**		
SEMESTER VI												
23BTU601	Bioprocess Technology	II, III	f	5	-	-	5	40	60	100	CC 15	106
23BTU602	Environmental Biotechnology and Management	II, III	d	5	-	-	5	40	60	100	CC 16	108
23BTU603A/ 23BTU603B	Genomics and Proteomics / Bioinformatics	II, III	e	5	-	-	5	40	60	100	MC 8	110 -113
23BTU611	Bioprocess Technology, Environmental Biotechnology and Management Practical	II, III	d	-	-	4	2	40	60	100	CC 17	114
23BTU613A / 23BTU613B	Genomics and Proteomics / Bioinformatics	II, III	e	-	-	4	2	40	60	100	SEC 7	116 - 119
23BTU691	Project	II, III		-	-	7	4	80	120	200	CC 18	120
Semester Total				**15**	**-**	**15**	**23**	**280**	**420**	**700**		
3rd year total				**110**	**07**	**63**	**140**	**1880**	**2520**	**4400**		
SEMESTER VII												
23BTU701	Pharmaceutical Biotechnology	II, III	k	5	01	-	5	40	60	100	CC 19	121
23BTU702	Nano Biotechnology	II, III	k	5	01	-	5	40	60	100	CC 20	123
23BTU703A/ 23BTU703B	Plant Physiology and Diversity / Animal Physiology and Diversity	II, III	e	4	01	-	4	40	60	100	MC 9	125 - 128
23BTU704 A/ 23BTU704 B	Molecular Diagnostics / Medical Devices	II, III	k	4	01	-	4	40	60	100	MC 10	129 - 132
23BTU711	Pharmaceutical, Nano Biotechnology Practical	II, III	k	-	-	3	1	40	60	100	CC 21	133
23BTU713A / 23BTU713B	Molecular Diagnostics Practical / Medical Devices Practical	II, III	k	-	-	3	1	40	60	100	MC 11	135 - 138
	Activity: Library/Seminar					02						139
Semester Total				**18**	**04**	**08**	**20**	**240**	**360**	**600**		
SEMESTER VIII A												
23BTU801	Food Biotechnology	II, III	k	4	01	-	4	40	60	100	CC 22	140
23BTU802	Research Methodology	II, III	a	4	01	-	4	40	60	100	MC 12	142
23BTU803	Medical Microbiology	II, III	k	4	01	-	4	40	60	100	CC 24	144
23BTU804	Agriculture Biotechnology	II, III	k	4	01	-	4	40	60	100	CC 25	146
23BTU805	Tissue Engineering and Regenerative	II, III	k	4	01	-	4	40	60	100	MC 13	148

	Medicine											
23BTU811	Food Biotechnology Practical	II, III	k	-	-	4	2	40	60	100	CC 23	150
	Activity:Library/Seminar					01						152
Semester Total				**20**	**05**	**05**	**22**	**240**	**360**	**600**		
				148	**16**	**76**	**182**	**2360**	**3240**	**5600**		
SEMESTER VIII B												
23BTU801	Food Biotechnology	II, III	k	4	-	-	4	40	60	100	CC 22	150
23BTU802	Research Methodology	II, III	a	4	-	-	4	40	60	100	MC 12	142
23BTU811	Food Biotechnology Practical	II, III	k	-	-	4	2	40	60	100	CC 23	150
23BTU891	Research Project	II, III	l		-	18	12	120	180	300	CC 26	153
Semester Total				**08**	**-**	**22**	**22**	**240**	**360**	**600**		
4th Year Toral				**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

Number of courses and Credits split-up for 3-year B.Sc., Biotechnology programme

S.No.,	Course Criteria	Number of courses	Total number of credits
1	Ability Enhancement Courses	4	16
2	Major course/Core courses	17	64
3	Minor courses/ Elective courses	8	27
4	Multidisciplinary Courses	3	9
5	Skill Enhancement courses	7	14
6	Value added courses	3	6
7	Project	1	4
Total		**43**	**140**

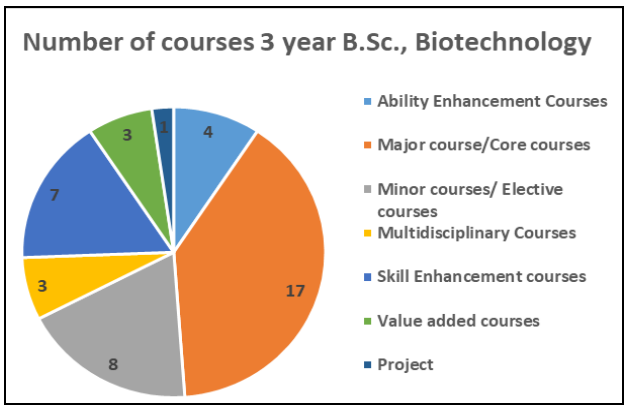
Number of courses and Credits split-up for 4-year B.Sc., Biotechnology programme (Hons) – without research

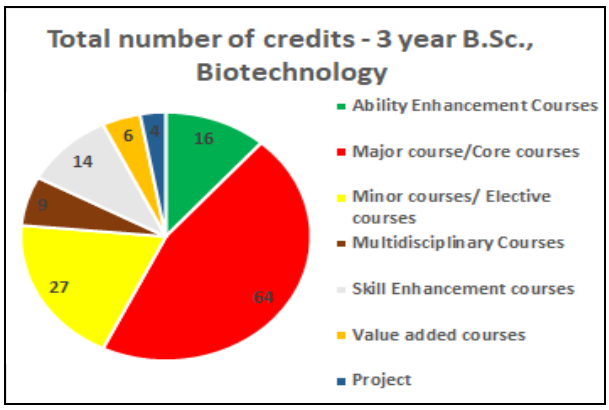
S.No.,	Course Criteria	Number of courses	Total number of credits
1	Ability Enhancement Courses	4	16
2	Major course/Core courses	24	89
3	Minor courses/ Elective courses	13	44
4	Multidisciplinary Courses	3	9
5	Skill Enhancement courses	7	14
6	Value added courses	3	6
7	Research Project	1	4
Total		**55**	**182**

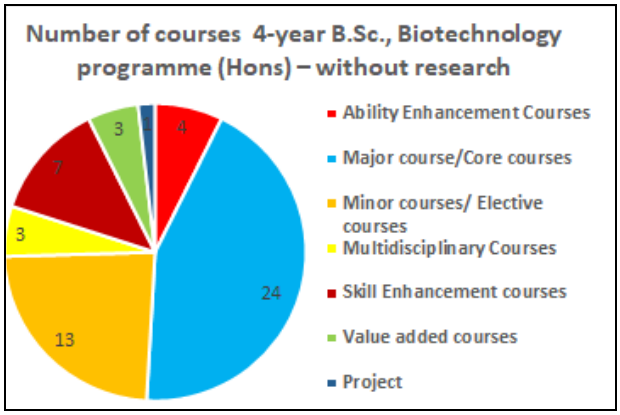
Number of courses and Credits split-up for 4-year B.Sc., Biotechnology programme (Hons) – with research

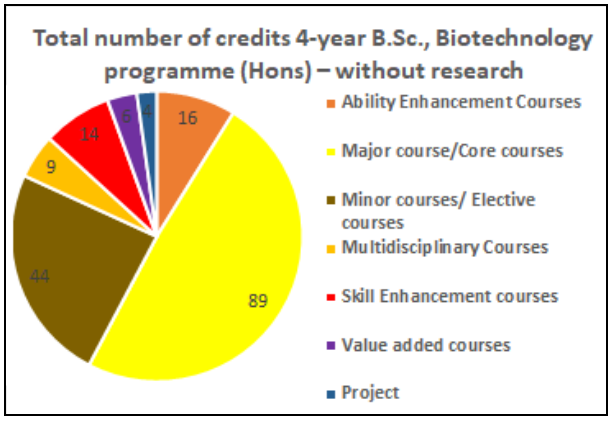
S.No.,	Course Criteria	Number of courses	Total number of credits
1	Ability Enhancement Courses	4	16
2	Major course/Core courses	23	85
3	Minor courses/ Elective courses	12	40
4	Multidisciplinary Courses	3	9
5	Skill Enhancement courses	7	14
6	Value added courses	3	6
7	Project	1	12
Total		**53**	**182**

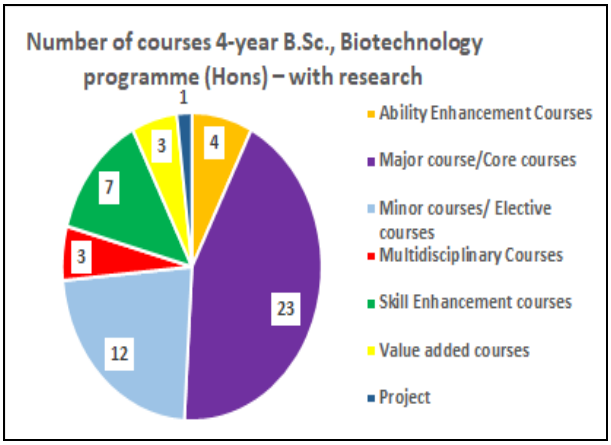
Number of Courses and Credit Distributions

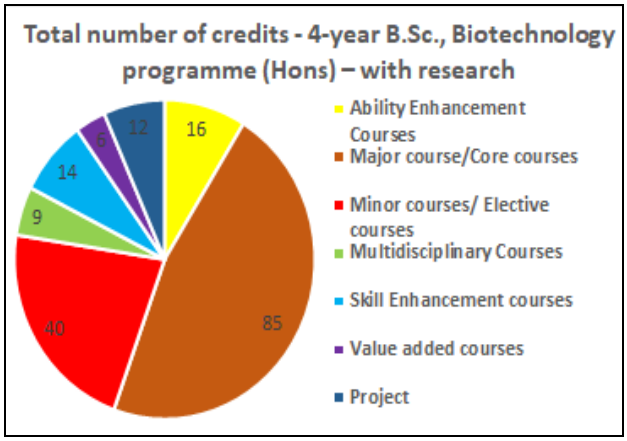












Credits split up: B.Sc., Biotechnology

Semester	AEC	Major course	Minor course	MDC	SEC	VAC	Internship	Project	Total credits
1.	4	5	6	3	2	2			22
2.	4	7	5	3	1	2			22
3.	4	10	4	3	-	2	2		25
4.	4	11	3	-	5	-			23
5.	-	19	4	-	-	-	2		25
6.	-	12	5	-	2	-	0	4	23
3rd year Total	16	64	27	9	10	6	4	4	140
7.	-	11	9	-	-	-	-	-	20
8. A	-	14	8	-	-	-	-	-	22
4th year total	16	89	44	9	10	6	4	4	182
8 B	-	6	4	-	-	-	-	12	22
4th year total	16	81	40	9	10	6	4	16	182

Courses split up: B.Sc., Biotechnology

Semester	AEC	Major course	Minor course	MDC	SEC	VAC	Intern	Project	Total courses	T	P	Int/ skill/ Pro
1.	1	1	2	1	1	1	-	-	7	5	2	
2.	1	2	1	1	1	1	-	-	7	5	2	
3.	1	3	2	1	-	1	1	-	9	6	2	1
4.	1	3	1	-	2	-	-	-	7	5	2	
5.	-	5	1	-	-	-	1	-	7	4	2	1
6.	-	3	1	-	1	-	-	1	6	4	1	1
3rd year Total	4	18	8	3	5	3	2	1	43	29	11	3
7.	-	3	3	-	-	-	-	-	6	4	2	-
8. A	-	4	2	-	-	-	-	-	6	5	1	-
4th year total	4	24	13	3	5	3	2	1	55	38	14	3
8 B	-	2	1	-	-	-	-	1	4	2	1	1
4th year total	4	22	12	3	5	3	2	2	53	35	14	4

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

	Core Courses (Major Courses) - CC		
S.No.,	**Semester**	**Course Code**	**Name of the course**
1.	I	23BTU101	Biochemistry and Metabolism
2.	II	23BTU201	Cell Biology
3.	II	23BTU211	Cell Biology Practical
4.	III	23BTU301	Molecular Biology
5.	III	23BTU302	General Microbiology
6.	III	23BTU311	Molecular Biology Practical
7.	IV	23BTU401	Recombinant DNA Technology
8.	IV	23BTU402	Genetics
9.	IV	23BTU411	Recombinant DNA Technology and Genetics Practical
10.	V	23BTU501	Plant Biotechnology
11.	V	23BTU502	Animal Biotechnology
12.	V	23BTU503	Immunology
13.	V	23BTU511	Plant and Animal Biotechnology Practical
14.	V	23BTU512	Immunology Practical
15.	VI	23BTU602	Bioprocess Technology
16.	VI	23BTU601	Environmental Biotechnology and Management
17.	VI	23BTU611	Bioprocess Technology, Environmental Biotechnology and Management Practical
18.	VI	23BTU691	Minor Project
19.	VII	23BTU701	Pharmaceutical Biotechnology
20.	VII	23BTU702	Nano Biotechnology
21.	VII	23BTU711	Pharmaceutical, Nano Biotechnology Practical
22.	VIII A	23BTU801	Food Biotechnology
23.	VIII A	23BTU811	Food Biotechnology Practical
24.	VIII A	23BTU803	Medical Microbiology
25.	VIIIA	23BTU804	Agricultural Biotechnology
26.	VIIIB	23BTU891	Research Project

	Core Courses (Minor Courses) - MC		
S.No.,	**Semester**	**Course Code**	**Name of the course**
1.	I	23BTU102	Chemistry I
2.	I	23BTU112	Chemistry I Practical
3.	II	23BTU202	Chemistry II
4.	III	23BTU303A/ 23BTU303 B	Bioinstrumentation and Biostatistics / Biophysics
5.	III	23BTU312	General Microbiology Practical
6.	IV	23BTU403A/ 23BTU403B	Basics of Forensic Science / Evolutionary Biology
7.	V	23BTU504A/ 23BTU504B	Microbial Biotechnology/ Marine Biotechnology
8.	VI	23BTU603A/ 23BTU603B	Genomics and Proteomics / Computational Biology
9.	VII	23BTU703A/23BTU703B	Plant Physiology and Diversity / Animal Physiology and Diversity /
10.	VII	23BTU704 A/ 23BTU704 B	Molecular Diagnostics / Medical Devises
11.	VII	23BTU713A / 23BTU713B	Molecular Diagnostics Practical / Medical Devises Practical
12.	VIIIA	23BTU802	Research Methodology
13.	VIIIA	23BTU805	Tissue Engineering and Regenerative Medicine

Ability Enhancement Courses - AEC			
S.No.,	**Semester**	**Course Code**	**Name of the course**
1.	I	23LSU101	Language – I
2.	II	23LSU201	Language – II
3.	III	23LSU201	Language – III
4.	IV	23LSU201	Language – IV

Value Added Courses - VAC			
S.No.,	**Semester**	**Course Code**	**Name of the course**
1.	I	23VAC101	Environmental Studies
2.	II	23VAC201	Indian Knowledge System
3.	III	23VAC301	Cyber security

Skill Enhancement Courses - SEC			
S.No.,	**Semester**	**Course Code**	**Name of the course**
1.	I	23BTU111	Biochemistry and Metabolism Practical
2.	II	23BTU212	Chemistry II Practical
3.	III	23BTU391	Internship*
4.	IV	23ENU401	English IV
5.	III	23BTU403A/ 23BTU403B	Basics of Forensic Science / Evolutionary Biology
6.	IV	23SEC412	General Microbiology Practical
7.	V	23BTU591	Internship*
8.	VI	23BTU613A / 23BTU613B	Genomics and Proteomics Practical / Computational Biology Practical

Multidisciplinary Courses - MDC			
S.No.,	**Semester**	**Course Code**	**Name of the course**
1.	I	23ENU101	English I
2.	II	23ENU201	English II
3.	III	23ENU301	English III

PROGRAMME OUTCOMES (POs)

1. The Graduates will be able to understand the language comprehension and vocabulary usage in languages.
2. Graduates will acquire in-depth understanding of basic concept, knowledge about biochemistry and cell organelles, metabolic aspects of biomolecules and their functions for applied field, allied subject and life skills.
3. The graduate will understand the environmental pollution and practices the policy environmental conservation and its awareness
4. The Graduates will gain the structural and functional attributes of cells growth and proliferation
5. The Graduates will gain insights to the microbial community and its dynamics.
6. The Graduates will be able to articulate the gene structure function and its expression strategies, and be an expertise in operating the instruments.
7. Develop skills associated with screening of industrially important strains, various aspects of bioprocess technology and rDNA technology by the graduates.
8. The graduates will be able to understand the development of transgenic organism for the welfare of the humans.
9. The graduate will be able to mitigate the environmental problem using the biotechnological tools and asses the basic concepts and modern knowledge of bioinformatics by graduates
10. Understand the basis of molecular pathogenesis and its diagnosis; the graduate will be equipped to design custom medicine for the infectious/non infectious diseases
11. Apply the knowledge and skills gained from molecular aspects should be useful in developing new innovations in different life forms by the graduates.
12. The student will be able design, solve the application-oriented problem in biotechnological field through project-based learning.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

To enable the student to emerge as:

1. Able to obtain the indigenous knowledge on central dogma of life processing and its consequences.
2. To get intrinsic exposure on medical, microbial, agricultural, environmental, plant and animal biotechnology and to address the challenges associated with them.
3. Proficiency to become a bio- entrepreneur and its requisite skills for the development of value-added products for the society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

To impart the following PEOs to the students of Under-graduates in Biotechnology:

PEO I: To comprehend the skills and vocabulary usage in languages and to ascertain the valuable prospects in Indian knowledge system.

PEO II: To acquire the detailed fundamental information about the concepts in biosciences and its relevant application in the biological sectors.

PEO III: To impart the knowledge about the origin of living organism and utilization of bio-resources and its related products for the welfare of humans and the environment.

PEO IV: To make the graduates of Biotechnology to learn and to adopt in a competitive world of technology update and contribute to all forms of life.

MAPPING OF PEOs AND POs

PEOs	Programme Outcome (s)											
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
PEO I	×	×	×									
PEO II		×	×	×	×	×						
PEO III							×	×	×	×		
PSO IV											×	×

கற்பகம் உயர்கல்விக்கழகம்

மொழிகள்துறை - தமிழ்ப்பிரிவு

தமிழ்ப்பாடத்திட்டம் (2023-2024)

முதல் பருவம் -பகுதி – I, தமிழ், தாள் 1 23LSU101 4 - H, 4 - C

(இளநிலை அறிவியல்பட்ட வகுப்புகளுக்குரியது)

பாடத்திட்டப் பொதுநோக்கம்

- கற்றல் வழி சிந்தனைத் திறனையும், கருத்து வெளிப்பாட்டுத் திறனையும், மேம்படுத்துதல்.
- ஆய்வுநோக்கை மேம்படுத்துதல்.
- இலக்கியங்கள் உணர்த்தும் வாழ்வின் நுட்பமான பகுதிகளை உணர்த்துதல்.
- மனித மனத்தினைப் பக்குவப்படுத்துதலில் இலக்கியம் தரும் பங்கினை உணர்த்துதல்.
- வளர்ந்து வரும் சமூகத்தில் அறஉணர்வு, பண்பாடு போன்றவை குறித்து அறிவூட்டல். அரசுத் தேர்வுகளுக்கு மாணவர்களை ஆயத்தமாக்குதல்.

பாடத்திட்டப் பயன்விளைவு

- இந்தியக் குடியுரிமைப்பணி முதலான போட்டித் தேர்வுகளில், விருப்பப்பாடமாக இடம்பெறுகின்ற, 'தமிழ்இலக்கியவரலாறு' குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.
- கல்வெட்டியல், ஓலைச்சுவடியியல் மற்றும் தொல்லியல் சார்ந்த ஆவணத் தேடலுக்குரிய ஆய்வு மனப்பான்மையுடன், இலக்கியங்களை அணுகுதல்.
- தமிழின் வளர்ச்சித்துறையாகிய, 'அறிவியல்தமிழ்';'இணையதமிழ்' குறித்த பன்நோக்கு அணுகுமுறையிலான ஆய்வுச்சிந்தனை மேம்பாடு.
- வேலைவாய்ப்புக்குரிய சுயதிறன் மேம்பாட்டுடன், படைப்பாக்கத்திறன் மேம்பாடும் பெற்றிருத்தல் .
- சமுதாய மற்றும் வாழ்வியல் மதிப்புகளைப் பேணுவதற்குக் கருவியாக இலக்கியங்களை நாடுகின்ற மனப்பான்மை வளர்ச்சி. மொழிபெயப்புத் துறைசார்ந்த வேலைவாய்புத்திறன் பெற்றிருத்தல்

தாள்கள் வரிசையும் தேர்வுச் செயல் திட்டமும்

பகுதி-I தமிழ்

இளநிலைப்பட்ட அறிவியல் வகுப்புகள்

பருவம்	தாள்	கற்பிக்கும் நேரம்/வாரம்	தேர்வு மணிகள்	மதிப்பெண் அக/எழுத்து	மொத்தம்	மதிப்பீடு
ஒன்று	I	4	3	40 / 60	100	4

கற்பகம் உயர்கல்விக்கழகம்

மொழிகள்துறை - தமிழ்ப்பிரிவு

தமிழ்ப்பாடத்திட்டம் (2023-2024)

முதல்பருவம் - பகுதி – I, தமிழ், தாள் 1 - 23LSU101 4 - H, 4 - C

(இளநிலை அறிவியல் பட்ட வகுப்புகளுக்குரியது)

(For I-UG Science DegreeClasses)

இலக்கிய இன்பம்

அலகு – I **(10 மணிநேரம்)**

சங்க இலக்கியம் – எட்டுத்தொகை - முச்சங்கங்கள் பற்றிய செய்திகள் – சங்க இலக்கியத்தின் தோற்றுவாய் – எட்டுத்தொகை அறிமுகம்

சங்க இலக்கியம் - நற்றிணை - நின்ற சொல்லர் –குறிஞ்சி – தலைவி கூற்று–1

சங்க இலக்கியம் - குறுந்தொகை - நிலத்தினும் பெரிதே–குறிஞ்சி – தலைவி கூற்று- 3

அறஇலக்கியம் - திருவள்ளுவர் – திருக்குறள் (எண்கள்-திருக்குறள் வரிசை எண்ணைக் குறிப்பன)

பாயிரம் – 8 அறவாழி அந்தணன்,13 - விண்இன்று பொய்ப்பின்,

34 - மனத்துக்கண் மாசிலன் ஆதல்

இல்லற இயல் - இல்வாழ்க்கை - 41- அன்பும் அறனும் உடைத்தா 50-வையத்துள்வாழ்வாங்கு

அன்புடைமை - 80 - அன்பின்வழியது, **விருந்தோம்பல் -** 90 – மோப்பக்குழையும்,

இனியவைகூறல் - 95 – பணிவுடையன் இன்சொலன்,

செய்நன்றி அறிதல் - 103 – பயன் தூக்கார்,

புறங்கூறாமை - 190 – ஏதிலார் குற்றம், **ஒப்புரவுஅறிதல் -** 216 – பயன்மரம்

ஈகை: 228 – ஈத்துவக்கும் இன்பம், **துறவற இயல் - தவம் -** 261 – உற்றநோய்

வாய்மை - 291 – வாய்மை எனப்படுவது, **வெகுளாமை -** 306 - சினமென்னும்

இன்னாசெய்யாமை : 316-இன்னா எனத்தான் உணர்ந்தவை

நிலையாமை - 331 – நில்லாதவற்றை, **ஊழியல் - ஊழ் -** 373 – நுண்ணியநூல்

ஆள்வினை உடைமை - 618 –பொறியின்மை யார்க்கும், 620-ஊழையும் உப்பக்கம்

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

காப்பியம் - சிலப்பதிகாரம்:

மங்கலவாழ்த்துப் பாடல் - பொதியில்ஆயினும் – 'கோவலன் என்பான்மன்னோ' (14-38), 'நீலவிதானத்து' – 'நோன்புஎன்னை'(48-53).

மனையறம்படுத்த காதை - 'வார்ஒலிகூந்தலை' – 'சிறப்பின் கண்ணகிதனக்குஎன்' (84-90)

அரங்கேற்று காதை -'மாமலர்நெடுங்கண்' - 'அகம்மறந்து' (170-175).

மதுரைக்காண்டம் - கொலைக்களக்காதை, 'இருமுதுகுரவர்' - 'எழுந்தனன்யான்' (67-83),'வினைவிளைகாலம்' - ' கொணர்கஈங்குஎன' (148-153)

கட்டுரை காதை - 'கடிபொழில்' - 'இல்சாபம்பட்டனிர்' (138-170)

வழக்குரைக் காதை - 'அல்லவை செய்தார்க்கு' - 'தோற்றான்உயிர்' (82-93)

வஞ்சிக் காண்டம் - நடுகல்காதை - 'மதுரைமூதூர்' - 'மன்னவர்ஏறு' (218-234)

வாழ்த்துக் காதை - 'என்னேஇஃது' - 'தோன்றுமால்' (9)

எழுத்திலக்கணம் - முதல் மற்றும் சார்பெழுத்துகள்

அலகு- 2 (10 மணிநேரம்)

சங்க இலக்கியம் – பத்துப்பாட்டு அறிமுகம்

சங்க இலக்கியம் - பதிற்றுப்பத்து : ஏழாம்பத்து- எறிபிணம் இடறிய செம்மறுக்– 65

சங்க இலக்கியம் - கலித்தொகை : அகன்ஞாலம் விளக்கும் - நெய்தல்கலி – தலைவிகூற்று- 119.

அற இலக்கியம் -முன்றுறையரையனார் - பழமொழி நானூறு 5 பாடல்கள்

காப்பியம் -மணிமேகலை : விழாவறைகாதை : 'தேவரும் மக்களும்' - 'மருங்குஎன்' (66-72)

ஊரலர் உரைத்தகாதை : 'நாவல்ஓங்கிய' - 'உண்டுகொல்'(1-17), 'கற்றுத்துறைபோகிய' – 'தீத்தொழில்படாஅள்' (32-57).

பாத்திரம் பெற்றகாதை : 'போதிநீழல்' - 'நல்அறம்கண்டனை' (73-98)

சிறைக்கோட்டம் அறக்கோட்டம் ஆக்கியகாதை -'வாழிஎம்கோ' - 'அரசுஆள்வேந்துஎன்' (129-163)

சொல்இலக்கணம் - பெயர், வினை, இடை, உரிச்சொல்-விளக்கமும்பயிற்சியும்

அலகு– 3 (10 மணிநேரம்)

அறஇலக்கியங்கள் அறிமுகம்

சங்க இலக்கியம் - பரிபாடல்: வையை : பாடல்-6. - நிறைகடல் முகந்து உராய் – சேறுஆடுபுனலதுசெலவு 1-50.

