V.V.VANNIAPERUMAL COLLEGE FOR WOMEN
(Belonging to Virudhunagar Hindu Nadars)
An Autonomous Institution Affiliated to Madurai Kamaraj University, Madurai
Reaccredited with 'A++' Grade (4th Cycle) by NAAC
VIRUDHUNAGAR
Quality Education with Wisdom and Values

OUTCOME BASED EDUCATION WITH CHOICE BASED CREDIT SYSTEM REGULATIONS AND SYLLABUS

(with effect from Academic Year 2025 - 2026)

V.V.Vanniaperumal College for Women, Virudhunagar, established in 1962, offers 13 UG Programmes (Aided), 13 UG Programmes (SF), 13 PG Programmes and 6 Ph.D. Programmes. The curricula for all these Programmes, except Ph.D. Programmes, have been framed as per the guidelines given by the University Grants Commission (UGC) & Tamil Nadu State Council for Higher Education (TANSCHE) under Choice Based Credit System (CBCS) and the guidelines for Outcome Based Education (OBE).

The Departments of Commerce, English, History, Mathematics, Biochemistry and Tamil upgraded as Research Centres offer Ph.D. Programmes as per the norms and regulations of Madurai Kamaraj University, Madurai and do not come under the purview of CBCS.

A. CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed Courses. The CBCS is followed as per the guidelines formulated by the UGC. The performance of students is evaluated based on the uniform grading system. Computation of the Cumulative Grade Point Average (CGPA) is made to ensure uniformity in evaluation system.

List of Programmes in which CBCS/Elective Course System is implemented

UG PROGRAMMES

Arts & Humanities	:	History (E.M. & T.M.), English, Tamil
Physical & Life Sciences	:	Mathematics, Zoology, Chemistry, Physics, Biochemistry, Home Science - Nutrition and Dietetics, Costume Design and Fashion, Microbiology, Biotechnology, Computer Science, Information Technology, Data Science, Computer Applications and Computer Applications - Graphic Design
Commerce & Management	:	Commerce, Commerce (Computer Applications), Commerce (Professional Accounting), Business Administration

PG PROGRAMMES

Arts & Humanities	:	History, English, Tamil
Physical & Life Sciences	:	Mathematics, Physics, Chemistry, Biochemistry, Home Science - Nutrition and Dietetics, Biotechnology, Computer Science and Computer Applications (MCA) *
Commerce & Management	:	Commerce, Business Administration (MBA) *

* AICTE approved Programmes

OUTLINE OF CHOICE BASED CREDIT SYSTEM- PG

1. Core Courses
2. Elective Courses
    - Discipline Specific Elective Courses (DSEC)
    - Generic Elective Courses
    - Non-Major Elective Courses (NMEC)
3. Skill Enhancement Courses
4. Self Study Course (Online)
5. Extension Activity
6. Extra Credit Courses (Optional)

List of Non Major Elective Courses (NME)
(2024-2025 onwards)

PG PROGRAMMES

Name of the Course	Semester	Course Code	Department
Introduction to Epigraphy	II	24PHIN21	History
Communication Strategies for Leadership Success	III	24PHIN31	
Functional English	II	24PENN21	English
English for Careers	III	24PENN31	
ஆளுமை மேம்பாடு	II	24PTAN21N	Tamil
தகவல் தொடர்பியல்	III	24PTAN31	
Accounting for Managers -1	II	24PCON21N	Commerce
Accounting for Managers -II	III	24PCON31	
Entrepreneurship Development	II	24PBAN21	Business Administration
Employability Skills	III	24PBAN31	
Mathematics for Life Sciences	II	24PMTN21	Mathematics
Statistics for Life and Social Sciences	III	24PMTN31	
Solid Waste Management	II	24PPHN21	Physics
Sewage and Waste Water Treatment and Reuse	III	24PPHN31	
Chemistry in Everyday Life	II	24PCHN21	Chemistry
Industrial Chemistry	III	24PCHN31	
Food Preservation	II	24PHSN21	Home Science - Nutrition and Dietetics
Nutrition and Health	III	24PHSN31	
Nutritional Biochemistry	II	24PBCN21	Biochemistry

Molecular Basis of Diseases and Therapeutic Strategies	III	24PBCN31	
Tissue engineering	II	24PBON21	Biotechnology
Gene manipulation Technology	III	24PBON31	
Web Programming	II	24PCSN21	Computer Science
Python Programming	III	24PCSN31	
Fundamentals of Web Design	II	24PCAN21N	Computer Applications
Fundamentals of Cyber Security	III	24PCAN31	

B.OUTCOME BASED EDUCATION (OBE) FRAMEWORK

The core philosophy of Outcome Based Education rests in employing a student - centric learning approach to measure the performance of students based on a set of pre- determined outcomes. The significant advantage of OBE is that it enables a revamp of the curriculum based on the learning outcomes, upgrade of academic resources, quality enhancement in research and integration of technology in the teaching-learning process. It also helps in bringing clarity among students as to what is expected of them after completion of the Programme in general and the Course in particular. The OBE directs the teachers to channelise their teaching methodologies and evaluation strategies to attain the Programme Educational Objectives (PEOs) and fulfill the Vision and Mission of the Institution.

Vision of the Institution

The founding vision of the Institution is to impart Quality Education to the rural womenfolk and to empower them with knowledge and leadership quality.

Mission of the Institution

The mission of the Institution is to impart liberal education committed to quality and excellence. Its quest is to mould learners into globally competent individuals instilling in them life-oriented skills, personal integrity, leadership qualities and service mindedness.