சங்க இலக்கியம் -அகநானூறு - ஈன்று புறம்தந்த எம்மும் உள்ளாள் – பாலை– நற்றாய்கூற்று-35

அற இலக்கியம் -ஒளவையார்- கொன்றை வேந்தன் (1-50 பாடல்கள்**)**

காப்பியம் - சூளாமணி–அரசியல்சருக்கம்- 1. நாவியே கமழும்(1131), 2. கண்மிசை கனிந்த (1132),3. விரைசெலலிவுளித்(1133), 4. அரைசர்கள் வருக (1134), 5. அருளுமாறடிகள் (1135), 6. விஞ்சையருலக (1136), 7. சொரிகதிர் (1137), 8. கரியவன் வளைந்த(1138), 9. மடித்தவா யெயிறு (1139),10. விஞ்சயரதனைக் (1140), **துறவுச்சருக்கம்** – பயாபதி மன்னனின் துறவுநெறி -1. மன்னிய புகழி(1840), 2. திருமகிழலங்கன் (1841) , 3. ஆங்கவ ரணைந்த (1842),

4. அலகுடன் விளங்கு (1843), 5. தன்னையோர் அரசனாக்கி (1844), 6. சென்றநாள்(1845), 7. எரிபுரை (1846.), 8. பிறந்தனர்(1847), 9. பிறந்தநாம் (1848), 10. தொகைமலர் (1849) 11. ஒழுகிய(1850).

பொருள் இலக்கணம் - அகத்திணை மற்றும் புறத்திணை இலக்கணங்கள்.

அலகு- 4 (10 மணிநேரம்)

சிற்றிலக்கியங்கள் தோற்றமும் வளர்ச்சியும்

சங்க இலக்கியம் - ஐங்குறுநூறு : தாய்சாப்பிறக்கும் – தோழிகூற்று – மருதம் - களவன்பத்து: 24

சங்க இலக்கியம் - புறநானூறு : உற்றுழிஉதவியும்-183, பல்சான்றீரே – பொதுவியல்-195

அற இலக்கியம் – வேதநாயகம் பிள்ளை -நீதி நூல்- தேர்ந்தெடுக்கப்பட்ட 5 பாடல்கள் மட்டும் சின்னவோர் பொருள், கடவுளை வருத்தி, எப்புவிகளும், வைத்தவர், ஈன்றவர்

காப்பியம் – கம்பராமாயணம் – சுந்தரகாண்டம் (தேர்ந்தெடுக்கப்பட்ட பாடல்கள் மட்டும்) வண்மையில்லை 84 - தாய் ஒக்கும் 171 - ஒரு பகல் 284 - எதிர் வரும் 314 – தருவனத்துள் 327 - எண் இலா 328 - சொல் ஒக்கும் 413 – இவ்வண்ணம் 559 - எண் அரு 598 - தடுத்து இமையாமல் 1979 - தோள் கண்டார் 1008 – மைந்தரை 1339 – அந்நகர் 1445 - சிவந்த வாய் 1550 - ஏய வரங்கள் 1593 – நின்மகன் 1526 – ஆழிசூழ் 1601 – மன்னவன் 1604 – பின்னும் 1752 – கிள்ளையொடு 1701 – எந்தையும் 2159 - பஞ்சி ஒளிர் 2762 - மயில் உடை 3248 – ஆண்டு 3390 –மற்றுஇனி 3812- கண்டனன் 5249 – வேலையுள் 6037 –மண்ணொடும் 6038- வாங்கிய 6170 – இங்குஉள 6172 – கண்டனென் 6031 - பைய பைய 6174 – அந்நெறி 6185 – குகனொடும் 6507 –கூவி 7131 –மாக்கூடு 7760 – அற்றவன் 9168 - ஆள் ஐயா 7271 - கார்நின்ற-10043

கடிதப்பயிற்சி

1. வேலைவேண்டி விண்ணப்பம் எழுதுதல்

2.பல்கலைக்கழகப் பன்னாட்டுக் கருத்தரங்கச் செய்தியை நாளிதழில் வெளியிட வேண்டி நாளிதழின் பதிப்பாசிரியருக்குக் கடிதம்

3. கருத்தரங்கப் பங்கேற்புக்கான அனுமதிக் கடிதம்

4. பல்கலைக்கழக விழாவுக்குத் தலைமையேற்க வேண்டி, மாவட்ட ஆட்சியருக்கு விண்ணப்பம்

அலகு – 5 (8 மணிநேரம்)

காப்பியங்கள் - தோற்றமும் வளர்ச்சியும்

சங்க இலக்கியம் - பத்துப்பாட்டு: சிறுபாணாற்றுப்படை

வானம் வாய்த்த – யாம் அவண்நின்றும் வருதும் (அடிகள்: 84-143),

செய்நன்றி அறிதலும் – நல்லியக்கோடனை நயந்தனிர் செலினே (207-269).

அற இலக்கியம் – குமரகுருபரர் - நீதி நெறி விளக்கம் (தேர்ந்தெடுக்கப்பட்ட 5 பாடல்கள் மட்டும்)

உறுதி பயப்ப, முயலாது வைத்து, உலையாமுயற்சி, காலம் அறிந்து, மெய்வருத்தம்

கடிதப்பயிற்சி

5. கல்விக் கடன்வேண்டி வங்கிமேலாளருக்கு விண்ணப்பம்
6. வசிப்பிடத்திற்கு அடிப்படை வசதிவேண்டி வட்டாட்சியருக்கு விண்ணப்பம்
7. விருதுபெற்ற நண்பனுக்குப் பாராட்டுக் கடிதம்
8. புத்தகங்கள் அனுப்பி உதவவேண்டி, பதிப்பகத்தாருக்கு விண்ணப்பம்

பார்வை நூல்கள்

1. **கற்பகச் சோலை – தமிழ்ப்பாட நூல், இலக்கிய நெறிகள்,** தமிழ்த்துறை வெளியீடு, கற்பகம் உயர்கல்விக்கழகம், கோயம்புத்தூர் – 21.
2. **தமிழ் இலக்கிய வரலாறு, முனைவர் கா.கோ. வேங்கடராமன்,** கலையக வெளியீடு, நாமக்கல்.

இணையதளம்

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

வினாத்தாள் கட்டமைப்பு

இடைத்தேர்வு வினாத்தாள்

மொத்த மதிப்பெண்கள் 50

பகுதி – அ (ஒரு மதிப்பெண் வினாக்கள்) 20 X 1 = 20 (சரியான விடையினைத் தேர்ந்தெடுத்தெழுதுதல்)

பகுதி – ஆ (இரு மதிப்பெண் வினாக்கள்) 3 X 2 = 6 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பகுதி – இ (ஆறுமதிப்பெண் வினாக்கள்) 6 X 4 =24 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பருவத்தேர்வு வினாத்தாள் - மொத்த மதிப்பெண்கள் 60

பகுதி – அ (ஒரு மதிப்பெண் வினாக்கள்) 20 X 1 = 20 (சரியான விடையினைத் தேர்ந்தெடுத்தெழுதுதல்)

பகுதி – ஆ (இரு மதிப்பெண் வினாக்கள்) 5 X 2 = 10 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பகுதி – இ (ஆறுமதிப்பெண் வினாக்கள்) 5 X 6 =30 (அல்லது வகையில் தேர்ந்தெடுத்து எழுதுதல்)

23ENU101 **ENGLISH – I** **3H–3C**

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

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	Blooms 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	M	L	L	L	L	L	L	L	L	L	M
CO2	S	M	L	L	L	L	L	L	L	L	L	M
CO3	S	M	L	L	L	L	L	L	L	L	L	M
CO4	S	M	L	L	L	L	L	L	L	L	L	M
CO5	S	M	L	L	L	L	L	L	L	L	L	M

S-Strong; M-Medium; L-Low

UNIT I **8 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 **8 Hours**

LISTENING: Principles of Listening Skills
SPEAKING: Descriptions
READING: Reading Techniques
WRITING: Paragraph Writing
LITERATURE: Of Friendship by Francis Bacon
GRAMMAR: Articles

UNIT III **8 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 **8 Hours**

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

UNIT V **4 hours**

LISTENING: Listening Strategeis
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.

23BTU101 BIOCHEMISTRY AND METABOLISM 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

The main objectives of the course are,

- To provide clear understanding on the underlying principles, structures and functions of bio molecules.
- To acquire fundamental knowledge about the anabolism and catabolism in living organisms.
- To obtain the facts of metabolism and its disorders in the living system.
- To implement experimental protocols, and adapt them to plan and carry out simple investigations.
- To expose the students to a wide range of careers that combine biology, plants and medicine.
- To understand the principles that govern the structures of macromolecules and their participation in molecular recognition.

Course Outcomes

The learners will be able

COs	Course Outcomes	Blooms Level
CO1	To acquire knowledge on the structure, functional relationship of proteins, nucleic acid, carbohydrates and their role in various biological processes	Remember
CO2	To know about the role of various enzymes in metabolic process	Understand
CO3	To quench the in-depth concepts of metabolism related disorders	Apply
CO4	To know how genes are transmitted between generations, and how and when errors can arise	Apply
CO5	To plan and safely perform fundamental techniques in molecular and cellular biology	Analyze
CO6	To get awareness of the ethical aspects of molecular science	Evaluate

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT- I **15 hours**

Carbohydrates and Metabolism:

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis, TCA cycle.

UNIT-II **15 hours**

Protein and Amino acid:

Amino acids & Proteins: Structure, properties and function of Amino acids and Protein, Amino acid and

protein classification. Protein Synthesis. Fibrous and globular proteins; Glycoproteins and their biological functions.

UNIT-III **15 hours**

Enzymes:

Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, Role of: NAD+, NADP+, FMN/FAD, coenzymes A. Photosynthesis – Photosystem I and II. Hormonal regulation and metabolism.

UNIT-IV **15 hours**

Lipids:

Structure and functions – Classification, nomenclature and properties of fatty acids, essential fatty acids. Structure, functions and Metabolism of Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. ß-oxidation of fatty acids, Digestion, Absorption, and Transport of Lipids, Lipid metabolism disorders - Atherosclerosis.

UNIT-V **12 hours**

Nucleic acids:

Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, biologically important nucleotides, Amino acid Metabolism, Nucleotide metabolism, Double helical model of DNA structure, A, B & Z – DNA, Structure and types of RNA, DNA and RNA metabolism.

SUGGESTED READINGS:

1. Berg JM, Tymoczko JL, and Stryer L. (2011). Biochemistry. 7th edition. Newyork: W.H. Freeman & Company.
2. Buchanan B, Gruissem W, and Jones R. (2015). Biochemistry and Molecular Biology of Plants. 2nd edition. American Society of Plant Biologists.
3. Hopkins WG, and Huner P.A. (2008). Introduction to Plant Physiology. 4nd edition. John Wiley & Sons.
4. Murray RK, Bender DA, Botham KM, and Kennelly P.J. (2018). Harper's illustrated Biochemistry. 31th edition. London: McGraw-Hill Medical.
5. Nelson DL, and Cox MM. (2017). Lehninger: Principles of Biochemistry. 7th edition. New York: W.H. Freeman and Company.
6. http://172.16.25.76/course/view.php?id=1607.

23BTU102 **CHEMISTRY– I** **5H–4C**

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

Course Objectives

The main objectives of the course are,

- The molecular orbital theory, preparation and properties of inorganic compounds.
- Theory of covalent bond, polar effects and stereochemistry of organic compounds.
- About important industrial chemicals like silicones, fuel gases and fertilizers and their impact on environment.
- Elements of photochemistry, chemical kinetics.
- The principle to perform the chromatography.
- About the dyes, chemotherapy and vitamins.

Course Outcomes

The learners will be able

COs	Course Outcomes	Blooms Level
CO1	To understand the molecular orbital theory, preparation and properties of inorganic compounds.	Understand
CO2	To know about the theory of covalent bond, polar effects and stereochemistry of organic compounds.	Understand
CO3	To analyze about the important industrial chemicals like silicones, fuel gases and fertilizers and their impact on environment.	Analyze
CO4	To apply the characteristics of elements in photochemistry, chemical kinetics.	Apply
CO5	To analyze about the dyes, chemotherapy and vitamins.	Analyze
CO6	To know about the principles and applications of Column, Paper and Thin Layer Chromatography.	Understand

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I **12 hours**

Chemical Bonding:

Molecular orbital theory-linear combination of atomic orbitals-bonding and antibonding molecular orbitals-energy level diagram-bond order- M.O. configuration of H_2, N_2 and F_2 molecules. Diborane: Preparation, properties and structure. $NaBH_4$: Preparation and uses. Borazole: Preparation and properties. Interhalogen compounds: ICl, BrF_3, IF_5 - preparation, properties, uses and structure. Basic properties of iodine. Compounds of sulphur: Sodium hydrosulphite- preparation, properties, uses and structure. Per acids of sulphur: Preparation, properties, uses and structure.

UNIT- II **12 hours**

Covalent Bond and Stereoisomerism:

Covalent Bond: Orbital overlap, hybridization and geometry of CH_4, C_2H_4 and C_2H_2. Polar effects: Inductive effect- electromeric effect- mesomeric effect- steric effect- hyperconjugation. Stereoisomerism: Elements of symmetry-polarised light and optical activity-isomerism in tartaric acid-racemisation- resolution- geometrical isomerism of maleic and fumaric acids-keto-enol tautomerism of acetoacetic esters.

UNIT-III **12 hours**

Industrial Chemistry:

Silicones: Synthesis, properties and uses. Fuels gases: Natural gas-water gas-semi water gas-carbureted water gas-producer gas- oil gas (Manufacturing details not required). Fertilizers: NPK fertilizer-ammonium sulphate-urea-superphosphate of lime-triple superphosphate- potassium nitrate-ammonium nitrate. Pollution: Water, air and soil pollution-sources and remedies-acid rain-ozone hole-greenhouse effect.

UNIT-IV **12 hours**

Elements of Photochemistry, Chemical Kinetics and Chromatography:

Elements of Photochemistry: Photochemical laws-Beer Lambert's law-Grotthuss-Draper law-Stark-Einstein law (statement only). Chemical Kinetics: Rate-order-molecularity-pseudo first order reactions-zero order reactions-determination of order of reaction-measurement of order and rates of reactions-effect of temperature on reaction rate-energy of activation. Chromatography: Principles and applications of Column, Paper and Thin Layer Chromatography.

UNIT- V **12 hours**

Dyes, Chemotherapy and Vitamins: Dyes:

Terms used chromophore, auxochrome, bathachromic shift and hypsochromic shift- classification of dyes– based on chemical structure and application-one example each for azo, triphenylmethane, vat and mordant dyes- preparation. Chemotherapy: Preparation, uses and mechanism of action sulpha drugs- preparation and uses of prontosil, sulphadiazine and sulphafurazole-structure and uses of pencillins and Chloromycetin. Vitamins: Diseases caused by the deficiency of vitamins A, B_1, B_2, C and D-sources of these vitamins.

SUGGESTED READINGS:

1. Bahl A, and Bahl BS. (2015). A Textbook of Organic Chemistry. 21st Revised edition. S. Chand & Company Pvt. Ltd. New Delhi.
2. Gopalan R. and Sundaram S. (2013). Allied Chemistry. IIIrd edition. Sultan Chand & Sons. New Delhi.
3. Puri BR, Sharma LR, and Kalia K.C. (2017). Principles of Inorganic Chemistry. 33rd edition. Jalandar: Vishal Publishing Company.
4. Puri BR, Sharma LR, and Pathania MS. (2014). Elements of Physical Chemistry. 46th edition. Jalandhar: Vishal Publishing Company
5. Thangamani A. (2018). Text Book on Allied Chemistry. 1st edition. Coimbatore: Karpagam Publication.

23BTU111 BIOCHEMISTRY AND METABOLISM PRACTICAL 4H–2C

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

Course Objectives

The main objectives of the course are,

- To acquire skill on various experimental methods and techniques on order to analyze the given biological samples.
- To know the standard procedures for handling the biochemical assays and instruments.
- To know the threshold levels of primary biochemical markers.
- To analyze common organic reagents and compounds based on their properties.
- To analyze biological compounds from unknown mixture/origin.
- To Understand Good laboratory practices in a laboratory.

Course Outcomes

The learners will be able

COs	Course Outcomes	Blooms Level
CO1	Gain skills on quantitative estimation methods for various biomolecules from natural sources	Understand
CO2	Acquire handling skills to handle the spectroscopy instrumentations	Apply
CO3	Obtain skills on primary screening of biochemical markers in samples	Apply
CO4	Develop skills to prepare useful reagents in the laboratory	Analyze
CO5	Use of handling of glass wares, minor equipment for conducting experiments	Evaluate
CO6	Learn safety and precautionary measures for working in a laboratory	Evaluate

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **48 hours**

1. Qualitative tests for Carbohydrates, lipids and proteins
2. Principles of Colorimetry: (i) Beer's law (ii) To study relation between absorbance and % transmission
3. Estimation of carbohydrates
4. Estimation of proteins
5. Estimation of lipids
6. Separation of Amino acids by paper chromatography/Thin layer chromatography
7. Effect of pH and temperature on amylase activity.
8. Estimation of urea, and creatinine in urine sample.

SUGGESTED READINGS:

1. Berg JM, Tymoczko JL, and Stryer L. (2011). Biochemistry. 7th edition. Newyork: W.H. Freeman & Company.
2. Buchanan B, Gruissem W, and Jones R. (2015). Biochemistry and Molecular Biology of Plants. 2nd edition. American Society of Plant Biologists.
3. Hopkins WG, and Huner P.A. (2008). Introduction to Plant Physiology. 4nd edition. John Wiley & Sons.
4. Murray RK, Bender DA, Botham KM, and Kennelly P.J. (2018). Harper's illustrated Biochemistry. 31th edition. London: McGraw-Hill Medical.
5. Nelson DL, and Cox MM. (2017). Lehninger: Principles of Biochemistry. 7th edition. New York: W.H. Freeman and Company.
6. http://172.16.25.76/course/view.php?id=1605

23BTU112 CHEMISTRY PRACTICAL – I 4H–2C

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

Course Objectives

The main objectives of the course are,

- The molecular orbital theory, preparation and properties of inorganic compounds.
- Theory of covalent bond, polar effects and stereochemistry of organic compounds.
- About important industrial chemicals like silicones, fuel gases and fertilizers and their impact on environment.
- Elements of photochemistry, chemical kinetics.
- The principles of chromatography.
- About the dyes, chemotherapy and vitamins.

Course Outcomes

The learners will be able

COs	Course Outcomes	Blooms Level
CO1	To understand the molecular orbital theory, preparation and properties of inorganic compounds.	Understand
CO2	To know about the theory of covalent bond, polar effects and stereochemistry of organic compounds.	Understand
CO3	To analyze about the important industrial chemicals like silicones, fuel gases and fertilizers and their impact on environment.	Analyze
CO4	To apply the characteristics of elements in photochemistry, chemical kinetics.	Apply
CO5	To analyze about the dyes, chemotherapy and vitamins.	Analyze
CO6	To know about the principles and applications of Column, Paper and Thin Layer Chromatography.	Understand

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Systematic analysis of an organic compound **48 hours**

1. Preliminary tests.
2. Detection of elements present.
3. Aromatic or aliphatic.
4. Saturated or unsaturated.
5. Nature of the functional group.
6. Confirmatory tests– aldehydes, ketones, amines, amides, diamide, carbohydrates, phenols, acids, esters & nitro compounds.

Note: Each student should analyze minimum 6 compounds.

SUGGESTED READINGS:

1. Ramasamy R. (2011). Allied Chemistry Practical Book. Karur: Priya Publications.
2. Thomas A.O. (2012). Practical Chemistry for B.Sc. Main Students. Cannanore: Kerala, Scientific Book Centre.
3. Venkateswaran V, Veeraswamy R, and Kulandaivelu AR. (2015). Basic Principles of Practical Chemistry. 2nd edition. S. Chand Publications. New Delhi.

23VAC101 **ENVIRONMENTAL STUDIES** **2H–2C**

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

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 environmental problem solving	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	L	M	M	M	M	M	M	M	M	M	M	M
CO2	L	M	M	M	M	M	M	M	M	M	M	M
CO3	L	S	S	M	M	M	M	S	S	M	S	S
CO4	L	S	S	M	M	M	M	S	S	M	S	S
CO5	L	S	S	M	M	M	M	S	S	M	S	S
CO6	L	S	S	M	M	M	M	S	S	M	S	S

S-Strong; M-Medium; L-Low

Unit I **5 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 **5 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 **5 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 **5 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 **4 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 Bharat Vidypeeth Institute of Environmental Education Research, New Delhi.
2. Anubha Kaushik., and Kaushik, C.P. 2008. Perspectives in Environmental Studies. (3rd ed.). New Age International 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., New Delhi.
6. Odum, E.P., Odum, H.T. and Andrews, J. 1971. Fundamentals of Ecology. 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. Daya Publishing House, New Delhi.
10. Tripathy. S.N., and Sunakar Panda. (2011). Fundamentals of Environmental Studies (3rd ed.). Vrianda Publications 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 Company Ltd, New Delhi.
13. Environmental Biotechnology: Principles and Applications, Second Edition 2nd Edition by Bruce Rittmann and Perry McCarty, 2020

ACTIVITY: LIBRARY/SEMINAR **2H**

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

கற்பகம் உயர்கல்விக்கழகம்

மொழிகள்துறை – தமிழ்ப்பிரிவு

பகுதி - I தமிழ்ப் பாடத்திட்டம் (2023 - 2024)

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

(இளநிலை அறிவியல்பட்ட வகுப்புகளுக்குரியது)

பாடத்திட்டப் பொதுநோக்கம்

- கற்றல்வழி சிந்தனைத் திறனையும், கருத்து வெளிப்பாட்டுத் திறனையும்,
- ஆய்வு நோக்கையும் மேம்படுத்துதல்.
- இலக்கியங்கள் உணர்த்தும் வாழ்வின் நுட்பமான பகுதிகளை உணர்த்துதல்.
- மனித மனத்தினைப் பக்குவப்படுத்துதலில் இலக்கியம் தரும்பங்கினை உணர்த்துதல்.
- வளர்ந்துவரும் சமூகத்தில் அற உணர்வு, பண்பாடு போன்றவை குறித்து அறிவூட்டல். அரசுத் தேர்வுகளுக்கு மாணவர்களை ஆயத்தமாக்குதல்.

பாடத்திட்டப் பயன்விளைவு

- இந்தியக் குடியுரிமைப்பணி முதலான போட்டித் தேர்வுகளில், விருப்பப்பாடமாக இடம்பெறுகின்ற, 'தமிழ்இலக்கியவரலாறு' குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.
- கல்வெட்டியல், ஓலைச் சுவடியியல் மற்றும் தொல்லியல் சார்ந்த ஆவணத் தேடலுக்குரிய ஆய்வு மனப்பான்மையுடன், இலக்கியங்களை அணுகுதல்.
- தமிழின் வளர்ச்சித் துறையாகிய, 'அறிவியல்தமிழ்' 'இணையதமிழ்' குறித்த பன்நோக்கு அணுகுமுறையிலான ஆய்வுச் சிந்தனை வளர்ச்சி.
- வேலை வாய்ப்புக்குரிய சுயதிறன் மேம்பாட்டுடன், படைப்பாக்கத் திறன் மேம்பாடும் பெற்றிருத்தல்.
- சமுதாய மற்றும் வாழ்வியல் மதிப்புகளைப் பேணுவதற்குக் கருவியாக இலக்கியங்களை நாடுகின்ற மனப்பான்மை வளர்ச்சி.

தாள்கள் வரிசையும் தேர்வுச் செயல்திட்டமும்

பகுதி- I தமிழ்

இளநிலைஅறிவியல்பட்டவகுப்புகள்

பருவம்	தாள்	கற்பிக்கும் நேரம்/வாரம்	தேர்வு மணிகள்	மதிப்பெண் அக/எழுத்து	மொத்தம்	மதிப்பீடு
இரண்டு	II	4	3	40 / 60	100	4

கற்பகம் உயர்கல்விக்கழகம்

மொழிகள் துறை – தமிழ்ப்பிரிவு

தமிழ்ப் பாடத்திட்டம் (2023-2024)

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

(இளநிலை அறிவியல்பட்ட வகுப்புகளுக்குரியது)

(For I-UG Science Degree Classes)

இலக்கிய நெறிகள்

அலகு – I **(8 மணிநேரம்)**

நாயன்மார்கள் : தமிழ் இலக்கிய வரிசையில் திருமுறைகளும் நாலாயிரத் திவ்யப்பிரபந்தமும் – பன்னிரு திருமுறைகள் அறிமுகம் – திருமுறை ஆசிரியர்களின் இலக்கியப் பங்களிப்பு

சைவம்-பெரியபுராணம் - காரைக்கால் அம்மையார் புராணம் .

முக்கூடற்பள்ளு - 2 பாடல்கள் - சித்திரக்காலிவாலான் (நெல் வகைகள்)

குற்றாலத் திரிகூடமால்வரை (மீன்வகைகள், காளை வகைகள்)

கவிதை : மகாகவி பாரதியார் - யோகசித்தி

கவிதை : கவிமணி தேசிக விநாயகம் பிள்ளை - வாழ்க்கைத் தத்துவங்கள்

கவிதை : கவிஞர் சுகந்திசுப்பிரமணியம் - புதையுண்டவாழ்க்கை

சிறுகதை : மகாமசானம் - புதுமைப்பித்தன்

இலக்கணம் - வாக்கியஅமைப்பு : தனிவாக்கியம் – தொடர்வாக்கியம் – கலவைவாக்கியம் - தன்வினை வாக்கியம் – பிறவினை வாக்கியம்- செய்வினை, செயப்பாட்டு வினைவாக்கியம், கட்டளைவாக்கியம் – வினாவாக்கியம் – உணர்ச்சி வாக்கியம். நன்னூல் – பொதுவியல் - அறுவகைவினா (385) - எண்வகைவிடை (386).

அலகு– 2 **(8 மணிநேரம்)**

ஆழ்வார்கள் : இலக்கியப் பங்களிப்பு - திவ்யப் பிரபந்தத்தில் பக்திநெறியும் இலக்கிய நயமும்

உரைநடை : தோற்றமும் வளர்ச்சியும்

வைணவம் : பெரியாழ்வார் திருமொழி: 3-ஆம் பத்து – பத்தாம் திருமொழி 'நெறிந்தகருங்குழல் மடவாய்' – சீதைக்கு அனுமன் தெரிவித்த அடையாளம்.

கவிதை - கவிஞர் வைரமுத்து - வித்தியாசமான தாலாட்டு

சிற்பி பாலசுப்பிரமணியன் - பாரதி எங்கள் கண்மணி

அரங்க பாரி - கண்ணீர்! கண்ணீர்!

தமிழலங்காரம் – வண்ணச்சரபம் தண்டபாணி சுவாமிகள் - 10 பாடல்கள்

1. கடல் நீரில் கல்மிதக்கும், 2. வண்டமிழ் ஆற்றுதி, 3. கோளத்தை முட்டி
4. எக்காலம்என்று, 5. கடவூர் மயானத்தொர், 6. தேவாதிதேவன், 7. விண்மாரி,
8. தேவர்முனிவர், 9. அழுதேங்கிநஞ்சிட்ட, 10. அத்தனைபொத்து.

சிறுகதை : ஆர். சூடாமணி - அந்நியர்கள்

கட்டுரை : ஆளுமைத்திறன் அறிவோம்- தன்னம்பிக்கை மாதஇதழிலிருந்து

அணிஇலக்கணம் : உவமையணி – பிறிதுமொழிதல் அணி – சிலேடை அணி – தீவக அணி- ஏகதேச உருவக அணி – வேற்றுமையணி – பின்வருநிலையணி

அலகு - 3 **(8 மணிநேரம்)**

புதுக்கவிதை - தோற்றமும் வளர்ச்சியும்

சிற்றிலக்கியம் -தோற்றமும்வளர்ச்சியும்

மதுரைசொக்கநாதர் - தமிழ்விடுதூது – தமிழின் சிறப்பு பாடியருள பத்துப்பாட்டும் - விளம்பக்கேள்.

கவிதை- ஈரோடுதமிழன்பன் – இன்னொரு சுதந்திரம்

சிறுகதை - கு. அழகிரிசாமி - இருவர் கண்ட ஒரேகனவு

கட்டுரை - ஔவைதுரைசாமி - ஏட்டில் இல்லாத இலக்கியம்

படைப்பிலக்கியப் பயிற்சிகள் - மரபுக்கவிதை, புதுக்கவிதை, சிறுகதை, கட்டுரை படைப்பாக்க உத்திகள் –பயிற்சிகள்

அலகு – 4 **(8 மணிநேரம்)**

சிறுகதை - தோற்றமும் வளர்ச்சியும்

கலிங்கத்துப்பரணி – தேவாசுரம், உடலின்மேல், நெடுங்குதிரை மிசைக்கலணை, விருந்தினரும் வறியவரும், தரைமகள் தன்கொழுநன்றன், பொருதடக்கை வாளெங்கே, வெயில்தாரை.

அருள்தரும் பூங்கோதையன்னை அந்தாதி - 11பாடல்கள்

1. பகவன்பெயரை, 2.மெல்லியல்மேலை,3.வாலின் குரங்கு, 4.தவளே இவள், 5.சுரக்கும் திருவருட், 6.வதிவாய் விளைபயில்,7.உறைவான், 8.பச்சைப்பேர், 9.வித்தகம், 10.துணையாய், 11.கலந்தார்.

கவிதை - கவிஞர்தாமரை - தொலைந்துபோனேன்

சிறுகதை – அம்பை - வல்லூறுகள்

கட்டுரை- முனைவர் ப. தமிழரசி - நொய்யல்,

சொல்லின் செல்வர் ரா.பி.சேதுப்பிள்ளை - காளத்திவேடனும் கங்கைவேடனும்

மொழிபெயர்ப்புப் பயிற்சிகள் : தமிழ்-ஆங்கில மொழிபெயர்ப்புப் பயிற்சிகள் -2.

அலகு – 5 **(8 மணிநேரம்)**

நாட்டுப்புற இலக்கியங்கள் – அறிமுகம்

கவிதை – புரட்சிக்கவிஞர் பாரதிதாசன் - தமிழின் இனிமை

கவிதை - கவிஞர் அறிவுமதி - நட்புக்காலம்

சிறுகதை - நாஞ்சில்நாடன் - இந்நாட்டு மன்னர்

கீழடி - வைகை நதிக்கரையில் சங்ககால நகரநாகரிகம்

மொழிபெயர்ப்புப் பயிற்சிகள் : ஆங்கிலம் - தமிழ் மொழிபெயர்ப்புப் பயிற்சிகள்-2.

பார்வை நூல்கள்

1. **கற்பகச் சோலை – தமிழ்ப்பாட நூல், இலக்கிய நெறிகள்,** தமிழ்த்துறை வெளியீடு, கற்பகம் உயர்கல்விக்கழகம், கோயம்புத்தூர் – 21.
2. **தமிழ் இலக்கிய வரலாறு, முனைவர் கா.கோ. வேங்கடராமன்,** கலையக வெளியீடு, நாமக்கல்.

இணையதளம்

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

வினாத்தாள் கட்டமைப்பு

இடைத்தேர்வு வினாத்தாள்

மொத்த மதிப்பெண்கள் 50

பகுதி – அ (ஒரு மதிப்பெண் வினாக்கள்) 20 X 1 = 20 (சரியான விடையினைத் தேர்ந்தெடுத்தெழுதுதல்)

பகுதி – ஆ (இரு மதிப்பெண் வினாக்கள்) 3 X 2 = 6 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பகுதி – இ (ஆறுமதிப்பெண் வினாக்கள்) 6 X 4 =24 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பருவத்தேர்வு வினாத்தாள் - மொத்த மதிப்பெண்கள் 60

பகுதி – அ (ஒரு மதிப்பெண் வினாக்கள்) 20 X 1 = 20 (சரியான விடையினைத் தேர்ந்தெடுத்தெழுதுதல்)

பகுதி – ஆ (இரு மதிப்பெண் வினாக்கள்) 5 X 2 = 10 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பகுதி – இ (ஆறுமதிப்பெண் வினாக்கள்) 5 X 6 =30 (அல்லது வகையில் தேர்ந்தெடுத்து எழுதுதல்)

SEMESTER - II

23ENU201 **ENGLISH – II** **3H–3C**

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

End Semester Exam: 3 Hours

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	S	M	L	L	L	L	L	L	L	L	L	M
CO2	S	M	L	L	L	L	L	L	L	L	L	M
CO3	S	M	L	L	L	L	L	L	L	L	L	M
CO4	S	M	L	L	L	L	L	L	L	L	L	M
CO5	S	M	L	L	L	L	L	L	L	L	L	M

S-Strong; M-Medium; L-Low

UNIT-I **8 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 **8 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 **8 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 **8 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 **4 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

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

23BTU201 **CELL BIOLOGY** **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

The main objectives of the course are

- To provide the fundamental knowledge on structures and role of basic components in prokaryotic and eukaryotic cells
- To understand the role of macromolecules, membranes, and organelles in cells
- To understand the mechanism of cellular components underlying mitotic cell division
- To understand the energy production and utilization of the cells
- To understand the evolution and changes in the genetic composition of cells
- To understand the gene expression regulation during organogenesis and mis-regulation in carcinogenesis

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Understand the composition and function of prokaryotic and eukaryotic cells and its function	Remember
CO2	Acquire information about intracellular and extracellular organelles and their functions	Understand
CO3	Gain knowledge to prevent cellular abnormalities and associated disorders	Understand
CO4	Apply the genetic knowledge in a variety of problem- solving situations	Apply
CO5	Apply their knowledge of cell biology to selected examples of changes or losses in cell function	Analyze
CO6	Apply their knowledge of causal relationships between molecule and cell level phenomena	Analyze

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT- I **15 hours**

Basic of cell biology:

Cell as a basic unit: discovery of the cells, Function of cells, classification of cell types, development of cell theory, early chemical investigation in cell biology. Prokaryotic and Eukaryotic cell organization.

UNIT-II **15 hours**

Structure and functions of cell organelles:

Cell membrane, cytosol, ribosomes, mitochondria, chloroplasts, lysosomes, Vacuoles and micro bodies peroxisomes, glyoximes, nucleus and chromosomes. Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

Unit - III **15 hours**

Cell division and interactions:

Mitosis and meiosis. Cell cycle – stages of interphase and M-phase, Check points in cell cycle, cell synchrony and its applications. Cell-cell interactions –Cell adhesion, Metabolic cooperation, electrical coupling, contact inhibition, autocrine, paracrine and endocrine signaling**.**

UNIT- IV **15 hours**

Membrane transport:

Membrane transport, Transport across cell membrane, simple diffusion, passive transport, active transport, Na/K ion channel, vesicular transport, Membrane potential, Depolarization, hyperpolarization of membrane (neuronal). Generation of action potential. Types of biopotentials. Biopotential measurement instrument.

Unit – V **12 hours**

Cell differentiation, senescence and death:

Fertilization, initial divisions, seed formation, germination, primordial layer formation (sources of organs from each layer), Role of hormones in cellular differentiation, Cell death and abnormalities – Biochemical changes during senescence, necrosis and programmed cell death, Cancer biology and Autophagy.

SUGGESTED READINGS:

1. Karp G. (2013). Cell and Molecular Biology: Concepts and Experiments. 7th edition. Hoboken, US: John Wiley & Sons. Inc.
2. Cooper GM, and Hausman RE. (2013). The Cell: A Molecular Approach. 6th edition. Washington, USA: ASM Press & Sunderland, D.C., Sinauer Associates.
3. Becker WM, Kleinsmith LJ, Hardin J. and Bertoni GP. (2015). The World of the Cell. 8th edition. San Francisco: Pearson Benjamin Cummings Publishing.
4. De Robertis EDP, and De Robertis E.M.F. (2017). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (2018). Molecular Biology of the Cell Sixth Edition Garland Science publishers.
6. http://172.16.25.76/login/index.php
7. https://nptel.ac.in/courses/102103012/

23BTU202 **CHEMISTRY - II** **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

The main objectives of the course are

- To know the principles of volumetric analysis
- To estimate the compounds by acidimetry, alkalimetry and permanganometry
- Experimental practice of quantitative volumetric analysis
- The objective of the titration is the determination of the concentration or the mass of the minimum formula from the titrated chemical material composing a pure liquid or a solution
- The main objective of volumetric analysis is to determine the amount of a substance ϖ in a given sample
- To deal with volumetric analysis the concept of concentration cannot be avoided. Molarity i.e. moles per litre or decimeter is widely used unit of concentration

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Learn the principles of quantitative analysis of inorganic compounds	Remember
CO2	Estimate the sample present in a solution by volumetric analysis	Understand
CO3	Understand the concepts of quantitative analysis	Understand
CO4	Recognize the indicators, acid and bases used in volumetric analysis	Apply
CO5	Estimate the amount of substance present in a given solution	Analyze
CO6	Utilize the mathematical skills doing calculations	Analyze

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Unit-I **15 hours**

Metals and Coordination Chemistry:

Metals: General methods of extraction of metals-methods of ore dressing-types of furnaces-reduction methods-electrical methods-types of refining-Van Arkel process-Zone refining. **Coordination Chemistry:** Nomenclature-theories of Werner, Sidgewick and Pauling-chelation and its industrial importance-EDTA-haemoglobin-chlorophyll-applications in qualitative and quantitative analysis.

Unit-II **15 hours**

Aromatic Compounds and Heterocyclic Compounds:

Aromatic Compounds: Aromaticity-Huckel's (4n+2) rule- aromatic electrophilic substitution in benzene- mechanism of nitration, halogenation, alkylation, acylation and sulphonation. Naphthalene: Isolation, preparation, properties and structure. **Heterocyclic Compounds:** Preparation and properties of pyrrole, furan, thiophene and pyridine.

Unit-III **15 hours**

Amino acids, Proteins and Carbohydrates:

Amino acids: Classification, preparation and properties. Peptides-preparation of peptides (Bergmann method only). **Proteins:** Classification, properties, biological functions and structure. **Carbohydrates:** Classification, preparation and properties of glucose and fructose- discussion of open chain and ring structures of glucose and fructose-glucose-fructose interconversion.

Unit-IV **15 hours**

Energetics:

Type of systems-processes and their types - isothermal, adiabatic, reversible, irreversible and spontaneous processes-statement of first law of thermodynamics-need for the second law of thermodynamics-heat engine-Carnot cycle-efficiency-Carnot theorem-thermodynamics scale of temperature-Joule-Thomson effect- Enthalpy- Entropy and its significance-Free energy change.

Unit-V **12 hours**

Electrochemistry:

Kohlrausch law-conductometric titrations-hydrolysis of salts-galvanic cells-E.M.F.-standard electrode potentials-reference electrodes- electrochemical series and its applications-buffer solution-buffer solution in the biological systems-pH and its determination-principles of electroplating.

SUGGESTED READINGS:

1. Bahl A, and Bahl BS. (2015). A Textbook of Organic Chemistry. 21st Revised edition. S. Chand & Company Pvt. Ltd. New Delhi.
2. Gopalan R, and Sundaram S. (2013). Allied Chemistry. IIIrd edition. Sultan Chand & Sons. New Delhi.
3. Puri BR, Sharma LR, and Kalia KC. (2017). Principles of Inorganic Chemistry.33rd edition Jalandar: Vishal Publishing Company.
4. Puri BR, Sharma LR, and Pathania MS. (2014). Elements of Physical Chemistry. 46th edition. Jalandhar: Vishal Publishing Company.
5. Veeraiyan V, and Vasudevan ANS. (2012). Text Book of Allied Chemistry. IInd edition. Highmount Publishing House. Chennai.

23BTU211 CELL BIOLOGY PRACTICAL 4H–2C

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

Course Objectives

The main objectives of the course are

- To learn the basics of prokaryotic and eukaryotic cells
- To develop practical biological skills such as staining, sterilization, dialysis etc.
- To understand the physiology of organisms such as cell division, enzyme activity etc.
- To understand the basics of techniques to study cells
- To handle the equipment available and identify the suitable and appropriate experiments for their experiments
- To learn the fundamental aspects of microtomy technique

Course Outcomes

The learners will be able to,

COs	Course Outcomes	Blooms Level
CO1	Understand the unique features of plant and animal cells.	Apply
CO2	Gain the practical skills on tissue mounting techniques to visualize the cell morphology.	Understand
CO3	Knowledge about cell's response to various environmental conditions.	Understand
CO4	Differentiate the cells of various living organisms and get awareness of physiological processes of cell.	Analyze
CO5	Observe and correctly identify different cell types, cellular structures using different microscopic techniques.	Evaluate
CO6	Handle the equipment available and identify the suitable and appropriate experiments for their experiments.	Create

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **48 hours**

1. Study of Prokaryotic and Eukaryotic cell structure.
2. Study the effect of temperature and organic solvents on semi permeable membrane.
3. Demonstration of dialysis.
4. Study of plasmolysis and de-plasmolysis.
5. Cell division in onion root tip.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, pancreas, kidney.
7. Cell counting methods.

8. Chromosomal banding techniques.
9. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READINGS:

1. Becker WM, Kleinsmith LJ, Hardin J. and Bertoni GP. (2015). The World of the Cell. 8th edition. San Francisco: Pearson Benjamin Cummings Publishing.
2. Cooper GM, and Hausman, RE. (2013). The Cell: A Molecular Approach. 6th edition. ASM Press & Sunderland, D.C., Sinauer Associates. Washington, USA.
3. De Robertis EDP, and De Robertis E.M.F. (2017). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G. (2013). Cell and Molecular Biology: Concepts and Experiments. 7th edition. Hoboken, US: John Wiley & Sons. Inc.

23BTU212 **CHEMISTRY – II PRACTICAL** **3H–1C**

Instruction Hours / week: L: 0 T: 0 P:03 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are to

- Know the principles of volumetric analysis
- Estimate the compounds by acidimetry, alkalimetry and permanganometry
- Experimental practice of quantitative volumetric analysis
- Understand the objective of the titration is the determination of the concentration or the mass of the minimum formula. from the titrated chemical material composing a pure liquid or a solution
- Determine the amount of a substance in a given sample
- To analyze the concept of concentration and Molarity

Course Outcomes

The learners will be able to,

COs	Course Outcomes	Blooms Level
CO1	Know the principles of quantitative analysis of inorganic compounds	Apply
CO2	Calculate the estimation of sample present in a solution by volumetric analysis	Understand
CO3	Understand the concepts of quantitative analysis	Understand
CO4	Recognize the indicators, acid and bases used in volumetric analysis	Analyze
CO5	Estimate the amount of substance present in a given solution	Evaluate
CO6	Utilize the mathematical skills doing calculations	Create

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Course Outcomes

Student will be able to

1. Know the principles of quantitative analysis of inorganic compounds
2. Calculate the estimation of sample present in a solution by volumetric analysis
3. Understand the concepts of quantitative analysis
4. Recognize the indicators, acid and bases used in volumetric analysis
5. Estimate the amount of substance present in a given solution
6. Utilize the mathematical skills doing calculations

Volumetric analysis **24 hours**

A. Acidimetry & Alkalimetry

1. Estimation of sodium carbonate using standard sodium hydroxide
2. Estimation of sodium hydroxide using standard sodium carbonate
3. Estimation of sulphuric acid using standard oxalic acid
4. Estimation of potassium permanganate using standard sodium hydroxide

B. Permanganometry **12 hours**

1. Estimation of ferrous sulphate using standard Mohr's salt
2. Estimation of oxalic acid using standard ferrous sulphate
3. Estimation of calcium-direct method

SUGGESTED READINGS:

1. Thomas AO. (2012). Practical Chemistry for B.Sc. Main Students. Scientific Book Centre. Cannanore: Kerala.
2. Ramasamy R. (2011). Allied Chemistry Practical Book. Priya Publications. Karur.
3. Venkateswaran V, Veeraswamy R, and Kulandaivelu AR. (2015). Basic Principles of Practical Chemistry. 2nd edition. S. Chand Publications. New Delhi.

23VAC201 **INDIAN KNOWLEDGE SYSTEM** **2H–2C**

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

COURSE OBJECTIVES:

To make the students

1. To understand the Indian knowledge systems about origin, evolution and ontological approach
2. To comprehend the Indian knowledge approaches with respect to time and language
3. To obtain key knowledge on life and mind of Indian knowledge system
4. To acquire key information on torchbearers of Indian knowledge system
5. 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	Apply the Indian knowledge in modern life styles	Apply
CO3	Analyze the importance of philosophical concepts	Analyze
CO4	Evaluate the origin of Indian knowledge and practices	Evaluate
CO5	Assess the role of Women in ancient and modern India.	Analyze

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Unit I **5 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 **5 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 **5 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 **5 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 **5 hours**

Torch bearers - 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:

1. 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/

SEMESTER - II

ACTIVITY: LIBRARY/SEMINAR **2H**

Instruction Hours / week: L:0 T: 0 P:2 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3Hours

கலை, அறிவியல், வணிகவியல் மற்றும் மேலாண்மையியல் புலம்

மொழிகள் துறை – தமிழ்ப்பிரிவு

தாள் - 3, 4 - H, 4 - C

(2024- 2025 Odd Semester)

பாடத்திட்ட பயன் விளைவு

1. வரலாற்றிற்கு முற்பட்ட தமிழகத்தை மாணவர்களுக்கு அறிமுகப்படுத்துதல்
2. பழந்தமிழர் பண்பாடு சார்ந்த வாழ்க்கை முறையை மாணவர்கள் அறிய ஊக்குவித்தல்
3. தமிழ்மொழியின் பழைமையும், திராவிட மொழிகளில் தமிழ்மொழியின் தனிச்சிறப்பையும் மாணவர்களுக்கு அறிமுகப்படுத்துதல்.
4. தமிழர்களின் வாழ்வியல், தமிழர் கலைகள், ஆற்றங்கரைப் பண்பாடுகள் குறித்து மாணவர்கள் அறியச் செய்தல்.
5. இந்தியக் குடியுரிமைப் பணி முதலான போட்டித் தேர்வுகளில் விருப்பப் பாடமாக இடம்பெறுகின்ற தமிழ் நாகரிகமும் பண்பாடும் குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.

பாடத்திட்டப் பொது நோக்கம்

1. இந்தியக் குடியுரிமைப்பணி முதலான போட்டித் தேர்வுகளில், விருப்பப்பாடமாக இடம்பெறுகின்ற,'தமிழ்இலக்கியவரலாறு' குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.
2. கல்வெட்டியல், ஓலைச்சுவடியியல் மற்றும் தொல்லியல் சார்ந்த ஆவணத் தேடலுக்குரிய ஆய்வு மனப்பான்மையுடன், இலக்கியங்களை அணுகுதல்.
3. தமிழின் வளர்ச்சித்துறையாகிய, 'அறிவியல்தமிழ்';'இணையதமிழ்' குறித்த பன்நோக்கு அணுகுமுறையிலான ஆய்வுச்சிந்தனை மேம்பாடு.
4. வேலைவாய்ப்புக்குரிய சுயதிறன் மேம்பாட்டுடன், படைப்பாக்கத்திறன் மேம்பாடும் பெற்றிருத்தல் .
5. சமுதாய மற்றும் வாழ்வியல் மதிப்புகளைப் பேணுவதற்குக் கருவியாக இலக்கியங்களை நாடுகின்ற மனப்பான்மை வளர்ச்சி. மொழிபெயப்புத் துறைசார்ந்த வேலைவாய்புத்திறன் பெற்றிருத்தல்

தாள்கள் வரிசையும் தேர்வுச் செயல் திட்டமும்

பகுதி-I தமிழ்

இளநிலை கலைத்துறைப் பட்ட வகுப்புகளுக்குரியது

பருவம்	தாள்	கற்பிக்கும் நேரம்/வாரம்	தேர்வுமணிகள்	மதிப்பெண் அக/எழுத்து	மொத்தம்	மதிப்பீடு
மூன்று	3	4	3	40 / 60	100	4

கலை, அறிவியல், வணிகவியல் மற்றும் மேலாண்மையியல் புலம்

மொழிகள் துறை – தமிழ்ப்பிரிவு

தமிழ் இலக்கிய வரலாறு- தாள் 3,

(2024- 2025 Odd Semester)

அலகு:1 சங்க இலக்கியம் (8 மணிநேரம்)

தமிழ் இலக்கிய வரிசை-அறிமுகம்-முச்சங்க வரலாறு-பாட்டும் தொகையுமாகிய சங்க இலக்கியத் தொகுப்பு-அறிமுகம்-எட்டுத்தொகையில் அகத்திணை-புறத்திணை-பத்துப்பாட்டில் அமைந்த ஆற்றுப்படை இலக்கியங்கள்-பத்துப்பாட்டில் அகமும் புறமும்-புலவர்களும் பாடல்களும்-பெண்பாற் புலவர்கள்.

அலகு: 2 அற இலக்கியமும் காப்பியமும் (12 மணிநேரம்)

திருக்குறள்-அமைப்பு-இலக்கியச் சிறப்பு-உலகப் பொதுமைத் தன்மை-பொருட் சிறப்பு-இலக்கியச் சிறப்பு-நாலடியார் முதலாக குமரகுருபரரின் நீதிநெறிவிளக்கம் ஈறாக அமைந்த நீதி இலக்கியங்கள்-நீதி நூல்களில் அகமும் புறமும்-தமிழ் இலக்கிய வரிசையில் ஐம்பெருங் காப்பியங்களும், ஐஞ்சிறு காப்பியங்களும்- சிலம்பும் மணிமேகலையும் – இரட்டைக்காப்பியங்கள்- கம்பராமாயணம்-பெரியபுராணம்-சீறாப்புராணம்-தேம்பாவணி-இராவண காவியம்.

அலகு:3 திருமுறைகளும் திவ்யப்பிரபந்தமும் (10 மணிநேரம்)

தமிழகத்தில் பக்தி இயக்கத்தின் தோற்றமும் வளர்ச்சியும்-பன்னிரு திருமுறைகளும், பதிநான்கு சித்தாந்த சாத்திரங்களும்-திவ்யப்பிரபந்தமும், இராமானுஜ நூற்றந்தாதி முதலான வைணவ இலக்கியங்களும்.

அலகு: 4 சிற்றிலக்கியங்களும் இக்கால இலக்கியங்களும் (10 மணிநேரம்)

குற்றாலக்குறவஞ்சி, முக்கூடற்பள்ளு, மதுரை மீனாட்சியம்மை பிள்ளைத்தமிழ், மதுரை சொக்கநாதர் தமிழ்விடு தூது, அழகர் கிள்ளைவிடு தூது முதலான சிற்றிலக்கிய வரிசை-தமிழில் புதுக்கவிதை இயக்கங்களின் தோற்றமும் வளர்ச்சியும்-தமிழ்ப் புதுக்கவிதை வடிவங்கள்-தமிழின் நாடக இலக்கியங்கள்- மனோண்மணீயம் – தமிழின் உரைநடை இலக்கிய வளர்ச்சி-தமிழின்பம் முதலான உரைநடை நூல்கள்-தமிழில் சிறுகதை இலக்கிய வளர்ச்சி-இருபதாம் நூற்றாண்டுச் சிறுகததைகள்-தமிழில் புதின இலக்கியங்கள்-இக்கால இலக்கியங்களில் காலந்தோறும் தனி மனிதப் பதிவுகளும், சமுதாயப் பதிவுகளும்.

அலகு: 5 தமிழின் ஐந்திலக்கணம் (8 மணிநேரம்)

தமிழின் எழுத்து – சொல் – பொருள் – யாப்பு - அணி என்றமைந்த தமிழின் ஐந்திலக்கணக் கொள்கைகள் – நன்னூல் - தொல்காப்பியம் - யாப்பருங்கலக்காரிகை - புறப்பொருள் வெண்பாமாலை – நம்பி அகப்பொருள் முதலான இலக்கண நூல் சிந்தனைகள்.

பாடநூல்:

தமிழ் இலக்கிய வரலாறு - மொழிகள் துறை - தமிழ்ப்பிரிவு, கற்பகம் உயர்கல்விக்கழகம், கோயம்புத்தூர் -21.

பார்வை நூல்கள்:

1. தமிழ் இலக்கிய வரலாறு – தமிழண்ணல், மீனாட்சி புத்தக நிலையம்- மதுரை.
2. தமிழ் இலக்கிய வரலாறு – வேங்கடராமன்.கா.கோ. கலையகம் பதிப்பகம், நாமக்கல்.
3. புதிய நோக்கில் தமிழ் இலக்கிய வரலாறு-சுந்தரமூர்த்தி.செ, அவ்வை பதிப்பகம், திருவாரூர்.
4. தற்காலத் தமிழ் இலக்கிய வரலாறு - கவிஞர் திலகம் மானூர் புகழேந்தி, நிலாப் பதிப்பகம், 63,பாரதிதாசன் நகர், இராமநாதபுரம், கோவை – 641045.

இணையதளம்

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

வினாத்தாள் கட்டமைப்பு

இடைத்தேர்வு வினாத்தாள்

மொத்த மதிப்பெண்கள் 50

பகுதி – அ (ஒரு மதிப்பெண் வினாக்கள்) 20 X 1 = 20 (சரியான விடையினைத் தேர்ந்தெடுத்தெழுதுதல்)

பகுதி – ஆ (இரு மதிப்பெண் வினாக்கள்) 3 X 2 = 6 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பகுதி – இ (ஆறுமதிப்பெண் வினாக்கள்) 6 X 4 =24 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பருவத்தேர்வு வினாத்தாள் - மொத்த மதிப்பெண்கள் 60

பகுதி – அ (ஒரு மதிப்பெண் வினாக்கள்) 20 X 1 = 20 (சரியான விடையினைத் தேர்ந்தெடுத்தெழுதுதல்)

பகுதி – ஆ (இரு மதிப்பெண் வினாக்கள்) 5 X 2 = 10 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பகுதி – இ (ஆறுமதிப்பெண் வினாக்கள்) 5 X 6 =30 (அல்லது வகையில் தேர்ந்தெடுத்து எழுதுதல்)

SEMESTER - III

23ENU301 ENGLISH - III 3H–3C

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

End Semester Exam: 3 Hours

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	S	M	L	L	L	L	L	L	L	L	L	M
CO2	S	M	L	L	L	L	L	L	L	L	L	M
CO3	S	M	L	L	L	L	L	L	L	L	L	M
CO4	S	M	L	L	L	L	L	L	L	L	L	M
CO5	S	M	L	L	L	L	L	L	L	L	L	M

S-Strong; M-Medium; L-Low

UNIT-I **8 hours**

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

UNIT- II **8 hours**

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

UNIT-III **8 hours**

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

UNIT- IV **8 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 **4 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 Universiity 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.

23BTU301 **MOLECULAR BIOLOGY** **5H–4C**

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

Course Objectives

The main objectives of the course are

- To emphasize the basic knowledge about the structure and functions of nucleic acids (DNA/RNA) and proteins
- To obtain the adequate knowledge on the replication of DNA
- To gain the information about the DNA damage and repair mechanisms
- To understand the mechanisms behind gene regulations
- To understand the mechanism behind translation and transcription
- To understand the mutations and its significance

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Achieve knowledge about the functions of nucleic acids and proteins	Remember
CO2	Acquire an in-depth knowledge of chemical and molecular processes that occur within and between the cells	Understand
CO3	Gain an insight into the most significant molecular and cell-based methods used today to expand our understanding of biology	Apply
CO4	Acquire knowledge about the mechanisms behind gene regulations	Analyze
CO5	Gain knowledge about mechanism behind translation and transcription	Evaluate
CO6	Acquire an in-depth knowledge about mutation and its significance	Create

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I **12 hours**

DNA organization:

DNA as genetic material. Organization of DNA in prokaryote and eukaryotic cells, Genome Organization (Griffith's experiment, Avery, MacLeod and McCarty's experiment, Hershey-Chase experiment), Chromosome biology - histone and non-histone proteins, organization, structure and functions.

UNIT-II **12 hours**

DNA replication:

Replication of DNA in prokaryotes and eukaryotes: Semi-conservative nature of DNA replication, Bi-directional replication, DNA polymerases and its types of enzymes involved in replication. Replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT-III **12 hours**

Transcription and RNA processing:

RNA structure and types of RNA, Central dogma of life, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT-IV **12 hours**

Regulation of gene expression and translation:

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins.

UNIT-V **12 hours**

DNA damage and repair:

Causes and types of DNA damage, Spontaneous mutations, Induced mutations – physical mutagen: radiations, temperature as mutagen, chemical mutagens: alkylating agents, nitrous acid, hydroxylamine. Mechanism of DNA repair: SOS repair, Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, recombinational repair, non-homologous end joining. Homologous recombination: models and mechanism.

SUGGESTED READINGS:

1. Becker, W.M., Kleinsmith, L.J., Hardin. J., & Bertoni, G. P. (2009). *The World of the Cell* (7th ed.). San Francisco: Pearson Benjamin Cummings Publishing.
2. De Robertis, E.D.P., & De Robertis, E.M.F. (2011). *Cell and Molecular Biology* (8th ed.). Lippincott Williams and Wilkins, Philadelphia.
3. Karp, G. (2015). *Cell and Molecular Biology: Concepts and Experiments* (8th ed.). Hoboken, US: John Wiley & Sons. Inc.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). *Molecular Biology of the Gene* (7th ed.). Cold Spring Harbour Lab. Press, Pearson Pub.

23BTU302 **GENERAL MICROBIOLOGY** **4H–4C**

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

Course Objectives

The main objectives of the course are

- To inculcate knowledge on fundamentals of microorganisms
- To learn the structural organization, morphology and reproduction of microbes
- To know the principles of Microscopy and advancements in Microscopy
- To deal with the study of genetic, metabolic strategies and ecology of microorganisms
- To know the basic knowledge of the main microbiological techniques to be applied in the laboratory
- To develop understanding about microbial metabolism, growth, energy generation and disease caused

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Gain knowledge on historical perspective of Microbiology	Understand
CO2	Acquire basic knowledge on different structure of microbes	Understand
CO3	Analyze the structure of microbes on different types of microscope	Analyze
CO4	Apply the different applications of microbes in biotechnology	Apply
CO5	Assess the genetic, metabolic strategies of microorganisms	Analyze
CO6	Analyze the microbial metabolism, growth, energy generation	Analyze

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I **10 hours**

Introduction:

Introduction to Microbiology, Haeckel's three–kingdom concept, Whittaker's Five-kingdom concept, Three-domain concept of Carl Woese, Classification of Bacteria according to Bergey's manual.

UNIT-II **10 hours**

Structure and Classification:

Morphology and cell structure of major groups of microorganisms e.g. Bacteria, Fungi, Unique features of Viruses and Protozoans. Microbial taxonomy, criteria used to include molecular approaches, Microbial phylogeny and current classification of bacteria. Principles, types and applications of microscopy (Light and electron microscope).

UNIT-III **10 hours**

Cultivation and Maintenance of microorganisms:

Nutritional categories of micro-organisms, Media, Types of media, Sterilization, Methods of isolation (pour plate and spread plate), Staining types (Simple, Gram positive, Gram negative, flagella staining), Pure culture techniques, culture preservation.

UNIT-IV **10 hours**

Microbial growth:

Growth curve, Microbial growth kinetics, batch and continuous culture, Measurement of growth, growth factors, factors affecting growth of microbes. Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT-V **10 hours**

Applied Microbiology:

Water Microbiology. Major water borne diseases. Food Microbiology: Important microorganism in food processing: Moulds, yeasts and bacteria. Role of microbes in fermented foods, probiotics, prebiotics. Clinical Microbiology: Bacterial diseases – tuberculosis, cholera, typhoid; Viral diseases – measles, AIDS, hepatitis B; Fungal diseases – mycosis, candidiasis; Protozoan diseases – malaria, sleeping sickness. Antimicrobial agents.

SUGGESTED READINGS:

1. Gerard Tortora, Berdell Funke, Christine Case (2018), Microbiology: An Introduction 13th Edition, Pearson.
2. Aneja KR, and Mehrotra RS. (2015). An Introduction to Mycology. 4nd edition. New Age International.
3. Jay JM, Loessner MJ, and Golden DA. (2005). Modern Food Microbiology. 7th edition. CBS Publishers and Distributors. Delhi: India.
4. Madigan MT, Martinko JM, and Parker J. (2010). Brock Biology of Microorganisms. 13th edition. Pearson/Benjamin Cummings. McGraw Hill Publishers, Boston
5. Prescott, L.M., Harley, J.P. and Klein, D.A. (2014). Microbiology (9th Edition),
6. Robert Edward Lee, (2008). Phycology. 4th edition. Cambridge University Press.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
8. Tortora GJ, Funke BR, and Case CL. (2018). Microbiology: An Introduction. 13th edition. Pearson Education
9. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India

23BTU303A **BIOINSTRUMENTATION AND BIOSTATISTICS** **3H–3C**

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

Course Objectives

The main objectives of the course are

- To understand the fundamental principles of bioinstrumentation commonly used in biomedical research labs and hospitals
- To comprehend the colorimetric and spectroscopic principles
- To recognize the concepts on centrifugation and chromatography
- To obtain key knowledge on electrophoresis
- To understand key concepts on biostatistics and its various tools
- To attain strong knowledge on data representation

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Demonstrate the bioinstrumentation principles with respect to device design and applications	Remember
CO2	Perform colorimetric and spectroscopic methods to analyze biological samples	Understand
CO3	Apply the principles of centrifugation and chromatography for compound separation	Apply
CO4	Carryout the separation of nucleic acids and proteins using electrophoresis	Analyze
CO5	Recognize the definition of biostatistics and its relation with other sciences	Evaluate
CO6	Apply the biostatistical knowledge in analyzing biological problems using biostatistics	Evaluate

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT – I Microscopy, Colorimetry and Spectroscopy: **8 hours**

Microscopy: Tranmission and scanning electron microscope (TEM & SEM), Fluorescence microscope. Colorimetry and Spectroscopy: Colorimetry, basic principles, Color and absorption spectra, Beer's and Lambert's law. Instrumentation and applications of UV Visible light spectroscopy, Spectrofluorimeter, FTIR, atomic spectroscopy, NMR spectroscopy.

UNIT – II Centrifugation and Chromatography: **8 hours**

Principle, types of centrifuges, g and RPM value, Applications of analytical and preparative centrifuge, density gradient and ultra-centrifuge. Chromatography: Principles, Type - Paper, thin layer, normal and reverse phase, ion-exchange, affinity, gel filtration, size exclusion, HPLC.

UNIT – III Electrophoresis: **8 hours**

Principle, instrumentation and applications of Electrophoresis: Agarose gel electrophoresis, Sodium dodecyl sulphate - polyacrylamide gel (SDS-PAGE), native PAGE, pulse field, capillary electrophoresis, 2D-Electrophoresis, isoelectric focusing.

UNIT- IV Biostatistics: **8 hours**

Basis of Statistics. Definition- Statistical Methods- Kinds of Biological Data Collection and Organization. Types of data: primary Data, secondary Data. Methods of Collecting Data. Sampling and Sampling Designs- Definition: Random and Non-random sampling. Editing the Data: Definition, Objectives of Editing. Classification of Data: Definition, Objectives of classification of Data: Ungrouped raw data- continuous- discrete variation.

UNIT- V Tabulation, Representation of the Data and Measures of Central Tendency: **4 hours**

Tabulation: Definition. Parts of table - advantages. Representation of the Data: Diagrammatic: simple bar diagram, Rectangles, squares, circles or Pie diagram - Graphic representation: Histogram, Frequency- Polygon frequency curve, cumulative frequency curve. Measures of central Tendency: Explanation, Types of averages: Arithmetic mean, Median, Mode. Explanation problems related to: ungrouped data, Simple grouped data: continuous, discrete series.

SUGGESTED READINGS:

1. Hofmann, A. &Clokie, S. (2018). *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology* (8th ed.). Cambridge University Press, Cambridge, United Kingdom.
2. Sawhney, S.K.& Singh, R. (2018). Introductory *Practical Biochemistry* (6th ed.). Alpha Science International Ltd. Publishers, Oxford, UnitedKingdom.
3. Marcello Pagano, Kimberlee Gauvreau. (2018). *Principles of Biostatistics* (2nd ed.). Chapman and Hall/CRC Publishers, New York, United States of America.
4. Rosner, B. (2019). *Fundamentals of Biostatistics* (8th ed.). Cengage Learning Publishers, Massachusetts, United States.

23BTU303B **BIOPHYSICS** **3H–3C**

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

Course Objectives

The main objectives of the course are

- To develop the human resource with the interdisciplinary approach in the field of Science & Technology.
- To create future researchers to be expertised in the field of Biophysics that are excellently trained and excited to work on various important medical & health problems.
- To adequately emphasize on the applications of physics, chemistry and other branches to biological sciences needed to develop the new approach in the academic and industrial research.
- To recognize the concepts on atomic and molecular structures.
- To comprehend the role of thermodynamics and bioenergetics.
- To understand key concepts on basic biophysical techniques.

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Recognize the importance of interdisciplinary research to resolve health problems.	Remember
CO2	Apply the knowledge to develop novel paradigms for academic and industrial research.	Understand
CO3	Understand the basic concepts of atomic and molecular structures.	Understand
CO4	Develop research protocols using the Mole concepts.	Analyze
CO5	Appreciate thermodynamics and bioenergetics in biological systems.	Evaluate
CO6	Apply the knowledge of biophysical techniques for their research questions.	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT- I Atomic & Molecular structure: **8 hours**

Structure of atom: Models & theories, Periodic table, Concept of bonding; valence of carbon; hybridizations of carbon; hybridizations of nitrogen & oxygen; molecular orbital theories, polar & non polar molecules; Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole interactions; London dispersion forces. Bonds within molecules-Ionic, covalent, Hydrogen,

Electrostatic, Disulphide & peptide bonds, Van-der Waals forces. Bond lengths & Bond energies.

UNIT- II Physico-chemical Foundations: **8 hours**

Biophysics of Water: Physicochemical properties of water, Molecular structure. Hydrophiles and Hydrophobes. Aqueous Environment of the Cell and its significance. Mole concept, Molarity, Molality and Normality, Ampholyte, concept of pH, measurements of pH, Henderson–Hasselbatch equation. Buffers & Stability of their pH. Redox potential: Oxidation –Reduction, examples of redox potential in biological system

UNIT- III Thermodynamics: **8 hours**

Thermodynamics of Biological system: First and second laws of thermodynamics, activation energy. Biological systems as open, non-equilibrium systems, Concept of free energy, unavailable energy and entropy, heat content of food, bomb calorimetry, Enthalpy, Negative entropy as applicable to biological systems. thermodynamics of passive and active transport, glycolytic oscillations, biological clocks.

UNIT- IV Bioenergetics: **8 hours**

Concept of energy coupling in biological processors, Energy requirements in cell metabolism, structure and role of mitochondria, high energy phosphate bond, energy currency of cell, biological oxidation, Electron-transport chain, Oxidative Phosphorylation including chemiosmotic hypothesis. Thermodynamic analysis of TCA cycle and oxidative phosphorylation.

UNIT- V Basic Biophysical Techniques: **4 hours**

Light microscopy: Simple, compound optical microscopes; Phase contrast and interference contrast microscopes: principle, design, resolution and applications. Centrifugation: Concept of sedimentation. Basic principles, RCF. Centrifugation techniques - Differential centrifugation: principle and design, types and applications of different Centrifuges. Chromatography: Basic principles of Adsorption & Partition Chromatography. Methodology & Applications of paper, thin layer, and column chromatography. Electrophoresis: Principle and applications of paper and gel electrophoresis (AGE and SDS-PAGE).

SUGGESTED READINGS:

1. Gauri Misra. (2018). Introduction to Biomolecular Structure and Biophysics - Basics of Biophysics. (1st ed.). Springer Singapore Publishers, Singapore.
2. Jean-Philippe Ansermet and Sylvain D. Brechet. (2019). Principles of Thermodynamics (1st ed.). Cambridge University Press. United Kingdom.
3. Hofmann, A. &Clokie, S. (2018). *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology* (8th ed.). Cambridge University Press, Cambridge, United Kingdom.
4. Sawhney, S.K.& Singh, R. (2018). Introductory *Practical Biochemistry* (6th ed.). Alpha Science International Ltd. Publishers, Oxford, United Kingdom.

23BTU311 **MOLECULAR BIOLOGY PRACTICAL** **4H–2C**

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

Course Objectives

The main objectives of the course are

- To learn what are the solutions required for and molecular biology experiments and how to prepare it.
- To learn about the prokaryotic and eukaryotic genetic system using modern techniques.
- To inculcate knowledge on cell division stages and pedigree analysis
- To develop skills on cell mounting techniques & karyotyping
- To inculcate practical skill in extraction of protein, chromosomal and plasmid DNA and separation by electrophoresis
- To detect the reverse mutation for carcinogenicity

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Gain rich knowledge on genetic model system used in research	Remember
CO2	Acquire basic knowledge on cell division, karyotyping and genetic variations among microorganisms	Understand
CO3	Get Ideas on pedigree analysis for detection of genetic disorders	Apply
CO4	Apply the principles of inheritance as formulated by Mendel	Analyze
CO5	Perform the experiments for isolation, purification and visualize the chromosomal DNA & Plasmid DNA from various sources	Evaluate
CO6	Know the protocol for detection of mutation in microbes	Create

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **48 hours**

1. Isolation of chromosomal DNA from plants
2. Isolation of chromosomal DNA from bacterial cells
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Extraction and separation of protein from bacterial cells-SDS page
7. Demonstration of AMES test or reverse mutation for carcinogenicity

SUGGESTED READINGS:

1. Griffiths AJF, Wessler SR, Lewontin RC, and Carroll SB. (2015). Introduction to Genetic Analysis. 11th edition W. H. Freeman & Co.
2. Klug WS, Cummings MR, and Spencer CA. (2018). Concepts of Genetics. 12th edition. Benjamin Cummings.
3. Russell PJ. (2016). Genetics- A Molecular Approach. 5th edition. Benjamin Cummings.
4. Carson, S., H. Miller, M. Srougi, D. Scott Witherow (2019). Molecular Biology Techniques 4th Edition - A Classroom Laboratory Manual.Academic Press.
5. Chaitanya KV (2013). Cell and Molecular biology laboratory manual. PHI learning private limited, New Delhi.

23BTU312 **GENERAL MICROBIOLOGY 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

The main objectives of the course are

- To understand the basic principles of microscopy ultra-structure of microbes along with staining and sterilization methods
- To understand various accessories for microbiology practicals
- To explain the students with various aspects of basic and applied microbiology
- To understand the biochemical characterization of isolated microbes
- To develop practical biological skills such as staining, sterilization etc.
- To develop skills on primary screening of microorganisms

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Develop basic skill in aseptic techniques	Apply
CO2	Have outline knowledge on isolation, sub culture and maintenance of microbes	Understand
CO3	Gain experience in microbiological laboratory practices and skills in the design and execution of microbiology related research	Understand
CO4	Develop skills to prepare useful media for microbial growth in the laboratory	Apply
CO5	Use of handling of glass wares and minor equipments for conducting experiments	Apply
CO6	Learn safety and precautionary measures for working with microbes in a laboratory	Analyze

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **36 hours**

1. Preparation of media & sterilization methods
2. Methods of isolation of bacteria from different sources
3. Enumeration of microorganism - total & viable count
4. Basic staining methods
5. Biochemical characterization of isolated microbes
6. Determination of bacterial motility by hanging drop method
7. Antibiotic sensitivity of microbes

SUGGESTED READINGS:

1. Cappuccino, J.H. and Sherman, N. (2014). Microbiology – A Lab Manual (10th Edition), The Benjamin Publishing Company, Singapore.
2. Goering R, Dockrell H, Zuckerman M, and Wakelin D. (2012). Mims' Medical Microbiology. 5th edition. Elsevier.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

SEMESTER - III

23VAC301 CYBER SECURITY 2H–2C

Instruction Hours / week: L:2 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- Understand various block cipher and stream cipher models.
- Describe the principles of public key cryptosystems, hash functions and digital signature used for security.
- To get a firm knowledge on Cyber Security Essentials.
- To Learn about Basic Principles of Policies and Cyber Security.
- To gain information on Laws and Legal Procedures.

Course Outcomes:

COs	Course Outcomes	Blooms Level
CO1	Implement basic security algorithms required by any computing system	Apply
CO2	Analyze the vulnerabilities in any computing system and hence be able to design a security solution	Analyze
CO3	Analyze the possible security attacks in complex real time systems and their effective countermeasures	Analyze
CO4	Differentiate various governing bodies of cyber laws	Understand
CO5	Impart various privacy policies for an organization	Understand

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT I Introduction to Security **5 Hours**

Data Encryption Standard-Block cipher principles-block cipher modes of operation-Advanced Encryption Standard (AES)-Triple DES-Blowfish-RC5 algorithm.

UNIT II Public Key Cryptography and Hash Algorithms **5 Hours**

Principles of public key cryptosystems-The RSA algorithm-Key management - Diffie Hellman Key exchange- Hash Functions-Hash Algorithms (MD5, Secure Hash Algorithm)

UNIT III Fundamentals of Cyber Security **5 Hours**

How Hackers Cover Their Tracks- Fraud Techniques- Threat Infrastructure- Techniques to Gain a Foothold (Shellcode, SQL Injection, Malicious PDF Files)- Misdirection, Reconnaissance, and Disruption Methods.

UNIT IV Planning for Cyber Security **5 Hours**

Privacy Concepts -Privacy Principles and Policies -Authentication and Privacy - Data Mining - Privacy on the Web - Email Security - Privacy Impacts of Emerging Technologies.

UNIT V Cyber Security Management **5 Hours**

Security Planning - Business Continuity Planning - Handling Incidents - Risk Analysis - Dealing with Disaster – Legal Issues – Protecting programs and Data – Information and the law – Rights of Employees and Employers - Emerging Technologies - The Internet of Things - Cyber Warfare.

SUGGESTED READINGS

1. William Stallings, "Cryptography and Network Security", Pearson Education, 6th Edition,2013.
2. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition, Pearson Education, 2015.
3. Graham, J. Howard, R., Olson, R., Cyber Security Essentials, CRC Press, 2011.
4. George K. Kostopoulous, Cyber Space and Cyber Security, CRC Press, 2013.

Web Sites:

1. Web resources from NDL Library,
2. E-content from open-source libraries

SEMESTER - III

23BTU391	**INTERNSHIP PROGRAMME**	**2 C**

Instruction Hours / week: L:0 T: 0 P: 0 **Marks:** Internal: **100** External: **00** Total: **100**

ACTIVITY: LIBRARY/SEMINAR **2H**

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

கலை, அறிவியல், வணிகவியல் மற்றும் மேலாண்மையியல் புலம்

மொழிகள் துறை – தமிழ்ப்பிரிவு

தாள் 4, 4 - H, 4 - C

(2024 – 2025 Even Semester)

பாடத்திட்ட பயன் விளைவு

1. வரலாற்றிற்கு முற்பட்ட தமிழகத்தை மாணவர்களுக்கு அறிமுகப்படுத்துதல்
2. பழந்தமிழர் பண்பாடு சார்ந்த வாழ்க்கை முறையை மாணவர்கள் அறிய ஊக்குவித்தல்
3. தமிழ்மொழியின் பழைமையும், திராவிட மொழிகளில் தமிழ்மொழியின் தனிச்சிறப்பையும் மாணவர்களுக்கு அறிமுகப்படுத்துதல்.
4. தமிழர்களின் வாழ்வியல், தமிழர் கலைகள், ஆற்றங்கரைப் பண்பாடுகள் குறித்து மாணவர்கள் அறியச் செய்தல்.
5. இந்தியக் குடியுரிமைப் பணி முதலான போட்டித் தேர்வுகளில் விருப்பப் பாடமாக இடம்பெறுகின்ற தமிழ் நாகரிகமும் பண்பாடும் குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.

பாடத்திட்டப் பொது நோக்கம்

1. இந்தியக் குடியுரிமைப்பணி முதலான போட்டித் தேர்வுகளில், விருப்பப்பாடமாக இடம்பெறுகின்ற,'தமிழ்இலக்கியவரலாறு' குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.
2. கல்வெட்டியல், ஓலைச்சுவடியியல் மற்றும் தொல்லியல் சார்ந்த ஆவணத் தேடலுக்குரிய ஆய்வு மனப்பான்மையுடன், இலக்கியங்களை அணுகுதல்.
3. தமிழின் வளர்ச்சித்துறையாகிய, 'அறிவியல்தமிழ்';'இணையதமிழ்' குறித்த பன்நோக்கு அணுகுமுறையிலான ஆய்வுச்சிந்தனை மேம்பாடு.
4. வேலைவாய்ப்புக்குரிய சுயதிறன் மேம்பாட்டுடன், படைப்பாக்கத்திறன் மேம்பாடும் பெற்றிருத்தல் .
5. சமுதாய மற்றும் வாழ்வியல் மதிப்புகளைப் பேணுவதற்குக் கருவியாக இலக்கியங்களை நாடுகின்ற மனப்பான்மை வளர்ச்சி. மொழிபெயப்புத் துறைசார்ந்த வேலைவாய்புத்திறன் பெற்றிருத்தல்

தாள்கள் வரிசையும் தேர்வுச் செயல் திட்டமும்

பகுதி-I தமிழ்

இளநிலை அறிவியல் பட்ட வகுப்புகளுக்குரியது

பருவம்	தாள்	கற்பிக்கும் நேரம்/வாரம்	தேர்வுமணிகள்	மதிப்பெண் அக/எழுத்து	மொத்தம்	மதிப்பீடு
நான்கு	4	4	3	40 / 60	100	4

கலை, அறிவியல், வணிகவியல் மற்றும் மேலாண்மையியல் புலம்

மொழிகள் துறை – தமிழ்ப்பிரிவு

தமிழர் நாகரிகமும் பண்பாடும் - தாள் 4

(2024 – 2025 Even Semester)

அலகு – I வரலாற்றுக்கு முற்பட்ட தமிழகமும் சங்ககால வரலாறும் (8 மணிநேரம்)

வரலாறும் நிலஅமைப்பும் – வரலாற்றின் செல்வாக்கு – பல்வேறு காலங்களில் வரலாறு உண்டாக்கிய நாட்டுப் பிரிவுகள் - பழைய கற்காலம் – புதிய கற்காலம் – இரும்புக் காலம்.

அலகு – 2 தமிழின் தொன்மை (8 மணிநேரம்)

தமிழ் தோன்றிய இடம் – குமரிக்கண்டத் தமிழ் நாடுகள் – தமிழ் என்னும் பெயர் வரலாறு – திராவிட மொழிக்குடும்பம் – தமிழ்மொழிச் சிறப்பு – தமிழுக்குத் தமிழ் நாட்டவர் செய்ய வேண்டியவை – தமிழுக்கு வெளிநாட்டிற் செய்ய வேண்டியவை.

அலகு – 3 தமிழர் வாழ்வியல் (8 மணிநேரம்)

ஐவகை நிலங்கள் – களவு வாழ்க்கை – கற்பு வாழ்க்கை – அரசர் கடமை – கல்வி நிலை – தொழில் நிலை – ஆடவர் நிலை – பெண்டிர் நிலை.

அலகு – 4 கட்டடக்கலையும் தமிழர் பண்பாடும் (8 மணிநேரம்)

கட்டடக்கலை தோற்றுவாய் – முதற்கலை – கட்டடக்கலையின் பழைமை – புதிய கற்காலம் – சங்ககாலம் – கோயில்கள் – அரண்மனைகள் – கோட்டைகள் – வீடுகள் – நீர்ப்பாசனக் கட்டடக்கலை – தமிழர் கட்டடக் கலையின் தனிச்சிறப்பு.

அலகு – 5 ஆற்றங்கரை நாகரிகம் (8 மணிநேரம்)

ஆறும் நாகரிகமும் – ஆறுகளின் தோற்றமும் நீளமும் – காவிரிக்கரை நாகரிகம் – இலக்கியச் சிறப்பு – கலைச்சிறப்பு – வைகைக்கரை நாகரிகம் - இலக்கியச் சிறப்பு – கலைச்சிறப்பு , நொய்யல்கரை நாகரிகம்.

Part I TAMIL 2024. Even Sem Science Karpagam Academy of Higher Education, Coimbatore –21.

பார்வை நூல்கள்

1. முனைவர் அரங்க இராமலிங்கம் (பதிப்பாசிரியர்), தமிழர் நாகரிகமும் தமிழ் மொழிவரலாறும் (தொகுதி -1, 6, 2, 5, 10), வர்த்தமானன் பதிப்பகம், தியாகராயநகர், சென்னை-17.

2. கே.கே.பிள்ளை, தமிழக வரலாறு மக்களும் பண்பாடும், உலகத்தமிழ் ஆராய்ச்சி நிறுவனம் தரமணி, சென்னை-13.
3. நா.வானமாமலை, தமிழர் வரலாறும் பண்பாடும், நியூசெஞ்சுரி புக்ஹவுஸ், சென்னை -98.

இணையதளம்

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

வினாத்தாள் கட்டமைப்பு

இடைத்தேர்வு வினாத்தாள்

மொத்த மதிப்பெண்கள் 50

பகுதி –அ (ஒரு மதிப்பெண் வினாக்கள்) 20X1 = 20 (சரியான விடையினைத் தேர்ந்தெடுத்தெழுதுதல்)

பகுதி – ஆ (இரு மதிப்பெண் வினாக்கள்) 3 X 2 = 6 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பகுதி – இ (ஆறுமதிப்பெண் வினாக்கள்) 6 X 4 =24 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பருவத்தேர்வு வினாத்தாள் - மொத்த மதிப்பெண்கள் 60

பகுதி–அ (ஒரு மதிப்பெண் வினாக்கள்) 20X1 =20 (சரியான விடையினைத் தேர்ந்தெடுத்தெழுதுதல்)

பகுதி – ஆ (இரு மதிப்பெண் வினாக்கள்) 5X 2 = 10 (அனைத்து வினாக்களுக்கும் விடையளித்தல்)

பகுதி – இ (ஆறுமதிப்பெண் வினாக்கள்) 5 X 6 =30 (அல்லது வகையில் தேர்ந்தெடுத்து எழுதுதல்)

SEMESTER - IV

23ENU401 ENGLISH - IV 3H–3C

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

End Semester Exam: 3 Hours

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	S	M	L	L	L	L	L	L	L	L	L	M
CO2	S	M	L	L	L	L	L	L	L	L	L	M
CO3	S	M	L	L	L	L	L	L	L	L	L	M
CO4	S	M	L	L	L	L	L	L	L	L	L	M
CO5	S	M	L	L	L	L	L	L	L	L	L	M

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- Dicto Composition--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

SUGGESTED READINGS:

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.

SEMESTER - IV

23BTU401 RECOMBINANT DNA TECHNOLOGY 5H–5C

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

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To learn the procedure for isolation of nucleic acids and proteins
- To learn the strategies for gene transfer in plants and animals
- To acquire knowledge on genome mapping
- To familiarize the student with emerging field of biotechnology
- To acquaint the students to utilize versatile tools and techniques employed in recombinant DNA technology
- To learn the history and recent developments in rDNA technology

Course Outcomes

The learners will be to

COs	Course Outcomes	Blooms Level
CO1	Know the fundamental steps in genetic engineering techniques	Understand
CO2	Describe the mechanism of action and the use of restriction enzymes in biotechnology research	Understand
CO3	Explain the procedures for plasmid preparations	Apply
CO4	Discuss cloning strategies and techniques used to probe DNA for specific gene of interest	Apply
CO5	Conceptualize PCR technique in medical and forensic science	Apply
CO6	Summarize various applications of rDNA technology in human health care and safety regulations	Evaluate

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I **10 hours**

Introduction to r-DNA technology: Basic tools and applications – isolation and purification of nucleic acids, Enzymes used in cloning - restriction enzymes, ligases, polymerases, kinases, phosphatases. Expression vectors and cloning vector, Artificial vectors, Gene recombination and gene transfer – transformation, transfection, microinjection, electroporation, ultrasonication.

UNIT-II **10 hours**

Selection and screening of recombinant clones: Probes – radio labeled and non-radio-labeled, guessmer and degenerate probes. Sequence dependent and independent screening, Southern / Northern / Western blot, dot blot and zoo blot. Southern and northern hybridization, colony and plaque hybridization, *in situ* chromosomal hybridization, chromosome walking, Genome mapping, DNA fingerprinting, DNA foot printing, Polymerase chain reaction (PCR), RT- (Reverse transcription) PCR.

UNIT-III **10 hours**

Expression and characterization of cloned DNA: Optimization of protein expression in heterologous systems, Synthesis and purification of proteins from cloned genes – Fusion proteins, *In vitro* translation systems. Preparation and comparison of Genomic and cDNA library. GFP and RFP.

UNIT-IV **10 hours**

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts (any two) and applications.

UNIT-V **10 hours**

Applications of Genetic Engineering: In plants: use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors. In animals: Production and applications of transgenic mice, role of embryonic stem cells in gene targeting in mice, Therapeutic products - blood proteins, human hormones, immune modulators and vaccines (one example each). Q PCR, Ethical, legal and social issues, Human Genome Project.

SUGGESTED READINGS:

1. Brown, T.A., (2016). *Gene Cloning and DNA Analysis* (7th ed.). Wiley-Blackwell.
2. Clark, D.P., & Pazdernik, N.J. (2009). *Biotechnology-Applying the Genetic Revolution*. USA: Elsevier Academic Press.
3. Glick, B.R., & Patten C. L. (2017). *Molecular Biotechnology- Principles and Applications of recombinant DNA*. (5th ed.). Washington: ASM Press.
4. Primrose, S.B., & Twyman, R.M. (2013). *Principles of Gene Manipulation and Genomics* (7th ed.). Wiley-Blackwell.

23BTU402 **GENETICS** **5H–4C**

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

Course Objectives

The main objectives of the course are

- To deliver the basic concepts of heredity in different living organisms
- To gain the information about the level of genome organization in various living organisms
- To obtain the knowledge about transmission of genetic information across generation at the individual and population level
- To understand the identification and classification of mutations in DNA
- To relate the structure and function of the DNA molecule, its functional role in encoding genetic material
- To describe the basic aspects of the flow of genetic information from DNA to proteins

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Acquire knowledge about the central theories and methodologies traditional, molecular and population genetics.	Remember
CO2	Acquire information on sex- linked inheritance and associated diseases.	Understand
CO3	Understand the role of genetics in breeding and natural selection.	Apply
CO4	Apply the principles of inheritance as formulated by Mendel.	Apply
CO5	Apply the Hardy-Weinberg Law in analyzing population genetics for gene frequency, sex linkage, equilibrium, and heterozygote frequency.	Evaluate
CO6	Acquire knowledge about the relationship between genetic and cytogenetic maps.	Evaluate

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I **10 hours**

Introduction to genetics:

Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Pre-Mendelian genetic concepts: Preformation, Epigenesis, Chromosomal Theory of inheritance. Heredity and Environment: Concepts of Phenotype, Genotype, Heredity, variation, Pure lines and Inbred lines. Biography of Mendel and his experiment on pea plants,

UNIT- II **10 hours**

Mendelian genetics:

Law of Segregation and Law of Independent assortment – monohybrid, di-hybrid cross, test cross, back cross and reciprocal cross. Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple alleles, pseudo-allele, essential and lethal genes, penetrance and expressivity. Application of Mendel's principles-The Punnett square method, Pedigree analysis.

UNIT-III **10 hours**

Chromosome and genomic organization:

Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, repetitive transposed sequences- SINEs & LINEs. Genetic organization of prokaryotic and viral genome. Structure and features of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. concept of cistron, exons, introns, genetic code, gene function.

UNIT-IV **10 hours**

Sex Determination, Sex linked disease and disorders:

Chromosomal theory of sex determinations: XX-XY, XX-XO, ZO-ZZ, ZZ-ZW; Mechanisms of Sex determination, Genic balance theory in Drosophila; Gynandromorphs; Chromosomal and Genetic mutations: Variations in chromosome structure - deletion, duplication, inversion and translocation, causes of mutations. Sex linkage, Sex linked disease and disorder: Hemophilia, muscular dystrophy, down syndrome, turner syndrome, Fragile-X-syndrome; Sex linked inheritance.

UNIT-V **10 hours**

Genetic linkage and population genetics:

Linkage and Recombination of genes in a chromosome crossing over. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

SUGGESTED READINGS:

1. Gardner EJ, Simmons MJ, and Snustad DP. (2006). Principles of Genetics. 8th edition. John Wiley & Sons.
2. Griffiths AJF, Wessler SR, Lewontin RC, and Carroll SB. (2015). Introduction to Genetic Analysis. 11th edition W. H. Freeman & Co.
3. Leland Hartwell, Michael L. Goldberg, Janice Fischer, Leroy Hood (2017). Genetics: From genes to genomes. 6th edition. McGraw-Hill Publishers.
4. Russell PJ. (2016). Genetics- A Molecular Approach. 5th edition. Benjamin Cummings.
5. Snustad DP, and Simmons MJ. (2009). Principles of Genetics. 5th edition. John Wiley and Sons nc. USA

23BTU403A **BASICS OF FORENSIC SCIENCE** **3H–3C**

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

Course Objectives

The main objectives of the course are

- To give knowledge on molecular analysis in forensic science
- To offer knowledge to assess DNA finger printing
- To understand the evidence for suspecting victims in crime
- To handle the evidences left out at the crime scene
- To understand the basic methods for examine the different types of questioned documents
- To understand the Classification of fire arms

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Demonstrate competency in the collection, processing, analyses, and evaluation of evidence	Understand
CO2	Demonstrate competency in the principles of crime scene investigation, including the recognition, collection, identification, preservation, and documentation of physical evidence	Understand
CO3	Demonstrate an understanding of the scientific method and the use of problem-solving within the field of forensic science	Understand
CO4	Identify the role of the forensic scientist and physical evidence within the criminal justice system	Apply
CO5	Demonstrate the ability to document and orally describe crime scenes, physical evidence, and scientific processes	Understand
CO6	Identify and examine current and emerging concepts and practices within the forensic science field	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT- I **6 hours**

Introduction and principles of forensic science: Forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operand in criminal investigation. Crime – types and characteristics – crime scene management.

Classification of injuries and their medico-legal aspects, method of assessing various types of deaths. Criminal justice system. Role of mobile forensic science laboratory in crime scene investigation.

UNIT-II **6 hours**

Classification of fire arms and explosives: Introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of various ink samples.

UNIT-III **6 hours**

Toxicology and Physical evidence: Role of the toxicologist, significance of toxicological findings, Physical evidence types, significance, collection, preservation, packing and forwarding different evidences, Blood stain pattern analysis, Detection of blood group, Identification of blood stains, Fundamental principles of fingerprinting, classification of fingerprints.

UNIT-IV **6 hours**

DNA finger printing: Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers. Types and applications in criminal investigation, Automated fingerprint identification system.

UNIT-V **6 hours**

Application of Forensic Science: Cyber Crime, Introduction to Cyber security and recent techniques. development of fingerprint as science for personal identification. Recent Advanced techniques used in forensic science (Lie detection, Voice identification, Narco Analysis, Brain fingerprinting).

SUGGESTED READINGS:

1. Bernard J. Glick, Jack J. Pasternak, & Cheryl L. Patten. (2010). *Molecular Biotechnology- Principles and Applications of recombinant DNA* (4th ed.). Washington: ASM Press.
2. Bhasin, M.K., & Nath S. (2002). *Role of Forensic Science in the New Millennium*. Delhi: University of Delhi.
3. Eckert, W.G., & Wright, R.K. (1997). *An Introduction to Forensic Sciences* (2nd ed.). CRC Press, Boca Raton (1997).
4. James, S.H., & Nordby J.J. (2005). *Forensic Science: An Introduction to Scientific and Investigative Techniques* (2nd ed.). CRC Press, BocaRaton.
5. Nabar BS,(2013) *Forensic Science in Crime Investigation,* Asia Law House (3rd ed.), Telangana, India
6. Nanda, B.B., & Tiwari, R.K. (2001). *Forensic Science in India: A Vision for the Twenty First Century*. New Delhi: Select Publishers.
7. Saferstein R., (2015). *Criminalistics: An Introduction to Forensic Science* (11th ed.). New Jersey: Prentice Hall.

SEMESTER - IV

23BTU403B EVOLUTIONARY 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

The main objectives of the course are

- To give detailed explanation of key concepts of population genetics in terms of Hardy-Weinberg Law, genetic drift and types of Natural Selection
- To provide adequate knowledge about Micro-evolutionary changes, Speciation and Adaptive Radiation
- To give detailed outline of Extinctions and its types
- To impart descriptive knowledge regarding Origin and Evolution of Man
- To provide glimpse of Phylogenetic Trees and highlight their construction along with interpretation
- To provide adequate information about geological time scale and neutral Theory of molecular evolution.

Course Outcomes

On completion of the course, students are able to

COs	Course Outcomes	Blooms Level
CO1	Relate knowledge on modern synthetic theory	Remember
CO2	Extend the information about the concepts of evolution	Understand
CO3	Get familiarized on the Concept of Stratigraphy	Evaluate
CO4	Analyze the model organism used for experimental study	Analyze
CO5	To assess the salient features of hybrid vigor	Analyze
CO6	To analyze the genetic drift in organisms	Analyze

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT- I **6 hours**

Historical Review of Evolutionary Concept: Pre-Darwinian ideas -Lamarckism – Merits and demerits. Darwinism – Merits and demerits, Post-Darwinian era –Modern synthetic theory; and the theory of population genetics leading to Neo-Darwinism.

UNIT- II **6 hours**

Life's Beginnings: Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres).

Endosymbiotic theory – Evolution of Eukaryotes from Prokaryotes. Genome evolution. Anaerobic metabolism. Origin of photosynthesis and aerobic metabolism. Micro, Macro and Mega evolution. Co-evolution.

UNIT-III **6 hours**

Evidences of Evolution: Paleobiological – Concept of Stratigraphy and geological timescale; fossil study (Types, formation and dating methods). Anatomical – Vestigial organs; Homologous and Analogous organs (concept of parallelism and convergence in evolution). Taxonomic – Transitional forms/evolutionary intermediates; living fossils. Phylogenetic – a) Fossil based – Phylogeny of horse as a model. b) Molecule based – Protein model (Cytochrome C); gene model (Globin gene family)

UNIT-IV **6 hours**

Biochemical and Molecular Evolution: Gene evolution, Evolution of gene families, molecular drive, Amino acid sequence divergence in proteins, Nucleotide sequence divergence in DNA, Molecular clocks, Ancient DNA. Biochemical and genomic evolution: The evolutionary history of proteins and the concept of molecular clock. Outline of organization of prokaryotic and eukaryotic genomes. The "C-Value paradox". Evolutionary history of neural integration. Evolution of the endocrine system – Hormones and Evolution. Role of environment in regulating evolution.

UNIT-V **6 hours**

Forces of Evolution – Qualitative Studies Based on Field Observations: Natural selection as a guiding force – Its attributes and action Basic characteristics of natural selection. Coloration, camouflage and mimicry, Co-adaptation and co-evolution, Man-made causes of change – Industrial melanism; brief mention of drug, pesticide, antibiotic in various organisms. Modes of selection, Polymorphism, Heterosis and Balanced lethal systems. Genetic Drift (Sewall Wright effect) as a stochastic/random force – Its attributes and action. Basic characteristics of drift; selection vs. drift, Bottleneck effect. Founder principle.

SUGGESTED READINGS:

1. Ridley, M. (2014). *Evolution* (3rd ed.). Blackwell.
2. Hall, B. K., & Hallgrimson, B. (2018). *Strickberger's Evolution* (4th ed.). Jones and Barlett
3. Zimmer, C., & Emlen, D. J. (2013). *Evolution: Making Sense of Life.* Roberts & Co.
4. Evolution: A Very Short Introduction 2017 Brian Charlesworth, Deborah Charlesworth – Oxford University Press London
5. http://172.16.25.76/login/index.php
6. https://nptel.ac.in/content/storage2/courses/122103039/pdf/mod2.p

23BTU411 RECOMBINANT DNA TECHNOLOGY AND GENETICS PRACTICAL 4H–2C

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

Course Objectives

The main objectives of the course are

- To familiarize with practical knowledge in the emerging field of biotechnology: Recombinant DNA technology
- To perform basic molecular biology techniques including DNA and RNA isolation from microbes, plants and animals
- To obtain key concepts of different blotting techniques
- To learn about the prokaryotic and eukaryotic genetic system using modern techniques
- To inculcate knowledge on cell division stages
- To develop skills on cell mounting techniques

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Perform recombinant DNA techniques including restriction and digestion, ligation, transformation and PCR	Create
CO2	Carry out DNA and RNA isolation from microbes, plants and animals	Understand
CO3	Demonstrate various blotting techniques	Understand
CO4	Gain rich knowledge on genetic model system used in research	Apply
CO5	Acquire basic knowledge on different stages in cell division.	Evaluate
CO6	Apply the principles of inheritance as formulated by Mendel	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Recombinant DNA technology practical's **20 hours**

1. Isolation and analysis of total genomic DNA from Microbes (*E. coli*) and plant.
2. Isolation and analysis of plasmid DNA.
3. Isolation and analysis of total RNA.
4. Restriction digestion, ligation of DNA and vector.
5. Transformation of plasmid DNA using calcium chloride.
6. Southern blotting (Demonstration).
7. Northern blotting (Demonstration).

8. Western blotting (Demonstration)

Genetics Practicals **20 hours**

1. Permanent and temporary mount of mitosis
2. Permanent and temporary mount of meiosis
3. Genetic study of model organisms and their significance
   a) Bacteria: *E. coli*
   b) *Saccharomyces* sp.
   c) Drosophila melanogaster
   d) Arabidopsis thaliana
4. Study of polyploidy in onion root tip by colchicine treatment

SUGGESTED READINGS:

1. Green, M.R. &Sambrook, J. (2012). *Molecular Cloning: A Laboratory anual*. (4thed.). Cold Spring Harbor Laboratory Press, New York, United States.
2. Greene, J.J.&Rao, V.B. (2001). *Recombinant DNA Principles and Methodologies.* (2nded.) CRC Press, Florida, United States.
3. Kulandaivelu, S. &Janarthanan, S. (2012). *Practical Manual on Fermentation Technology*. IK International Publishers, New Delhi, India.
4. Schuler, M.A. & Zielinski, R.E. (2012). *Methods in Plant Molecular Biology.* (1sted.).Academic Press Publishers, New York, United States.

23BTU413A **BASICS OF FORENSIC SCIENCE PRACTICAL** **4H–2C**

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

Course Objectives

The main objectives of the course are

- To give practical knowledge on molecular analysis in forensic science
- To perform DNA finger printing
- To get knowledge on lifting of foot prints from crime scene
- To handle the evidences left out at the crime scene
- To examine the different types of questioned documents
- To Identify the different petroleum products by TLC examination

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Apply the Laboratory skills to participate in the career needs of Forensic community	Apply
CO2	Become trained in the laboratory skills of different division of Forensic Science	Understand
CO3	Be able to work with different R&D organizations	Apply
CO4	Identify the role of the forensic scientist and physical evidence within the criminal justice system	Apply
CO5	Demonstrate the ability to document and orally describe crime scenes, physical evidence, and scientific processes	Apply
CO6	Identify and examine current and emerging concepts and practices within the forensic science field	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **40 hours**

1. Documentation of crime scene by photography, sketching and field notes
2. a. Simulation of a crime scene for training
   b. To lift footprints from crime scene
3. Case studies to depict different types of injuries and death
4. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography
5. Investigate the method for developing fingerprints by Iodine crystals
6. PCR amplification on target DNA and DNA profiling
7. Study of different searching methods at scene of crime.

SUGGESTED READINGS:

1. Tilstone, W.J., Hastrup, M.L., & Hald, C. (2013). *Fisher's Techniques of Crime Scene Investigation*. CRC Press.
2. Bernard J. Glick, Jack J. Pasternak, & Cheryl L. Patten. (2010). *Molecular Biotechnology- Principles and Applications of recombinant DNA* (4th ed.). Washington: ASM Press.
3. Bhasin, M.K., & Nath S. (2002). *Role of Forensic Science in the New Millennium.* Delhi: University of Delhi.
4. Eckert, W.G., & Wright, R.K. (1997). *An Introduction to Forensic Sciences* (2nd ed.). CRC Press, Boca Raton (1997).
5. James, S.H., & Nordby J.J. (2005). *Forensic Science: An Introduction to Scientific and Investigative Techniques* (2nd ed.). CRC Press, Boca Raton.
6. Nanda, B.B., & Tiwari, R.K. (2001*). Forensic Science in India: A Vision for the Twenty First Century*. New Delhi: Select Publishers.
7. Saferstein R. (2004). *Criminalistics: An Introduction to Forensic Science* (8th ed.). New Jersey: Prentice Hall.
8. http://172.16.25.76/course/view.php?id=1577

SEMESTER - IV

23BTU413B EVOLUTIONARY BIOLOGY PRACTICAL 4H–2C

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

End Semester Exam: 3Hours

Course Objectives

The main objectives of the course are

- To obtain practical concepts of variations
- To practically learn about adaptive strategies
- To attain knowledge on Neo-Darwinian concepts
- To give detailed explanation of practical analyzing the living fossil
- To impart practical knowledge regarding the origin and evolution of Man
- To obtain skills on genetic variation at population level

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Get hold of the practical knowledge on fundamentals of evolutionary biology	Apply
CO2	Expertise on the sampling techniques	Understand
CO3	Acknowledge the skills on the qualitative studies based on field observations	Apply
CO4	Develop skills regarding various Sources of Variations and their role in evolution	Apply
CO5	Explore salient features of various theories of evolution comprising of Lamarckism, Darwinism and Neo-Darwinism	Apply
CO6	Impart detailed understanding of Analogy, Homology, Paleontological Evidences, Embryological Evidences and Molecular Phylogeny	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **40 hours**

1) Variations
    a. Sampling of human height, weight and BMI for continuous variation.
    b. Sampling for discrete characteristics (dominant *vs* recessive) for discontinuous variations e.g hitch-hiker's thumb, dexterity, tongue rolling, ear lobe (data

categorization into 16 groups based on the combination of 4 traits; assigning each subject to the respective group).

2) Selection Exemplifying Adaptive strategies (Colouration, Mimetic form, Co-adaptation and co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life) using Specimens.
3) Neo-Darwinian Studies
    a. Calculations of genotypic, phenotypic and allelic frequencies from the data provided
    b. Simulation experiments using coloured beads/playing cards to understand the effects of Selection and Genetic drift on gene frequencies
4) Phylogeny.

SUGGESTED READINGS:

1. Barton, Briggs, Eisen, Goldstein, & Patel, (2007). *Evolution.* Cold Spring Harbor Laboratory Press.
2. Hall, B. K., & Hallgrimson, B. (2013). *Strickberger's Evolution* (4th ed.). Jones and Barlett
3. Ridley, M. (2014). *Evolution* (3rd ed.). Blackwell.
4. Zimmer, C., & Emlen, D. J. (2013). *Evolution: Making Sense of Life.* Roberts & Co.
5. http://172.16.25.76/login/index.php

SEMESTER - IV

ACTIVITY: LIBRARY/SEMINAR **2H**

Instruction Hours / week: L:0 T: 0 P:2 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3Hours

23BTU501 **PLANT BIOTECHNOLOGY** **5H–5C**

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

Course Objectives

The main objectives of the course are

- To cognize and get the knowledge on plant tissue culture
- To give knowledge about various methods of gene transfer and gene expression in plants
- To introduce biotechnological methods for production of transgenic plant
- To understand the processes involved in gene transfer methods in plant
- To infer the production of edible vaccines using primary and secondary metabolites
- To acquaint recent developments in plant based engineering

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Understand the growth conditions required to culture the plants in *in vitro* conditions	Understand
CO2	Inculcate the deep information of genetic engineering of plants	Understand
CO3	Assess the secondary metabolite products through cell suspension culture	Evaluate
CO4	Analysis the gene transfer methods and its mechanism for the development of transgenic plants	Analyze
CO5	Develop plant-based enzyme engineered edible vaccines	Apply
CO6	Evaluate the various steps involved in plant regeneration and transformation	Evaluate

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT – I Introduction: **12 hours**

Principles of Plant Breeding: Nutritional requirement by plants. Important conventional methods of breeding – self, cross pollinated and vegetatively propagated crops. Non-conventional methods. Polyploidy, Genetic variability.

UNIT - II Plant genome organization: 12 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-III Micropropagation: 12 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-IV Plant genetic engineering: 12 hours

Methodology; Plant transformation with Ti plasmid of *Agrobacterium tumifacians*; 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 Application of genetic transformation: 12 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, plantbioreactors.

SUGGESTED READINGS:

1. Slater, A., Scott, N.W., & Fowler, M. R. (2008). *Plant Biotechnology.* Oxford: Oxford UniversityPress.
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 Biotehnology and biodiversity conservation.* Jodhpur: Agrobios.
5. Stewart, N.C. (2016). *Plant Biotechnology and Genetics.* 2nd Edition. New Jersey: John Wiley & Sons, Inc.
6. Halford, N., & Halford, N. G. (2007). *Plant Biotechnology: Current and Future Applications of Genetically Modified Crops*. New Jersey: John Wiley & Sons.
7. Nirmala, C.B., Rajalakshmi, G., & Karthik, C.(2009). *Plant Biotechnology.* Chennai: MJP Publication

23BTU502 **ANIMAL BIOTECHNOLOGY** **5H–5C**

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

Course Objectives

The main objectives of the course are

- To cognize and get the knowledge on animal tissue culture
- To give knowledge about various methods of gene transfer and gene expression in animals
- To introduce biotechnological methods for production of transgenic animal
- To understand the processes involved in gene transfer methods in animal
- To infer the production and preservation of embryos
- To acquaint knowledge on ethical issues in animal biotechnology

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Understand the growth conditions required to culture the animal in *in vitro* conditions	Understand
CO2	Inculcate the deep information of genetic engineering of animal	Understand
CO3	Acquire strong knowledge on transgenic animal	Understand
CO4	Implement and analyze the gene transfer methods to develop transgenic animal	Analyze
CO5	Develop animal-based growth hormone	Apply
CO6	Evaluate various progresses involved in development of transgenic animal	Evaluate

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT I Animal cells: **12 hours**

Culture media, types of media, balances salt solutions. Physical, chemical and metabolic functions of different constituents of culture medium; Role of carbon dioxide, serum, growth factors, glutamine in cell culture; Serum and protein free defined media and their applications.

UNIT II Cell culture: **12 hours**

Disaggregation of tissue, primary culture, established culture; Suspension culture, organ culture and tissue engineering, feeder layers, cryopreservation. Biology and characterization of cultured cells, tissue typing; cell – cell interaction; measuring parameters of growth; Measurement of cell death – apoptosis and its determination.

UNIT III Molecular cell techniques: **12 hours**

Cell transformation- physical, chemical and biological methods; Manipulation of genes; Cell and organism cloning; Green fluorescent protein and its application. Gene therapy.

UNIT IV Embryology: **12 hours**

Collection and preservation of embryos; Culturing of embryos; Gametogenesis and fertilization in animals; Types of cleavage pattern; Role of maternal contributions in early embryonic development; *In vitro* fertilization and stem cell research.

UNIT V Transgenics: **12 hours**

Transgenic animals; Production and application; Transgenic animals as models for human diseases; Transgenic animals in live- stock improvement; Expression of the bovine growth hormone;Transgenics in industry. Ethical issues in animal biotechnology

SUGGESTED READINGS:

1. Ranga, M. M. (2007). Animal Biotechnology. (3rd ed.). Jodhpur: Agrobios.
2. Freshney, R.I. (2000). Animal Cell Culture: A Practical Approach (4th ed.). New York: John Wiley Publications.
3. Glick, B.R., & Pasternack, J.J. (2003). Molecular Biotechnology (3rd ed.). UK: Blackwell Science.
4. Gordon, I. (2003). Laboratory Production of Cattle Embryos (2nd ed.). New Delhi: CAB International.
5. Yagasaki, K., Miura, Y., Hatori, M. & Nomura, Y. (2008). Animal Cell Technology: Basic and Applied Aspects (Vols 13). New York: Springer-Verlag.
6. Primrose, S.B., Twyman, R.M., & Old, R.W. (2001). Principles of Gene Manipulation (6th ed.). Germany: Blackwell Science Publishing Company.
7. Portner, R. (2014). Animal Cell Biotechnology: Methods and Protocols. 3rd edition. New York: Springer-Verlag.

SEMESTER - V

23BTU503 IMMUNOLOGY 5H–5C

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

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To understand the basic concepts of immunology
- To expose students to use these principles of immune system to combats infections
- To gain the information about the auto-immune diseases
- To elucidate the genetic basis for immunological diversity and the generation of adaptive immune Responses
- To understand the basic knowledge of immunological processes at cellular and molecular level
- To learn central immunological principles and concepts

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Gain knowledge about the various cells and organs involved in the immune system	Understand
CO2	Understand the molecular mechanisms of antigen-antibody interactions	Understand
CO3	Learn the theoretical basis for various immunological techniques	Understand
CO4	Analyze which cell types and organs present in the immune response	Analyze
CO5	Apply basic techniques for identifying antigen antibody interactions	Apply
CO6	Illustrate various mechanisms that regulate immune responses	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I 12 hours

Immune system: An overview, components of mammalian immune system, Antigens- Essential features of Ag, haptens, Carrier molecule, Immunological valence, Antigenic determinants. Adjuvants: Freund's complete and incomplete. Antibodies - Molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells).

UNIT-II 12 hours

Regulation of immunoglobulin gene expression: T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination. Clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic

memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT-III 12 hours

Hypersensitivity Reactions (HS): Type I: Allergies and anaphylaxis; Type II: Antibody mediated HS reactions; Mechanism and pathogenicity; Type III: Immune complex mediated HS reactions: Mechanism & pathogenicity; Type IV: Delayed type (or) cell-mediated HS reactions; Mechanisms and pathogenicity. Type V: Stimulatory HS reactions. Mechanism and pathogenesis.

UNIT-IV 12 hours

Major Histocompatibility complexes: Class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies: avoidance, resistance and tolerance. Autoimmune diseases with special reference to Hashimoto's thyroiditis, Multiple sclerosis and Systemic Lupus Erythematosus**,** Immunodeficiency diseases (AIDS).

UNIT-V 12 hours

Vaccines & Vaccination: Cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization Introduction to immunodiagnostics – RIA, ELISA, Immunoblotting, Immunofluorescence.

SUGGESTED READINGS:

1. Goldsby, R.A., Kindt, T.J., Osborne, B.A. (2007). *Kuby's Immunology* (6th ed.). New York: W.H. Freeman and Company.
2. Hayat, M. (2017) Immunology, (1st ed) Academic Press, New Jersey, USA.
3. Murphy, K., Travers, P., & Walport, M. (2008). *Janeway's Immunobiology* (7th ed.). New York: Garland Science Publishers.
4. Owen, J., Punt, J. and Stranford, S. (2012) Immunology, Seventh Edition, W.H. Freeman and Company Publishers, New York.
5. Peakman, M., & Vergani, D. (2009). *Basic and Clinical Immunology* (2nd ed.). Edinberg: Churchill Livingstone Publishers.
6. Prescott, L.M., Harley, J.P. and Klein, D.A. (2010) Microbiology, Eight Edition, The McGraw Hill Companies Publishers, New York.
7. Richard, C., & Geiffrey, S. (2009). *Immunology* (6th ed.). Wiley Blackwell Publication.
8. Roitt, I., Brostoff, J. and Male, D. (2012). Essential Immunology, Twelfth Edition, Wiley Blackwell Publishers, New York.
9. William E. Paul (2012) Fundamental Immunology (7th ed), Lippincott Williams and Wilkins.

23BTU504A **MICROBIAL BIOTECHNOLOGY** **5H–4C**

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

Course Objectives

The main objectives of the course are

- To provide an in-depth look at how microbes and their metabolic pathways and products can be used in biotechnology
- To develop genetically engineered microbes for biomedical industries and research
- To impart the basics of microalgae
- To understand the microbial bio-conservation rate in the yield of agriculture
- To understand fundamentals of bioconversion
- To describe the waste utilization of sewage

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Critically evaluate the role of micro-organisms in specific biotechnological processes.	Evaluate
CO2	Explain the complex processes behind the development of genetically manipulated organisms.	Understand
CO3	Apply the knowledge of microalgae in pharmaceutical industries	Apply
CO4	Discuss state-of-the-art technologies of genetics of antimicrobial metabolite production in biocontrol bacteria.	Understand
CO5	Assess the major groups of microorganisms used in microbial bioconversion	Apply
CO6	Analyze the utilization of waste material to commercially important compounds	Analyze

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT– I **12 hours**

Introduction: History and scope of Microbial biotechnology, General concepts of microbial biotechnology. Classification of microbes using genome mapping**:** DNA and RNA present as genetic material in microbes. Types and division of microbes according to their genetic organization. Classification of microbes according to genotyping. Microscope and its types: Phase contrast microscope, Electron microscope, SEM, TEM; Microscopic examination of microorganisms.

UNIT– II **12 hours**

Metabolism in microbes: Microbial growth kinetics- Microbial growth in response to temperature, pH, solute and water activity, oxygen, pressure and radiation. Enzymes and their regulation, Microbial metabolism energy production, utilization of energy and biosynthesis. Role of ATP in metabolism.

UNIT – III **12 hours**

Microbial Biotechnology IPR & Ethics: Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations – types of biosafety containment - GM crops and GMO's - benefits and risks – ethical aspects of genetic testing – ethical aspects relating to use of genetic information and bio-warfare. Ethical implications of cloning - Reproductive cloning, therapeutic cloning; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Biotechnology and biopiracy.

UNIT– IV **12 hours**

Microbial Bioconversion: Bioconversion of cellulosic and non-cellulosic wastes. Mechanism of novel carboxylase genes involved in bioconversion. Agro byproducts. Bioremediation of wood, fuels lubricants, rubber, plastics.

UNIT – V **12 hours**

Application of microbial biotechnology in waste management: Waste water treatment, Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries. Sewage disposal, compost making, methane generation. Microbiology of degradation of xenobiotics in environment: Mineral recovery and removal of heavy metals from aqueous effluents.

SUGGESTED READINGS:

1. Bernad. R. Glick and Jack J. Pasternak. (2002). Molecular Biotechnology Principles and Applications of Recombinant DNA. WCB.
2. Glazer, A.N. and Nikaido, H. (2007) Microbial Biotechnology. Cambridge, New York.
3. Harzevili, D.F. and Chen, H. (2015). Microbial Biotechnology: Progress and trends. Taylor and Francis group.
4. Kun, Y.L (2013). Microbial Biotechnology: Principles and applications. World Scientific Publishing Company; 3rd revised ed. Edition.
5. Michael Pelczar JR, E.C.S. Chan, Noel R. Krieg: Microbiology, Mc Graw Hill, 6th Edition.
6. Foster WM, Food Microbiology, CBS publishers, 2018 Edition

23BTU504B **MARINE BIOTECHNOLOGY** **5H–4C**

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

Course Objectives

The main objectives of the course are

- To provide an in-depth knowledge of marine organism and their metabolic pathways and products can be used in biotechnology.
- To develop marine hydro-colloids from marine organisms for industrial application.
- To provide knowledge about genetic engineering and marine organism for various application.
- To understand the extraction of bio active compounds from marine organism.
- To understand fundamentals of bioconversion
- To explain about transgenic fishes for pharmaceutical application.

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Critically evaluate the role of micro-organisms in specific biotechnological processes.	Evaluate
CO2	Explain the complex processes behind the development of genetically manipulated organisms.	Understand
CO3	Apply the knowledge of microalgae in pharmaceutical industries	Apply
CO4	Discuss state-of-the-art technologies of genetics of antimicrobial metabolite production in biocontrol bacteria.	Understand
CO5	Assess the major groups of microorganisms used in microbial bioconversion	Apply
CO6	Analyze the utilization of waste material to commercially important compounds	Analyze

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT I **12 hours**

Biotechnology in Marine Sciences. Aquaculture: culture of shrimp, crab, edible mollusc, oysters and pearl oysters, Culture of milkfish, mullets and eel. Culture of sea weeds. Culture of live feed organismsbrine shrimp, rotifers.Marine micro algae- aquaculture, antioxidants-carotenoids, astaxanthin

UNIT II **12 hours**

Marine hydrocolloids-agar,agarose, carageenan, alginates, chitosans and chitin. Marine enzymes - Applications of enzyme for fish processing. Marine Lipids- application of lipases for modification of fats and oils. Marine flavourants. Bioconversion of organic materials and fish ensilage.

UNIT III **12 hours**

Aquaculture biotechnology- hormonal manipulation of sex,chromosomal manipulation of sex fish, cryopreservation of fish gametes and embryo. Diseases of cultured shrimp, fish. Diagnostics and their application to aquaculture.

UNIT IV **12 hours**

Production of transgenic fishes -growth hormone, antifreeze protein, disease resistant fish, application of hormones in induced breeding in aquaculture. Antifreeze protein and its applications.

UNIT V **12 hours**

Pharmaceuticals from marine realms, type of drugs from marine organisms and their medical applications. Biofouling and their control. Marine bioremediation-Biosurfactants and Control of oil spills. Extremophiles

Text Books:

1. Aquaculture: Principles and Practices - T.V.R. Pillay -1990
2. Steven M. Colegate and Russel J. Molyneux. 2008. Bioactive Natural Products (II Ed.). CRC Press.
3. Aquaculture: The farming and husbandry of Freshwater & Marine organisms by J.Bardach, Ryther J.Mclarhey.W. 1972.

References:

1. Advances in Fisheries Technology and biotechnology for increased profitability - Ed. Michael N. Voigt, J. Richard Botta. Technomic Publishing Co. Inc.(1990)
2. Biotechnology in the Marine Science- Proceedings of the first Annual MIT Sea Grant Lecture and Seminar - Colwell R.R. 1982.
3. New Developments in Marine BiotechnologyEd. LeGal and H.O.Halvorson Plenum press 1998.

23BTU511 **PLANT AND ANIMAL BIOTECHNOLOGY PRCATICAL** **4H–2C**

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

Course Objectives

The main objectives of the course are

- To provide the practical knowledge about the culture the plant and animal cell under *in vitro* condition and for application purpose
- To get proficiency in handling the contamination free plant and animal tissue culture techniques
- To acquire hands on training of plant and animal tissue culture Techniques
- To explain the basics of the viable and non-viable cells of plant and animal tissue
- To execute plant and animal biotechnology experiments
- To get expertise in preserving plant and animal cell

Course Outcomes

On completion of the course, students are able to

COs	Course Outcomes	Blooms Level
CO1	Acquaint with principles, technical requirement, scientific and commercial applications in plant and animal biotechnology	Apply
CO2	Support methodologies in plant and animal tissue/cell culture	Apply
CO3	Describe basic gene transfer technologies in plants	Apply
CO4	Designate problems associated with plant and animal tissue culture	Apply
CO5	Demonstrate strong knowledge in routine practices of plant and animal tissue culture	Apply
CO6	Join as lab manager or key scientist in plant and animal biotechnological research institute and industries	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals

Plant Tissue Culture Techniques **24 hours**

1. Media preparation and sterilization
2. *In vitro* germination of seeds and micropropagation
3. Callus induction
4. Synthetic seed production
5. Lab visit to Greenhouse unit

Animal Biotechnology **24 hours**

1. Preparation and filter-sterilization of animal tissue culture medium
2. Quantification of viable and non-viable cells by trypan blue dye exclusion method
3. Cryopreservation and revival of cell lines
4. Visit animal house and study about animal handling

SUGGESTED READINGS:

1. Bhojwani, S.S., & Razdan, (2004). *Plant Tissue Culture and Practice*.
2. Brown, T.A., (2006). *Gene Cloning and DNA Analysis* (5th ed.). Oxford: UK, Blackwell Publishing.
3. Butler, M. (2003). *Animal cell culture and technology: The basics* (2nd ed.). Taylor & Francis Publishers, Abingdon, United Kingdom.
4. Gardner, E.J., Simmonns, M.J., & Snustad, D.P. (2008). (8th ed.). *Principles of Genetics*. India: Wiley.
5. Raven, P.H., Johnson, G.B., Losos, J.B., & Singer, S.R. (2005). *Biology*. Tata MC Graw Hill.
6. Reinert, J., & Bajaj, Y.P.S. (1997). *Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture*. Narosa Publishing House.

SEMESTER - V

23BTU512 IMMUNOLOGY PRACTICAL 4H–2C

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

End Semester Exam: 3Hours

Course Objectives

The main objectives of the course are

- To understand the basic concepts of immunology
- To train the students to use these principles of immune system to combat infections
- To gain the information about the auto immune diseases
- To familiarize students with the various immunological techniques
- To identify the cellular and molecular basis of immune responsiveness
- To describe immunological response and how it is triggered and regulated

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	To identify the cellular and molecular basis of immune responsiveness	Apply
CO2	To identify the cellular and molecular basis of immune responsiveness	Apply
CO3	Demonstrate Hemagglutination assay	Apply
CO4	Demonstrate Hemagglutination assay	Apply
CO5	Separate serum from blood sample	Apply
CO6	Perform immunoblotting	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **48 hours**

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen
8. ELISA
9. Immuno blotting

SUGGESTED READINGS:

1. Abbas, A.K., Lichtman, A.H., & Pillai, S. (2011). *Cellular and Molecular Immunology* (7th ed.). Philadelphia: Saunders Publication.
2. Delves, P., Martin, S., Burton, D., & Roitt, I.M. (2017). *Roitt's Essential Immunology* (13th ed.). Wiley- lackwell Scientific Publication, Oxford
3. Goldsby, R.A., Kindt, T.J., Osborne, B.A. (2013). *Kuby's Immunology* (7th ed.). New York: W.H. Freeman and Company.
4. Murphy, K., Travers, P., Walport, M. (2017). *Janeway's Immunobiology* (9th ed.). New York: Garland Science Publishers.
5. Peakman, M. & Vergani, D. (2009). *Basic and Clinical Immunology* (2nd ed.). Edinberg: Churchill Livingstone Publishers.
6. Richard, C., & Geiffrey, S. (2009). *Immunology* (6th ed.). Wiley Blackwell Publication.

SEMESTER - V

23BTU591	INTERNSHIP PROGRAMME	2C

Instruction Hours / week: L:0 T: 0 P: 0 **Marks:** Internal: **100** External: **00** Total: **100**

ACTIVITY: LIBRARY/SEMINAR **2H**

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

SEMESTER - VI

23BTU601 BIOPROCESS TECHNOLOGY 5H–5C

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

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To learn the procedure for isolation and screening of industrial important microbes
- To derive industrially important products from microbes
- To acquire knowledge on downstream processing
- To learn the principle and applications of bioprocess technology
- To learn the fundamental calculation for bioprocessing
- To learn the schematic diagram of upstream and downstream processing for product recovery and purification

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	To gain overall knowledge on industrial biotechnology	Remember
CO2	Obtain information about the application of industrially important microbes	Understand
CO3	Know the screening, extraction and purification of enzymes	Understand
CO4	Designing of bioreactors for large scale production of desired products	Apply
CO5	Select and optimize media for maximum production of microbial metabolites	Apply
CO6	Designing of protocols for strain improvement and separation of molecules after fermentation process	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT- I **10 hours**

Introduction to bioprocess technology: Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture. Types of fermentation- submerge and solid state; aerobic and anaerobic fermentation.

UNIT-II **10 hours**

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture production

vessels- Airlift; Stirred tank; Cyclone Column; trickled bed; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inoculum development and sterilization.

UNIT-III 10 hours

Bioreactor control and monitoring: Types of sensors. pH, temperature, O_2, CO_2 and pressure control and monitoring. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT-IV 10 hours

Downstream processing: Sedimentation, Filtration, Centrifugation, Cell disruption, Chromatography, liquid-liquid extraction, product recovery, purification, drying, and crystallization. Effluent treatment, sludge process, waste disposal, Bioenergy from waste.

UNIT-V 10 hours

Application of bioprocess technology: Microbial production of ethanol, amylase, lactic acid, citric acid and Single Cell Proteins (algal mediated and fungal mediated). Microbial Health care products, Applications in food industry, pharma industry, agriculture, fuels, chemicals etc, Fermentation economics. IPR and Microbial Process.

SUGGESTED READINGS:

1. Casida, LE. (1991). *Industrial Microbiology.* (1st ed.). Wiley Eastern Limited.
2. Crueger, W., & Crueger, A. (2017). *Biotechnology: A textbook of Industrial Microbiology* (3rd ed.). Medtech.
3. Patel, A.H. (1996). *Industrial Microbiology*. (1st ed.). Macmillan India Limited.
4. Patel, A.H. (2011). *Industrial Microbiology*. (2nd ed.). Laxmi Publications
5. Srivastava M. L. (2008). F*ermentation technology*. Narosa Publications.
6. Liu. S, Bioprocess Engineering; kinetics, biosystems, sustainability and reactor design, Elsevier, 2016.
7. Octave Levenspiel, Chemical Reaction Engineering, Wiley, 2016.

23BTU602 ENVIRONMENTAL BIOTECHNOLOGY AND MANAGEMENT 5H–5C

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

Course Objectives

The main objectives of the course are

- To obtain the basic concepts of Geological consideration of Atmosphere
- To ascertain the knowledge about Energy, transfer in an Ecosystem
- To obtain knowledge on pollution and environmental Health
- To gain knowledge about the biotechnological measures for restoring environment
- To involve in the present scenarios and find valuable solutions for remedy
- To update about the management strategies by Bio-transformation

Course Outcomes

On completion of the course, students are able to

COs	Course Outcomes	Blooms Level
CO1	Understand the principles & concepts of ecosystem	Understand
CO2	To utilize the knowledge on ecological efficiencies	Apply
CO3	Know about environmental significance for detection of pollutants	Understand
CO4	Explain the pathways regulating bio-geochemical cycles	Understand
CO5	To evaluate the process of phytoremediation	Evaluate
CO6	To Know the importance of bacteria in bioremediation	Evaluate

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I 10 hours

Environment: Atmosphere, Hydrosphere, Lithosphere, Biosphere. Bio- geochemical cycles (Nitrogen, Carbon and Phosphate cycles). Biological control of chemical environment. biosensors and toxicity testing. Air, water and soil sampling, Analyses of samples by physical, chemical and biological methods.

UNIT- II 10 hours

Pollution and Bioremediation: Role of microbes to solve the environmental pollution. Bioremediation of soil & water contaminated with oil spills and heavy metals. Phyto-remediation and its importance in environment. Xenobiotics: Degradation of pesticides and other toxic chemicals by micro-organisms - degradation of aromatic and chlorinated hydrocarbons and petroleum products. Biosurfactants: Microbial production and application Biodeterioration – Principles, prevention and control.

UNIT- III 10 hours

Waste management: Treatment of municipal waste and Industrial effluents. Basic aspects of Solid waste management (an introduction), Aerobic and anaerobic treatments of SWM, Composting, Vermicomposting, Biogas production, Treatment of Hazardous waste, treatment strategies of PCBP, Biomedical wastes, Types of biomedical waste, Hazards caused by Biomedical waste, Treatment strategies of Biomedical waste.

UNIT-IV 10 hours

Bio-fertilizers and Bioleaching: Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM). Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium), Heavy metal pollution.

UNIT- V 10 hours

Fuels: Fuels: Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas production, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol. GMO's: Environmental significance of genetically modified microbes (super bug), plants and animals and its impact on environment.

SUGGESTED READINGS:

1. Ajith Sankar R.N (2015). Environmental Management, 1st edition. Oxford University Press;
2. Alicia, L., Ragout De Spencer, & John Spencer, F.T. (Eds.). (2004). *Environmental Microbiology: Methods and Protocols*. Humana Press.
3. Hans-Joachim Jordening, & Jesef Winter, (Eds.). (2005). *Environmental Biotechnology*: Concepts and Applications. Wiley-VCH.
4. Metcalf, & Eddy, (2003). *Waste Water Engineering: Treatment and Reuse* (4th ed.). Tata McGraw hill.
5. Mohapatra, P.K., (2007). *Textbook of environmental biotechnology*. IK publication.
6. Pradipta Kumar Mohapatra, (2007). *Environmental Biotechnology*. I.K. International Publishing House.
7. Purohit, S.S. (2003). *Agricultural Biotechnology* (2nd ed.). Updesh Purohit.
8. Rana, S.V.S., (2013). *Environmental pollution – health and toxicology* (2nd ed.). Narosa Publication.
9. Santra, S.C. (2011). *Environmental Science* (3rd ed.). New Central Book Agency.
10. Sinha, S. (2010*). Handbook on Wildlife Law Enforsement in India*. India: TRAFFIC.
11. Thakur, I. S. (2011). *Environmental Biotechnology*. I K Publication.

23BTU603A GENOMICS AND PROTEOMICS 5H–5C

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

Course Objectives

The main objectives of the course are

- To import the basic and recent developments in the field of genome sequencing, genome mapping, proteomic data analysis
- To develop the knowledge on gene sequencing methods
- To know the structure and interactions of proteins
- To describe advanced genomics and proteomics technologies and the ways in which their data are stored
- To use bioinformatics techniques to query examples of genomic and proteomic databases to analyse cell biology
- To describe the different types of genome variation and their relationship to human diseases

Course Outcomes

On completion of the course, students are able to

COs	Course Outcomes	Blooms Level
CO1	Have a clear understanding on the application of genetic markers in genome mapping	Understand
CO2	Application of 2D technique to analyze the structure of protein	Apply
CO3	Analyze the genomic and proteomic data	Analyze
CO4	To acquire knowledge and understanding of fundamentals of genomics and proteomics	Understand
CO5	Discuss how biological systems information relating to genes, proteins and cellular structures can be used to model living cells, and even to create new synthetic cells	Apply
CO6	Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study	Create

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I **10 hours**

Introduction to Genomics: Genes, Pseudogenes – Gene structure – Human genome project - Genome sequencing methods –manual and automated strategies - Maxam and Gilbert method; Sangers method; Pyrosequencing. Shotgun and Hierarchical (clone contig) methods – Computer tools for sequencing projects: **Next Generation Sequencing (NGS)** Genome sequence assembly software. **Pharmacogenomics**

UNIT-II **10 hours**

Managing and Distributing Genome Data: Web based servers and software for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Organism-specific databases – FlyBase and OMIM; CRISPR cas9 technology.

UNIT-III **10 hours**

Genomic mapping: Genetic markers – RFLP, VNTR, mini and micro satellites, STS, SNPs, ESTs. Genome maps; Mapping techniques; Physical and genetic mapping; FISH and Restriction mappings; Map resources; Practical uses genome maps.

UNIT-IV **10 hours**

Introduction to protein structures: Proteins – protein diversity – Protein folds – Primary structures – Edman degradation – Secondary structures and their unique features – Tertiary structures - Physical interactions stabilizing proteins - Short-range interactions, electrostatic forces, van der Waal interactions, hydrogen bonds, Hydrophobic interactions. Structural characterization of proteins - Sedimentation analysis, Gel filtration, Native PAGE and SDS-PAGE.

UNIT-V **10 hours**

Introduction to Proteomics: Analysis of proteomes - 2D-PAGE - Sample preparation, solubilization, reduction, resolution - Reproducibility of 2D-PAGE. Mass spectrometry-based methods for protein identification - ESI-MS and its applications; *De novo* sequencing using mass spectrometric data. Three dimensional structure database – PDB, CATH and SCOP. **Protein Microarray**. **Cancer and genomic microarray.**

SUGGESTED READINGS:

1. Bhat S., (2008). Genomics, Bioscience Publishing, New Delhi,
2. Devarajan Thangadurai, Jeyabalan Sangeetha, (2015). Genomics and Proteomics: Principles, Technologies, and Applications. CRC Press, Tylor& Francis Group
3. Glick, B.R., & Patten C. L. (2017). *Molecular Biotechnology- Principles and Applications of recombinant DNA*. (5th ed.). Washington: ASM Press.
4. Lesk A.M., (2014). Introduction to Bioinformatics, (4th ed.). Oxford University Press, UK.
5. Primrose, S.B., &Twyman, R.M. (2013). *Principles of Gene Manipulation and Genomics* (7th ed.). Wiley-Blackwell.
6. Tamarin, R. H. (2017). *Principles of Genetics* (7th ed.). McGraw Hill Education.
7. Timothy P., (2007). Proteomics, SPRINGER.

23BTU603B **BIOINFORMATICS** **5H–5C**

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

Course Objectives

The main objectives of the course are

- To give knowledge on bioinformatics and its application
- To offer knowledge on biological databases
- To understand and analyze the protein/nucleotide sequences and to predict its 3D structure
- To understand the various online databases for submitting and retrieving data's
- To understand how the phylogeny plays a vital role in finding ambiguities
- To get practiced with the tools and techniques for analyzing the data

Course Outcomes

On completion of the course, students are able to

COs	Course Outcomes	Blooms Level
CO1	Understand the relationship between sequence - structure - function of genes	Understand
CO2	Familiarize with the algorithms required to compare sequences and require to know the phylogenetic relationship between the gene sequences	Understand
CO3	To adapt knowledge on building 3D structures of genes	Create
CO4	Construct and use the main databases at the NCBI and EBI resources	Apply
CO5	Know the difference between databases, tools, repositories and be able to use each one to extract specific information	Apply
CO6	Use selected tools at NCBI and EBI to run simple analyses on genomic sequences	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I **10 hours**

Introduction and role of Bioinformatics: Introduction to Bioinformatics – History, scope and Milestones. Bioinformatics in molecular biology: Data Generation-Generation of large scale molecular biology data (Genome sequencing and protein sequencing). Genome sequencing project and its application.

UNIT-II 10 hours

Biological databases: Sequence databases, Nucleic acid sequence databases – Primary (GenBank, EMBL, DDBJ), Secondary (UniGene, SGD, EMI Genomes, Genome Biology), Protein sequence database –

Primary (PIR, SWISS-PROT), Secondary (PROSITE, Pfam), Structural databases (PDB, PDBSUM, SCOP, CATH), Generic model organism database (ANISEED), Genome online database (GOLD), Bibliographic databases – PubMed, BioMed central, PloS, SCOPUS and web of science.

UNIT-III **10 hours**

Sequence alignment and Phylogeny analysis: Outline of sequence Assembly – Mutation/Substitution Matrices – Pairwise Alignments. Introduction to BLAST and FASTA, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT-IV **10 hours**

Genome analysis: Genome annotation; Genome annotation tools; DEG, Gene Ontology, Detecting open reading frames – primer designing and property predictions – 2D PAGE data analysis – Microarray data analysis – SAGE.

UNIT-V **10 hours**

***In-silico* structure prediction and analysis tools:** Predicting protein tertiary structure – Homology modelling, fold recognition and Ab-initio methods. Merits and limitations – Molecular visualization tools. Structural analysis – ERRAT, VERIFY 3D, Molecular docking and Cheminformatics.

SUGGESTED READINGS:

1. Shaik, N.A., Hakeem, K.R., Banaganapalli, B. and Elango, R. eds., 2019. *Essentials of Bioinformatics, Volume II: In Silico Life Sciences: Medicine*. Springer Nature.
2. Shanker, A. ed., 2018. *Bioinformatics: Sequences, Structures, Phylogeny*. Springer Ghosh, Z. & Bibekanand M. (2008). *Bioinformatics: Principles and Applications*. Oxford UniversityPress.
3. Pevsner, J. (2009). *Bioinformatics and Functional Genomics* (2nd ed.). Wiley-Blackwell.
4. Campbell, A.M., & Heyer, L.J. (2006). *Discovering Genomics, Proteomics and Bioinformatics* (2nd ed.). Benjamin Cummings.
5. Syed Ibrahim.K., GuruSubramanian, G., Zothansarga, yadav, R.P., Senthil Kumar N., Pandian, S.K., Borah., P., Mohan S., 2017. Bioinformatics- A student's companion.

SEMESTER – VI

BIOPROCESS TECHNOLOGY, ENVIRONMENTAL BIOTECHNOLOGY AND MANAGEMENT PRACTICAL

23BTU611 **4H–2C**

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

End Semester Exam: 3Hours

Course Objectives

The main objectives of the course are

- To learn the procedure for isolation, screening of industrial important microbes
- To obtain practical knowledge to solve the environmental problems
- To ascertain the knowledge about wastewater treatment
- To achieve a water treatment strategy
- To gain knowledge about for restoring environment
- To update about the microbial load in water sample

Course Outcomes

On completion of the course, students are able to

COs	Course Outcomes	Blooms Level
CO1	Analyze environmental problems	Analyze
CO2	Treat waste water	Understand
CO3	Estimate the Biological Oxygen Demand (BOD) and its calculation	Understand
CO4	Measure Chemical Oxygen Demand (COD) and its calculation	Evaluate
CO5	Produce biofertilizers from waste products	Apply
CO6	Apply Global Positioning System (GPS)	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals

Bioprocess Technology **15 hours**

1. Isolation and screening of industrially important microorganism from natural resources
2. Bacterial growth curve
3. Production and analysis of ethanol
4. Production and analysis of amylase
5. Production and analysis of lactic acid

Environmental Biotechnology **15 hours**

1. Estimation of total dissolved solids (TDS)/ TSS of water sample
2. Estimation of BOD of water sample
3. Estimation of COD of water sample
4. Examination of bacterial load in water sample by MPN method

Environmental management **10 hours**

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community.
3. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon

SUGGESTED READINGS:

1. Ghosh, S.K., & Singh, R. (2003). *Social forestry and forest management.* Global Vision Publishing House
2. Joseph, B. (2005). *Environmental studies.* Tata Mc Graw Hill.
3. Michael Allabay, (2000). *Basics of environmental science* (2nd ed.). Routledge Press.
4. Mohapatra, P.K., (2007). *Textbook of environmental biotechnology.* IK publication.
   Rana, S.V.S., (2013). *Environmental pollution – health*

23BTU613A GENOMICS AND PROTEOMICS PRACTICAL 4H–2C

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

Course Objectives

The main objectives of the course are

- To practically import the basic and recent developments in the field of genome sequencing, genome mapping, proteomic data analysis
- To develop the steps to retrieve knowledge on gene sequencing methods
- To view the structure in 3D form and understand the functional group interactions of proteins
- To practically describe advanced genomics and proteomics technologies and the ways in which their data are stored
- To identify query sequence in genomic and proteomic databases
- To get information from specific databases about the different types of genome variation and their relationship to human diseases

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Retrieve the sequence for genetic markers in genome mapping	Understand
CO2	Analyze the protein structure	Understand
CO3	Retrieve the genomic and proteomic data	Understand
CO4	To acquire practical knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology	Understand
CO5	Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study	Create
CO6	Perform the given procedures and utilize the various databases at NCBI and other sites for protein localization.	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **40 hours**

1. Use of NCBI and UniProt databases.
2. Use of OMIM database.
3. Detection of Open Reading Frames using ORF Finder.
4. Proteomics 2D PAGE database.
5. Software for Protein localization.

6. Predicting Secondary structures of proteins.
7. Hydropathy plots of proteins.
8. Three-dimensional protein structure prediction and visualization tools.

SUGGESTED READINGS:

1. Charles Markoff, (2016). Functional Genomics and Proteomics.
2. Devarajan Thangadurai, Jeyabalan Sangeetha, (2015). Genomics and Proteomics: Principles, Technologies, and Applications. CRC Press, Tylor& Francis Group
3. Glick, B.R., & Patten C. L. (2017). *Molecular Biotechnology- Principles and Applications of recombinant DNA*. (5th ed.). Washington: ASM Press.
4. Pevsner, J. (2009). *Bioinformatics and Functional Genomics* (2nd ed.) John Wiley & Sons.

23BTU613B BIOINFORMATICS PRACTICAL 4H–2C

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

Course Objectives

The main objectives of the course are

- To get practical knowledge on Bioinformatics and its application
- To retrieve the knowledge by assessing biological databases
- To understand and to analyze protein/nucleotide sequences and to predict its 3D structure
- To be familiar with online databases for genomics
- To perform phylogenetic analysis in finding ambiguities
- To understand the evolutionary history of an organism

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Workout and understand the relationship between sequence - structure - function of genes	Understand
CO2	Construct the nucleotide sequences in genbank	Analyze
CO3	Perform genome annotation	Understand
CO4	Compare the nucleotide sequences and perform the phylogenetic analysis	Understand
CO5	Get hands on experience in homology modelling	Apply
CO6	Know the informations about curated and noncurated databases	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **40 hours**

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results
5. Retrieval of information from nucleotide databases
6. Sequence alignment using BLAST
7. Multiple sequence alignment using Clustal W
8. Homology Modelling
9. Molecular Docking Studies
10. Genome Annotation tools

SUGGESTED READINGS:

1. Campbell, A. M., & Heyer, L.J. (2006). *Discovering Genomics, Proteomics and Bioinformatics* (2nd ed.). Benjamin Cummings.
2. Ghosh, Z., & Bibekanand M. (2008). *Bioinformatics: Principles and Applications*. Oxford University Press.
3. Mohammed, I., & Mohammed R.G. (2015). *Bioinformatics Practical Manual.* ACM, Digital Library, Create Space Independent Publishing Platform. USA.
4. Pevsner, J. (2009). *Bioinformatics and Functional Genomics* (2nd ed.). Wiley-Blackwell.

23BTU691 **PROJECT – VIVA VOCE** **7H–4C**

Instruction Hours / week: L:0 T: 0 P: 7 **Marks:** Internal: 80 External: 120 Total: **200**

23BTU701 **PHARMACEUTICAL BIOTECHNOLOGY** **6H–5C**

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

Course Objectives

The main objectives of the course are

- To obtain basic skills necessary for employing biotechnology principles in together with various pharmaceutical parameters
- To understand novel formulation approaches for better delivery of biotechnology-derived drugs
- To attain knowledge on drug safety and effectiveness
- To comprehend the physical and chemical properties of drugs
- To impart information on the delivery of peptide and proteins by conventional routes of administration
- To learn about special storage, handling, reconstitution and administration conditions and techniques for drug delivery systems containing bioactive macromolecules

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Evaluate different pharmaceutical parameters of current biotechnology products	Understand
CO2	Determine parameters related to stability and formulation of biotechnology-derived drugs	Understand
CO3	Discuss quality control procedures related to biotechnology products	Create
CO4	Apply the knowledge of physicochemical properties of drugs in novel drug designing	Apply
CO5	Demonstrate novel formulation methods for better delivery of biotechnology derived drugs	Apply
CO6	Join pharmaceutical biotechnology lab and industries as a research assistant	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Unit 1 – Introduction **15 hours**

Introduction, History of pharmaceuticals, origin of Medicines – Medicines of Ancient civilization, Isolation and synthesis of compounds, Development of Anti-Infective agents- Discovery of antiseptics and vaccines, Improvement in drug administration, new classes of pharmaceuticals, Transitions in drug discovery -Discovery of penicillin, Isolation of insulin, Identification of vitamins, Emergence of modern diseases and treatment, pharmaceutical industry in the modern era.

Unit II: **15 hours**

Drug discovery and Development: Introduction, Stages in the drug discovery process, Therapeutic agents, Recombinant proteins – Interferons, recombinant interferons, Manufacturing steps for interferon, Monoclonal antibody, Clinical applications. Routes of Drug administration.

Unit III: **15 hours**

Drug absorption, Distribution and Elimination Pharmacokinetics: Drug absorption- Biologic factors, Drug Distribution – Compartments- Protein Binding. Drug biotransformation. Drug Elimination. Pharmacokinetics – Order of Kinetics – Drug safety and Effectiveness- Drug Interactions.

Unit IV: **15 hours**

Formulations: Formulation of Biotechnological Products, Drug Delivery, Examples of some Biotechnological products in clinical development.

Unit V: **12 hours**

Regulations: Role of FDA, ICH Guidelines, The Regulation of Pharmaceutical Biotechnological Products and Ethical Issues.

References:

1. Abraham, D.J. & Rotella, D.P. (2010). Burger's Medicinal Chemistry, Drug Discovery and Development (7th ed.). Wiley Publishers, New York, United States.
2. Banga, A.K. (2015). Therapeutic Peptides and Proteins: Formulation, Processing, and Delivery Systems (3rd ed.). CRC Press, Florida, United States.
3. Bhagavan, N.V. & Ha, C-E. (2015). Essential of Medical Biochemistry (2nd ed.). Academic Press Publishers, New York, United States. 4. Crommelin, D.J.A., Sindelar, R. D. & Meibohm, B. (2019).
4. Pharmaceutical Biotechnology: Fundamentals and Applications (5th ed.). Springer Publishers, New York, United States. 5. Golan, D.E., Armstrong, E.J., & Armstrong, A.W. (2016).
5. Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy (4th ed.). LWW Publishers, Pennsylvania, United States.
6. Rho, J.P. & Louie, S.G. (2003). Hand book of Pharmaceutical Biotechnology (1st ed.). CRC Press, Florida, United States.
7. Satoskar, R. S., Rage, N.N., Tripathi, R.K., & Bhandarkar, S. D. (2017). Pharmacology and Pharmacotherapeutics (25th ed.). Elsevier India Publishers, Chennai, India. 8. Sethi, P.D. (2008).
8. Quantitative Analysis of Drugs in Pharmaceutical Formulations (3rd ed.). CBS Publishers and Distributers, New Delhi, India.

23BTU702 **NANO BIOTECHNOLOGY** **6H–5C**

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

Course Objectives

The main objectives of the course are

- To obtain sufficient knowledge on the fundamental concepts of Nano biotechnology
- To offer a strong information in the interface between chemistry and physics on the nano- structural level with a focus on biotechnological usage
- To provide basic concepts of synthesis and characterization of nanomaterials
- To understand the interaction of nanomaterials with biological molecules in living cells
- To learn nanomaterials and their use in agriculture
- To acquire information on nanoparticles in wastewater treatment

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Identify the role of bio nanotechnology as an interdisciplinary tool and to understand how to use these new tools in solving biological problems	Apply
CO2	To determine the interactions and relationship between molecular dynamics, nanoscale physics and macroscopic system behavior	Evaluate
CO3	Explain basic principles of characterization tools in nanobiotechnology	Understand
CO4	Establish the mechanism of action of nanomaterials in living cells	Understand
CO5	Develop nanocarriers for crop improvement	Apply
CO6	Implement eco-friendly nanoparticles in wastewater treatment	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Unit I: **15 hours**

Introduction to nanotechnology: History and Scope of Nanotechnology. Applications of Nanotechnology. Various types of nanostructured materials. Approaches of nanoparticles synthesis- Top down and Bottom up approach. Synthesis of metal/metal oxide nanoparticels –physical, chemical and biological sources. Nanocomposite, Polymers, Carbon Nanotubes, Quantum Dots

Unit II: **15 hours**

Characterization of nanostructure materials: UV-Visible Spectroscopy; Fourier Transform Infra Red Spectroscopy (FTIR); Transmission Electron Microscopy (TEM); Scanning Electron Microscopy (SEM); Dynamic Light Scattering (DLS); Zeta Potential; X-ray Diffraction

Unit III: **15 hours**

Biomedical Applications of Nanotechnology: Drug Delivery; Antimicrobial activity; Anticancer activity; Liposomes; Niosomes; Chemotherapeutic agent; Photothermal therapy; Diagnosing agent; Wound Healing and Nanozyme

Unit IV: **15 hours**

Environmental applications of Nanotechnology: Nanofertilzier, Nanopesticides, Nanoinsecticides, Plant Growth Promoter; Impact of nanoparticles on shoot germination and growth; Disease resistance; Plant yield and Quality. Nano based adsorption for waste water treatment.

Unit V: **12 hours**

Nanotechnology in food processing and technology: Post harvest technology - Food Packaging; Food Quality and Traits; Development of nano kit for insect repellents

References

1. Claudio Nicolini, Nanobiotechnology & Nanobiosciences Pan Stanford Publishing Pte. Ltd, 2009.
2. C.M. Niemeyer and C.A. Mirkin, Nanobiotechnology, Concepts, Applications and perspectives, WILEY VCH, Verlag Gmb H&Co, 2004.
3. S. David Goodsell, Bionanotechnology, Lessons from Nature, Wiley-Liss, Inc, 2004.
4. Melgardt M.deVilliers, Pornanong Aramwit, Glen S.Kwon, Nanotechnology in Drug Delivery, Springer-American Association of Pharmaceutical Scientists Press 2009.
5. Robert A. Freitas Jr. Nanomedicine, Volume I:Basic Capabilities, Landes Bioscience,1999.

23BTU703A **PLANT PHYSIOLOGY AND DIVERSITY** **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 main objectives of the course are

- To understand the physiological conditions of the plants and metabolism
- To understand the basic concepts of Photosystems and their importance in plant growth
- To gain the information about the economic importance of algae and fungi
- To acquire adequate knowledge on plant development, biochemistry, and their metabolism
- To be familiar with cutting edge technology employed in contemporary plant biology
- To integrate the acquired knowledge of plant physiology with cultural, social, and legal aspects of their lives

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	To build adequate knowledge on plant physiology and its importance	Apply
CO2	Understand the molecular mechanisms of macro and micro nutrients in plant growth	Understand
CO3	Get the basic and applied knowledge of plant growth, development and metabolism	Understand
CO4	To estimate the plant water relations	Evaluate
CO5	Understand the mechanism of various metabolic processes in plants	Apply
CO6	Equip students with skills and techniques related to plant physiology to design their own experiments	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Unit I **12 hours**

Plant-water relations: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit II **12 hours**

Translocation in phloem: Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading Photosynthesis: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

Unit III **12 hours**

Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway. Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition. Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit IV **12 hours**

Bryophytes: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. Ecology and economic importance of bryophytes with special mention of Sphagnum.

Pteridophytes: General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to family), morphology, anatomy and reproduction of Selaginella, Equisetum and Pteris. Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes. Gymnosperms: General characteristics; Classification (up to family), morphology, anatomy and reproduction of Cycas and Pinus. Ecological and economical importance.

Unit V **12 hours**

Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia. Economic importance of algae. Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True FungiGeneral characteristics, ecology and significance, life cycle of Rhizopus (Zygomycota).

SUGGESTED READINGS:

1. Esau, K. (2009) *Anatomy of Seed Plants.* 3rd edition. Wiley Publishers.
2. Hopkins,W.G., & Huner, P.A. (2008). *Introduction to Plant Physiology*. John Wiley & Sons.
3. Sambamurty, (2008). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany*. IK International Publishers.
4. Taiz, L., & Zeiger, E. (2010). *Plant Physiology* (5th ed.). MA: USA, Sinauer Associates Inc.
5. Srivastava, H.S. and Shankar, N. (2008) Plant physiology and Biochemistry, First Edition,Rastogi Publications, Meerut.
6. Pandey, S.N. and Sinha, B.K.(2008) Plant Physiology, Fourth Edition, VIKAS publishing House Pvt Ltd, New Delhi.
7. Lee, R.E. (2008). *Phycology* (4th ed.). USA: Cambridge University Press.
8. Pandey B P (2014), *College Botany Volume 20,* S. Chand Publishing, New Delhi.
9. Sambamurty, (2008). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany*. IK : International Publishers.
10. Shaw, A.J., & Goffinet, B. (2000). *Bryophyte Biology.* Cambridge University Press.
11. Vander-Poorteri, (2009). *Introduction to Bryophytes.* COP.
12. Webster, J. & Weber, R. (2007). *Introduction to Fungi* (3rd ed.). Cambridge: Cambridge University Press

23BTU703B **ANIMAL PHYSIOLOGY AND DIVERSITY** **5H–4C**

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

Course Objectives

The main objectives of the course are

- To provide the students with an in-depth knowledge of the diversity in form, structure and habits of invertebrates and vertebrates
- To learn the basics of systematic and understand the hierarchy of different categories
- To learn the diagnostic characters of different phyla through brief studies of examples
- To obtain an overview of economically important invertebrate fauna
- To explain the organizational hierarchies and complexities of invertebrates
- To describe the evolutionary trends in external morphology and internal structure

Course Outcomes

The learners will be able to

COs	Course Outcomes	Blooms Level
CO1	Outline the origin and classification of animal kingdom	Understand
CO2	To build the origin of animals and how they differ from other living organisms	Create
CO3	Explain the relationship between animal diversity and evolutionary derived changes in animal body	Understand
CO4	Analyze the various modes of adaptations in animals	Understand
CO5	Identify and classify with examples the invertebrates	Apply
CO6	Analyze the various modes of adaptations in animals	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT- I **12 hours**

Introduction to animal kingdom: Outline of classification of Non-Chordates up to subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes. International commission of zoological nomenclature. Protozoa: Locomotion, Reproduction, evolution of Sex, General features of *Paramecium* and *Plasmodium*. Pathogenic protozoans. General Characters and classification of Porifera, Coelenterata, Platyhelminthes and Reptilian.

UNIT II **12 hours**

Digestion and Respiration:

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

UNIT III **12 hours**

Circulation and Excretion:

Composition of blood, Plasma proteins & their role, blood cells, Hemopoiesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat. Modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV **12 hours**

Muscle and Nervous system:

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, mechanism of muscle contraction. Basic structure of neuron, mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters.

UNIT V **12 hours**

Endocrine coordination:

Mechanism of action of hormones (insulin and steroids), Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

Suggested Readings

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002). *The Invertebrates: A New Synthesis* (3rd ed.). Blackwell Science.
2. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions* (2nd ed.). E.L.B.S. and Nelson.
3. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
4. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition. McGraw-Hill Higher Education.
5. Kent, G.C., & Carr, R.K. (2000). *Comparative Anatomy of the Vertebrates* (9th ed.). The McGraw-Hill Companies.
6. Myers, P., Espinosa, R., Parr, C. S., Jones, T., Hammond, G. S., & Dewey, T. A. (2006). The Animal Diversity Web. 12, 2.
7. Ruppert, Edward, E., Fox Richard, S. & Barnes Robert, D. (2009). *Invertebrate Zoology: A Functional Evolutionary Approach* (7th ed.). Thomson Brooks/Cole.
8. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.

23BTU704A MOLECULAR DIAGNOSTICS 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 main objectives of the course are

- To obtain basic concepts of molecules and its effect on human and other animals
- To ascertain the diagnostics tools for infectious diseases
- To achieve a complete knowledge about molecular diagnostics techniques on human welfare
- To understand the utility and limitations of various molecular diagnostic tests used for managing patient care
- To attain the concepts of molecular methods used in clinical microbiology
- To recognize the importance of proper specimen collection and preparation for molecular detection

Course Outcomes

On completion of the course, students are able to

COs	Course Outcomes	Blooms Level
CO1	Get hold of the knowledge on fundamentals of molecular diagnostic techniques	Understand
CO2	Expertise on the concepts of infection, diagnosis and control assortment	Understand
CO3	Acknowledge on the qualitative studies based on biomarker observations	Understand
CO4	Apply methodologies of laboratory diagnostics to relevant states of health	Apply
CO5	Be aware of characteristics signs of clinical manifestations	Apply
CO6	Comprehend and analyse the concept of disease management	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT-I **12 hours**

Introduction and History of diagnostics: History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario.

UNIT-II **12 hours**

Molecular methods in clinical microbiology: Digital Droplet PCR – Next-Gen Sequencing, MALDI-TOF, Flow Cytometry, Medical Cytogenetics. Laser 22 Capture Microdissection (FFPE). Applications of Molecular Diagnostics for Genetic Diseases, Identification of Fetuses at Risk for Immune Cytopenic Disorders. Genetic Counselling Considerations in Molecular Diagnosis, Ethical, Social, and Legal Issues Related to Molecular Genetic Testing.

UNIT-III **12 hours**

Enzyme Immunoassays (EIA): Introduction, concept of EIA, enzymes used in EIA. Solid phases used in EIA. Homogeneous and heterogeneous EIA. ELISA, FISH and Immunoblotting. Polyclonal or Monoclonal antibodies in EIA. Enzyme immunohistochemistry, cytochemistry, and its applications. IA in microbial diagnosis, merits, and demerits, Radioimmunoassay (RIA) and direct and indirect Fluoro-immunoassays (FIA).

UNIT-IV **12 hours**

Biomarkers in disease diagnostics: FDA definition of disease biomarkers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumour and cancer markers, markers in inflammation and cytoskeletal disorders diagnosis. Flow cytometry.

UNIT-V **12 hours**

Diagnosis and Standardization: Automation in microbial diagnosis, Rapid diagnostic approach, Purification and standardization of antigen and specific antibodies. Diagnostic immunology: agglutination reactions, precipitation reactions, complement fixation test (CFT), direct and indirect hemagglutination (HA and IHA), hemagglutination inhibition (HAI), Concepts and methods: idiotypes, anti-idiotypes, molecular mimicry and receptors.

SUGGESTED READINGS:

1. Chang-Hui Shen (2019), Diagnostic Molecular Biology, Academic Press.
2. Claudio Carini, Mark Fidock, Alain van Gool (2019), Handbook of Biomarkers and Precision Medicine, CRC Press.
3. http://172.16.25.76/course/view.php?id=2088
4. Laura Anfossi (2018), Rapid Test: Advances in Design, Format and Diagnostic Applications, BoD – Books on Demand.
5. Michael Ford (2019), Medical Microbiology: Fundamentals of Biomedical Science, Oxford University Press, 3rd edition.
6. Vishal S. Vaidya, Joseph V. Bonventre (2010), Biomarkers: In Medicine, Drug Discovery, and Environmental Health, John Wiley & Sons.

23BTU704B **MEDICAL DEVICES** **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 main objectives of the course are

1. Examine the broad scope of the medical device industry and its quality assurance practices.
2. Explain the basics of medical devices and process of development.
3. Demonstrate the regulatory requirements for approval of medical devices.
4. Harmonize the initiatives for quality and ethical considerations for medical devices.
5. Conduct clinical evaluation and investigation for medical devices.
6. Propose procedures for approval and marketing of medical devices.

Course Outcomes

After completing the course, the students will be able to

COs	Course Outcomes	Blooms Level
CO1	Analyze fundamental concepts of electromagnetic radiation and acoustic waves for medical imaging.	Understand
CO2	Determine the critical parameters of electromagnetic radiation and acoustic waves for safe practice for diagnostic imaging	Understand
CO3	Identify the principle factors to modulate the generation of X-rays and design parameters of X-ray systems for different clinical applications.	Apply
CO4	Analyze the advanced X-ray modalities for imaging of static and dynamic anatomical structures of human.	Analyze
CO5	Determine the materials and design parameters for the production of Ultrasound waves for clinical applications	Apply
CO6	Analyze the key interventions of Ultrasonography with advanced tools for clinical diagnosis	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Unit I: **12 hours**

Biosensors: Introduction: Principles, Characteristics of Ideal Biosensors, Basic measuring procedure, Components of biosensors, Advantages & Limitations. Opportunities and challenges of integrating sensors in a system platform.

Unit II: **12 hours**

Transducers: Principles and applications of Calorimetric, Piezoelectric, semiconductor, and impedimetric based transducers; Biochemical Transducers: Electrode theory: electrode-tissue interface,

metal-electrolyte interface, electrode-skin interface, electrode impedance, electrical conductivity of electrode jellies and creams.

Unit III: 12 hours

Optical Sensors: Photo detectors, optical fiber sensors, indicator-mediated transducers; General principles of optical sensing, optical fiber temperature sensors; Pulse sensor: photoelectric pulse transducer, strain gauge pulse transducer.

Unit IV: 12 hours

Bio recognition systems: Enzymes; Oligonucleotides Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Immunoreceptors; Chemoreceptors.

Unit V: 12 hours

Fundamentals and Applications: Biosensors in clinical chemistry, Medicine and health care, Biosensors for veterinary, Agriculture and food, Low-cost biosensor for industrial processes for online monitoring, Biosensors for environmental monitoring.

References:

1. Biosensors: Fundamentals and applications, Oxford, U.K: Oxford University Press by Turner, A.P.F., Karube, I. & Wilson, GS.
2. Bilitewski, U. Turner, A.P.F. 2000 Biosensors for environmental monitoring Harwood, Amsterdam.
3. Rogers, K.R. and Mascini, M. 2001. Biosensors for analytical monitoring EPA biosensors group.
4. Aboul – Enein, H. V., Stefan, R. and Van Staden, (1999) Chemiluminiscence- based biosensors – An overview crit Rev. Anal. Chem. 29, 323-331.
5. Pearson, J.E. Gill, A., and Vadgama, P. (2000) Analytical aspects of biosensors, Ann Clin Biochem 37, 119-145.
6. Biosensors: Fundamentals and applications, Oxford, U.K: Oxford University Press by Turner, A.P.F., Karube, I. & Wilson, GS.

23BTU711 PHARMACEUTICAL, NANO BIOTECHNOLOGY PRACTICAL 3H–1C

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

Course Objectives

The main objectives of the course are,

1. Identify appropriate sources of drugs/medical information
2. To facilitate the students to know the definite path of metabolism of drugs and drug discovery.
3. Understand and analyze novel techniques of production, purification and characterization of enzymes and pharmaceuticals.
4. To attain knowledge on drug safety and effectiveness
5. To provide basic concepts of synthesis and characterization of nanomaterials
6. To understand the interaction of nanomaterials with biological molecules in living cells

Course Outcomes

After completing the course, the students will be able to

COs	Course Outcomes	Blooms Level
CO1	Perform basic and applied research in the field of biomedicine.	Understand
CO2	Apply novel techniques in drug discovery and the role of biotechnology in pharmaceutics.	Understand
CO3	Apply theoretical bases and practical applications of core pharmaceutical biotechnology subjects in concerned industries and organizations.	Apply
CO4	Discuss quality control procedures related to biotechnology products	Create
CO5	Study the basic principles and characterization tools in nanobiotechnology	Apply
CO6	Establish the mechanism of action of nanomaterials in living cells	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

List of Experiments

Pharmaceutical Biotechnology Experiments **18 hours**

1. Antibiotic production from biological sources.
2. To perform antibiotic assay.
3. Determination of Minimum Inhibitory Concentration (MIC) of given antibiotics.
4. Toxicity testing.

Nano Biotechnology Experiments **18 hours**

1. Synthesis of metal nanoparticles using plant extracts and characterization.
2. Synthesis and characterization of lipid-based nanoparticles for drug delivery.
3. Determination of antimicrobial properties of silver nanoparticles.
4. Functionalization of nanoparticles with proteins.
5. Characterization of nanoparticles

References

1. Nanomaterials Chemistry by Rao C. N., A. Muller, A. K. Cheetham,, WileyVCH , 2007.
2. Nanomaterials and Nanochemistry by Brechignac C., P. Houdy, M. Lahmani, Springer publication, 2007.
3. Nanoscale materials in chemistry by Kenneth J. Klabunde, Wiley Interscience Publications,2001.
4. Nanochemistry by Sergeev G.B., Elseiver publication,2006.
5. Nanostructures and Nanomaterials, synthesis, properties and applications by Guozhong Cao, Imperial College Press, 2004.
6. Nanomaterials – Handbook by Yury Gogotsi, CRC Press, Taylor & Francis group, 2006. NSC.

23BTU713A MOLECULAR DIAGNOSTICS PRACTICAL 3H–1C

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

Course Objectives

The main objectives of the course are

- To obtain the basic concepts of Identification of pathogenic bacteria
- To ascertain the diagnostics tools for infectious diseases - RFLP, RAPD
- To achieve a complete knowledge about molecular diagnostics techniques on microbial infection
- To understand the utility and limitations of various molecular diagnostic tests used for managing patient care
- To attain the concepts of molecular methods used in clinical microbiology
- To recognize the importance of proper specimen collection and preparation for molecular detection

Course Outcomes

On completion of the course, students are able to

COs	Course Outcomes	Blooms Level
CO1	Get hold of the knowledge on fundamentals of molecular diagnostic techniques	Understand
CO2	Explain on the concepts of infection, diagnosis and control assortment	Understand
CO3	Agree the qualitative studies based on biomarker observations	Evaluate
CO4	Apply methodologies of laboratory diagnostics to relevant states of health	Understand
CO5	Be aware of characteristics signs of clinical manifestations	Apply
CO6	Comprehend and analyses the concept of disease management	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Practicals **36 hours**

1. Perform/demonstrate RFLP analysis
2. Perform/demonstrate RAPD analysis
3. Kirby-Bauer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
4. A kit-based detection of a microbial infection (Widal test)

5. Study of Electron micrographs (any four)
6. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)
7. Molecular detection of bacteria from spoiled food sample by multiplex PCR

SUGGESTED READINGS:

1. Bruce Alberts (2014), Molecular Biology of cell, W. W. Norton & Company, 6th edition.
2. Chang-Hui Shen (2019), Diagnostic Molecular Biology, Academic Press.
3. Claudio Carini, Mark Fidock, Alain van Gool (2019), Handbook of Biomarkers and Precision Medicine, CRC Press.
4. Goering, R., Dockrell, H., Zuckerman, M., & Wakelin, D. (2007). *Mims' Medical Microbiology* (4th ed.). Elsevier.
5. Laura Anfossi (2018), Rapid Test: Advances in Design, Format and Diagnostic Applications, BOD – Books on Demand.
6. Michael Ford (2019), Medical Microbiology: Fundamentals of Biomedical Science, Oxford University Press, 3rd edition.
7. Vishal S. Vaidya, Joseph V. Bonventre (2010), Biomarkers: In Medicine, Drug Discovery, and Environmental Health, John Wiley & Sons.
8. Willey, J.M., Sherwood, L.M., & Woolverton, C.J. (2008). *Prescott, Harley and Klein's Microbiology* (7th ed.). McGraw Hill Higher Education.

23BTU713B MEDICAL DEVICES PRACTICAL 3H–1C

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

Course Objectives

The main objectives of the course are

- To obtain the basic concepts of Identification of pathogenic bacteria
- To ascertain the diagnostics tools for infectious diseases - RFLP, RAPD
- To achieve a complete knowledge about molecular diagnostics techniques on microbial infection
- To understand the utility and limitations of various molecular diagnostic tests used for managing patient care
- To attain the concepts of molecular methods used in clinical microbiology
- To recognize the importance of proper specimen collection and preparation for molecular detection

Course Outcomes

On completion of the course, students are able to

COs	Course Outcomes	Blooms Level
CO1	Get knowledge on fundamentals of molecular diagnostic techniques	Understand
CO2	Apply the concepts of infection, diagnosis and control assortment	Apply
CO3	Agree the qualitative studies based on biomarker observations	Evaluate
CO4	Apply methodologies of laboratory diagnostics to relevant states of health	Apply
CO5	Relate the various characteristics signs of clinical manifestations	Understand
CO6	Comprehend and analyses the concept of disease management	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

List of Practicals **36 hours**

1. Performance and practice of ECG
2. Performance and practice of EEG
3. Performance and practice of Blood pressure monitor
4. Performance and practice of Digital stethoscope
5. Performance and practice of Thermometer
6. Performance and practice of glucometer
7. Demonstration of Hemodialysis delivery system

Text Books:

1. Gail Baura, Medical Device Technologies: A Systems Based Overview Using Engineering,Elsevier science,2002.
2. Martin Culjat, Rahul Singh, Hua Lee Medical Devices: Surgical and Image-Guided Technologies,John Wiley and Sons,Reinaldo perez, Design of medical electronic device,Elsevier science, 2002.
3. Richard C, Fries, Handbook of Medical Device Design,Marcel DekkerAG,2nd edition 2005.

Reference Books:

1. Anthony Y. K,Chan, Biomedical device technology: principles and design,Charles Thomas, 2008.
2. Theodore R,Kucklick, The Medical Device Ramp-D Handbook, Taylor andFrancis Group LLC, 3rd edition 2013.
3. David Prutchi, Michael Norris,Design and Development of Medical Electronic Instrumentation: A Practical perspective of the design, construction and test of medical devices,John Wiley and Sons, 2005

ACTIVITY: LIBRARY/SEMINAR **1H**

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

23BTU801 **FOOD BIOTECHNOLOGY** **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 main objectives of the course are

- To understand the concepts of food biotechnology along with role of microbes in fermentation
- To attain strong knowledge on primary sources of microorganisms in food
- To explore the methods for development and preservation of fermented foods
- To obtain strong knowledge on food spoilage
- To recognize the methods used in food preservation
- To understand the concepts of food adulteration and food safety

Course Outcomes

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

Cos	Course Outcomes	Blooms Level
CO1	Understand the beneficial role of microorganisms in fermented foods and food processing	Understand
CO2	Understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods	Understand
CO3	Learn the various technological aspects of fermented products such as beer and wine in larger scale production	Apply
CO4	Know the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage	Apply
CO5	Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation	Apply
CO6	Recognize and describe the characteristics of food adulterants and their safety measures	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Unit – I Introduction: **12 hours**

History and scope of food biotechnology, nutritive value of food, characterization and role of important microbes in food biotechnology – bacteria, fungi and yeast, Development and formulation of probiotic foods.

Unit – II Food microbiology: **12 hours**

Primary sources of microorganisms in food. General principles and techniques in microbiological examination of food samples. Food-borne bacteria, molds and yeasts. Intrinsic- and extrinsic parameters of food affecting microbial count. Detection of microorganisms in food - SPC, membrane filters, dry films. Bacterial toxins - Botulism and staphylococcal toxin. Fungal toxins - Aflatoxins..

Unit – III Fermented foods: **12 hours**

Origin, scope and development, nutritive value and preservation of fermented foods - Cheese, yogurt, butter, miso, tempeh, kefir, koumiss, acidophilus milk, sauerkraut, pickles and vinegar. Technological aspects of industrial production of beer, wine and baker's yeast.

Unit – IV Food spoilage and preservation: **7 hours**

Causes of food spoilage, spoilage of fruits, vegetables, meat, soft Drinks, eggs, sea food products, dairy products. Food Preservation through chemicals - acids, salts, sugars, antibiotics, ethylene oxide, antioxidants. Other methods of food peservation - Radiations, low and high temperature, drying. Food packaging materials and their properties.

Unit – V Food adulteration and food safety: **7 hours**

Food additives - Definition, types and functional characteristics. Natural colors and artificial colors - Types, applications, advantages of natural colors. Sweeteners - Types and applications. Enzymes used in food industry. Adulteration -Adulteration detection systems and sensors, Ethical issues concerning GM foods; testing for GM foods; current guidelines for the production, release and movement of GM foods. Food safety - HACCP System to food protection, FSSAI guidelines.

SUGGESTED READINGS

1. Adam, M.R. & Moss, M.O. (2018). *Food Microbiology*. New Age International Publishers, New Delhi, India.
2. Bell, C., Neaves, P., & Williams, A.P. (2005). *Food Microbiology and Laboratory Practice.* Wiley-Blackwell Publishers, New Jersey, United States.
3. Bhatia, S.C. (2017). *Food Biotechnology*. WPI Publishers, New Delhi, India.
4. Export/import data by DGCIS-Calcutta.
5. Export/import policy by Govt. of India.
6. Frazier, W.C., Westhoff, D.C., & Vanitha, N.M. (2017). *Food Microbiology* (5th ed.). McGraw - Hill Education/ Medical, London, United Kingdom.
7. Harrigan, W. F. (2013). *Laboratory methods in Food Microbiology* (3rd ed.). Elsevier Publishers, Amsterdam, Netherlands.
8. Jain, K.S. & Jain, A.V. (2017). *Foreign Trade - Theory, Procedures, Practices and Documentation* (7th ed.). Himalaya Publishing House, Mumbai, India.
9. Jay, J.M., Loessner, J.M., & Golden, A.D. (2008). *Modern Food Microbiology* (7th ed.). Springer Publishers, New York, United States.
10. Suri, S. & Malhotra, A. *Food Science, Nutrition and Safety*. Pearson Education India Publishers, London, United Kingdom.

23BTU802 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

The main objectives of the course are

1. To impart the knowledge on Identification of research requirements
2. To apply the state of art knowledge for dissertation writing
3. To become familiarize with Experiment design
4. To understand the methods of data collection and analysis
5. To grasp knowledge on Objective and roll of higher education
6. To students will learn overall the basic concept in Characteristics of instructional design

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Understand principles of formulation of objectives and hypothesis	Understand
CO2	Explain Guidelines for review of literature	Understand
CO3	Get insight to Use of software for graphics	Apply
CO4	Students are able to correlate the results using biostatistics tool	Apply
CO5	Explain the Ethical issues in animal biotechnology	Apply
CO6	Explain the methods of teaching and learning	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT I –RESEARCH FORMULATION AND DESIGN 12 hours

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

UNIT II – DATA COLLECTION AND ANALYSIS **12 hours**

Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

UNIT III – SOFT COMPUTING **12 hours**

Computer and its role in research, Use of statistical software SPSS, GRETL etc in research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems.

UNIT IV –RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING **7 hours**

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

UNIT V –INTERPRETATION AND REPORT WRITING **7 hours**

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Text Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction toResearch Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New AgeInternational. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess EssPublications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic DogPublishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs andgeographical indications. Universal Law Publishing.

Reference Books:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: AProcess of Inquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, CambridgeUniversity Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet toPaper. Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design,Prentice Hall.
7. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess EssPublications

Web reference:

1. https://theintactone.com/2018/02/26/br-u1-topic-2-formulation-of-the-research-p
2. https://leverageedu.com/blog/research-design/
3. https://www.questionpro.com/blog/data-collection/
4. https://en.wikipedia.org/wiki/Soft_computing
5. http://www.aau.in/sites/default/files/Unit%203%20RESEARCH%20AND%20

23BTU803 **MEDICAL 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

The main objectives of the course are

1. To impart knowledge on micro-flora of human body, mode action, classification of microbes, function and biochemical reaction going on inside the microbial cell.
2. To study the importance of microorganisms in diagnosis, monitoring and treatment of infectious diseases.
3. To get knowledge about the bacteria and viruses that can cause infectious disease.
4. To gain knowledge of growth conditions.
5. To understand about the viruses and classification of viruses.
6. To understand about eukaryotic microorganisms and their role

Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Has knowledge of medical microbiology and the importance of microorganisms in diagnosis, monitoring and treatment of infectious diseases.	Understand
CO2	Get knowledge of bacteria and viruses that can cause infectious disease.	Understand
CO3	Gain knowledge of prokaryotic genetics, taxonomy, growth conditions and virulence.	Understand
CO4	Build knowledge of viruses and classification of viruses	Create
CO5	Understand about eukaryotic microorganisms and their role in infectious diseases	Apply
CO6	Has knowledge of normal flora, key concepts in medical microbiology, infection control and epidemiology	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT- I Introduction: **12 hours**

Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. leprae.*

UNIT- II Pathology: **12 hours**

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum, M. pneumoniae,* Rickettsiaceae, Chlamydiae. Bacterial infection:Medical importance of Salmonellosis, Shigellosis.

UNIT- III Diseases caused by viruses: **12 hours**

Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Adrenovirus, Retrovirus, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT- IV Fungal and Protozoan infections: **6 hours**

Dermatophytoses (Trichophyton, Microsporun and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides). Parasitiology : Medical importance of Entameoba, Giardia, Plasmodium, Taenia, Ascaris, Wucherhiria.

UNIT- V Opportunistic fungal infections: **6 hours**

Opportunistic fungal infections (Candidiasis, Aspergillosis), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria).

SUGGESTED READINGS:

1. Brooks, G.F., Carroll, K.C., Butel, J.S., & Morse, S.A. (2017). Jawetz, Melnick and Adelberg's Medical Microbiology (28th ed.). McGraw Hill Publication.
2. Goering, R., Dockrell, H., Zuckerman, M., & Wakelin, D. (2018). Mims' Medical Microbiology (8th ed.). Elsevier.
3. Willey, J.M., Sherwood, L.M., & Woolverton, C.J. (2018). Prescott, Harley and Klein's Microbiology (14th ed.). McGraw Hill Higher Education.
4. David greenwood, Richard CD., Slack., John forrest (2020), Medical Microbiology, (24th ed.). Churchilll Livingstone.

23BTU804 AGRICULTURE BIOTECHNOLOGY 5H–4C

Instruction Hours / week: L:4 T: 01 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3Hours

Course Objectives

The main objectives of the course are

- To learn the fundamentals of plant tissue culture and its applications
- To provide various concepts in genetics and its aspects in cultivation practice
- To attain the basic concepts in developing transgenic crops
- To understand the key knowledge in producing stress resistant crops
- To study the importance of metabolic engineering and agricultural farming in plants
- To obtain information on biosafety and risk assessment of genetically modified crops

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Demonstrate the techniques in plant tissue culture	Understand
CO2	Explain the genetic transformation techniques in plants	Understand
CO3	Develop transgenic plants in crop improvement	Apply
CO4	Produce stress resistant crops against microbes and insects	Create
CO5	Validate the applications of genetic transformation, metabolic engineering, production of pharmaceuticals and industrial products	Apply
CO6	To get a career in Industry / Research and Development	Create

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT – I Plant tissue culture and its applications: 12 hours

Recombinant DNA technology, methods of gene transfer in plants, development of transgenic plants for abiotic & biotic stress tolerance. Tools and techniques used in agriculture biotechnology.

UNIT –II Genetic and molecular basis: 12 hours

Heterosis and Apomixis and their significance, Mutations and polyploidy in crop improvement, Molecular markers, Marker assisted breeding, QTL mapping, Origin, evolution and cultivation practices of the major crop plants

UNIT –III Improvement of crop plants: 12 hours

Biofortification - increase in iron, protein and amino acids. Golden rice, Bt Cotton, GM crop transformations, Plants as biofactories - Developing vaccine and plantibodies, terminator technology and male sterility.

UNIT – IV Stress resistance on crops: 6 hours

Virus - coat protein mediated, nucleocapsid gene, antisense and RNAi, Fungal diseases: chitinase, 1-
3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins, Insect pests resistance: Bt genes, Non- Bt like protease inhibitors, alpha amylase inhibitor, nematodes resistance and herbicide resistance: phosphoinothricin, glyphosate, sulfonyl urea, atrazine.

UNIT – V Genetic engineering for increasing crop productivity: 6 hours

Enhancing photosynthetic, nutrient use and nitrogen fixing efficiencies of plants, genetic engineering for quality improvement: Seed storage proteins; essential amino acids, Vitamins and minerals, heterologous protein production in transgenic plants, Biosafety and risk assessment of GM crops.

SUGGESTED READINGS:

1. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press, 2003
2. Chakraborty .U, Bishwanath Chakraborty, 2005. Stress biology, Vidhyasekaran, P. 2007. Narosa Publishing House.
3. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.
4. Gupta P K Plant Biotechnology, Rastogi Publication, Meerut, India.
5. Jaiwal P K & Singh R P (eds) Plant Genetic Engineering Vol-1 to Vol. 9. Studium Press, USA, 2006.

23BTU805 TISSUE ENGINEERING AND REGENERATIVE MEDICINE 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 main objectives of the course are

- To learn the basic concepts of tissue engineering and regenerative medicine
- To attain strong knowledge in cellular fate process such as cell division and cell death
- To understand in vitro cell culture environment and maintenance
- To obtain information on stem cells properties, their types and resources
- To obtain knowledge on bioreactors used in tissue engineering
- To understand the relevance of the extracellular matrix and its interaction with materials

Course Outcomes

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

COs	Course Outcomes	Blooms Level
CO1	Apply tissue engineered cells as therapeutic agents	Apply
CO2	Analyze the co-ordination of cellular fate processes in soluble signaling	Analyze
CO3	Discuss the basic tools used to study cell fate and cell functions	Create
CO4	Demonstrate the application of stem cells in tissue engineering and regenerative medicine	Understand
CO5	Illustrate the basic concepts of cell culture and critical components of bioreactor/tissue design	Understand
CO6	Discuss about the biomaterials are used to fabricate devices for clinical use	Create

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

UNIT - I Introduction to Tissue engineering and Regenerative medicine: 12 hours

Tissue engineering – an introduction. Tissue structure and organization, Extra cellular matrix, and tissue dynamics.

UNIT – II Cellular fate processes: 12 hours

Cell division and cell death. Cellular fate processes and soluble signaling. Cell-extra cellular matrix interactions and cell-cell communications.

UNIT - III Cell and Tissue Culture: 12 hours

Separation, Culture environment and maintenance of cells *in vitro*. Microscopic characterization of tissues. Basic tools to detect cell fate and cell functions.

UNIT – IV Biomaterials and Bioreactors: 6 hours

Introduction and microscopic characterization of biomaterials. Degradable materials, porosity, mechanical strength, 3-D architecture and cell incorporation. Bioreactors in tissue engineering.

UNIT – V Stem cells: 6 hours

Stem cell properties, types, resources and application in tissue engineering and regenerative medicine. Genetically engineered stem cells for transplantation.

SUGGESTED READINGS:

1. Palsson, B.O. & Bhatia, S. N. (2017). *Tissue Engineering* (1st ed.). Pearson Education Publishers, London, United Kingdom.
2. Atala, A., Lanza, R., Mikos, T., & Nerem, R. (2018). *Principles of Regenerative Medicine* (3rd ed.). Academic Press, London, United Kingdom.
3. Ravi, B. (2018). *Introduction to Tissue Engineering: Applications & challenges* (2nd ed.). Wiley Publishers, New Jersey, United States.
4. Fisher, J.P., Mikos, A.G., Bronzino, J.D., & Peterson, D.R. (2017). *Tissue Engineering: Principles and Practices* (1st ed.). CRC Press, Florida, United States.
5. Wong, J.Y., Bronzino, J.D., & Peterson, D.R. (2019). *Biomaterials: Principles and practices* (1st ed.). CRC Press, Florida, United States.
6. Ramalingam, M., Ramakrishna, S., & Best,S. (2017). *Biomaterials and Stem Cells in Regenerative Medicine* (1st ed.). CRC Press, Florida, United States.

WEB LINKS:

http://web.mit.edu/langerlab/
http://faculty.virginia.edu/laurencin/index.html

23BTU811 FOOD BIOTECHNOLOGY PRACTICAL 4H–2C

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

Course Objectives

The main objectives of the course are

- To understand the concepts of food biotechnology along with role of microbes in fermentation
- To attain strong knowledge on primary sources of microorganisms in food
- To explore the methods for development and preservation of fermented foods
- To obtain strong knowledge on food spoilage
- To recognize the methods used in food preservation
- To understand the concepts of food adulteration and food safety

Course Outcomes

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

Cos	Course Outcomes	Blooms Level
CO1	Understand the beneficial role of microorganisms in fermented foods and food processing	Understand
CO2	Understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods	Understand
CO3	Learn the various technological aspects of fermented products such as beer and wine in larger scale production	Apply
CO4	Know the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage	Apply
CO5	Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation	Apply
CO6	Recognize and describe the characteristics of food adulterants and their safety measures	Apply

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Experiments: **48 hours**

1. Market Survey on Cereals, Legumes, Minor Millets, Oilseeds and their Products
2. Physicochemical Tests for Quality of Cereals, Legumes, and Oilseeds
3. Determination of Amylose in Rice
4. Extraction of Gluten from Cereals
5. Development of Simulated Milk and Milk Products from Soy
6. Preparation of Extruded Products from Pulses
7. Preparation of Peanut Butter

SUGGESTED READINGS

1. Adam, M.R. & Moss, M.O. (2018). *Food Microbiology*. New Age International Publishers, New Delhi, India.
2. Bell, C., Neaves, P., & Williams, A.P. (2005). *Food Microbiology and Laboratory Practice.* Wiley-Blackwell Publishers, New Jersey, United States.
3. Bhatia, S.C. (2017). *Food Biotechnology*. WPI Publishers, New Delhi, India.
4. Export/import data by DGCIS-Calcutta.
5. Export/import policy by Govt. of India.

ACTIVITY: LIBRARY/SEMINAR **2H**

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

SEMESTER – VIII B

23BTU891	**RESEARCH PROJECT**	**18H–12C**

Instruction Hours / week: L:0 T: 0 P: 18 **Marks:** Internal: 120 External: 180 Total: **100**

End Semester Exam: 3Hour