B.1 Programme Educational Objectives, Programme Outcomes and Programme Specific Outcomes

It is imperative for the Institution to set the Programme Educational Objectives (PEOs), Programme Outcomes (POs) and Course Outcomes (COs), consistent with its Vision and Mission statements. The PEOs and the POs should be driven by the Mission of the Institution and should provide distinctive paths to achieve the stated goals. The PEOs for each Programme have to fulfill the Vision and Mission of the Department offering the Programme.

Vision of the Department of M.Sc. BIOCHEMISTRY

To empower our students with scientific knowledge and skills and to mold them with pioneering spirit, forward thinking, leadership and collaborative approach.

Mission of the Department of M.Sc. BIOCHEMISTRY

- To handle scientific and research faculty of students through deep learning of Biochemistry for employability in research, academia and pharmaceutical fields,
- To advance traditional boundaries, to motivate for research and entrepreneurship
- Committed to improving the scientific world today.

B.1.1 Programme Educational Objectives (PEOs)

PEOs are broad statements that describe the career and professional achievements that the Programme is preparing the graduates to achieve within the first few years after graduation. PEOs are framed for each Programme and should be consistent with the Mission of the Institution.

Programme Educational Objectives (PEOs) of M.Sc. BIOCHEMISTRY Programme

The Students will be able to

- provide in-depth knowledge in the core areas of life sciences for industries, clinical, research , pharmaceutical labs, and academia.
- instill the ability of entrepreneurship in research and diagnostics
- equip skillful attitude promoting lifelong learning to meet the ever evolving professional demands by developing ethical , interpersonal and team skills

Key Components of Mission Statement	PEO1	PEO2	PEO3
Employability in research, academia and pharmaceutical fields	✓	✓	✓
Motivation for research and entrepreneurship	✓	✓	✓
Committed to improving the scientific world today	✓	✓	✓

B.1.2 Programme Outcomes (POs)

POs shall be based on Graduate Attributes (GAs) of the Programme. The GAs are the attributes expected of a graduate from a Programme in terms of knowledge, skills, attitude and values. The Graduate Attributes include Disciplinary Knowledge,

Communication Skills, Critical Thinking, Problem Solving, Analytical Reasoning, Research Related Skills, Co-operation/Team Work, Scientific Reasoning, Reflective Thinking, Information/Digital Literacy, Multicultural Competence, Moral and Ethical Awareness/Reasoning, Leadership Qualities and Lifelong Learning.

On successful completion of the Programme, the students will be able to

1 apply their in-depth domain knowledge and practical skills in interdisciplinary fields for research-based endeavours, employment and entrepreneurship development. (*Disciplinary Knowledge)*

2 communicate proficiently and confidently with the ability to present complex ideas both in spoken and written forms in a concise manner to assorted groups. (*Communication Skills*)

3 identify, formulate and solve problems in a consistent and systematic way with updated skills using modern tools and techniques. (*Scientific Reasoning and Problem Solving*)

4 analyze the data, synthesis the findings and provide valid conclusion by critical evaluation of theories, policies and practices for the fulfillment of the local, national, regional and global developmental needs. (*Critical Thinking and Analytical Reasoning*)

5 explore and evaluate globally competent research methodologies to apply appropriately in interdisciplinary research; Develop and sustain the research capabilities to meet the emerging needs for the welfare of the society. (*Research Related Skills*)

6 use ICT to mould themselves for lifelong learning activities to face career challenges in the changing environment. (*Digital Literacy, Self - directed and Lifelong Learning*)

7 self-manage and function efficiently as a member or a leader in diverse teams in a multicultural society for nation building. (*Co-operation/Team Work and Multicultural Competence*)

8 uphold the imbibed ethical and moral values in personal, professional and social life for sustainable environment. (*Moral and Ethical Awareness*)

B.1.3 Programme Specific Outcomes (PSOs)

Based on the Programme Outcomes, Programme Specific Outcomes are framed for each PG Programme**.** Programme Specific Outcomes denote what the students would be able to do at the time of graduation. They are Programme-specific and it is mandatory that each PO should be mapped to the respective PSO.

On Successful completion of M.Sc.Biochemistry Programme, the students will be able to

PO 1: *Disciplinary Knowledge*

PSO 1.a: Apply the knowledge of theoretical and experimental approaches of Biochemistry in research oriented Endeavour to unravel problems in health care with a scientific basis of life process and will have an ability to provide solution to new problems.

PSO 1.b: Recognize the importance of bioethics, entrepreneurship and career oriented skills, thus providing a strong foundation for both academic / industrial placements across the country and globe as well as setting up entrepreneurial ventures.

PO2: *Communication Skills*

PSO 2: Communicate the knowledge of Biochemistry to address environmental, intellectual, societal and ethical issues through case studies .

PO3: *Scientific Reasoning and Problem Solving*

PSO 3.a: Enrich their analytical and problem solving skills regarding biochemical principles of life processes and technologies for combating human diseases.

PSO 3.b: build up the capacity of decision making with regard to scientific progress, personal development and career choice.

PO4: *Critical thinking and Analytical Reasoning*

PSO 4: Apply the knowledge of experimental approaches on designing experiments, analysis, interpretation of data and synthesis of information to provide valid conclusions for life situations and entrepreneurial situations.

PO5: *Research Related Skills*

PSO 5: An ability to properly understand the technical aspects with research aptitude of existing technologies that help in addressing the biological and medical challenges faced by human kind by adhering the code of conduct of Biochemistry

PO6: *Digital Literacy, Self - directed and Lifelong learning*

PSO 6: Analyze and interpret the data using state-of the-art techniques with ICT and modern tools in planning and executing projects in Biochemistry for health care area, research area and entrepreneurial area.

PO7: *Cooperation/Team Work and Multicultural Competence*

PSO 7: Develop leadership qualities, team spirit and good interpersonal skills to work effectively in diverse fields like agriculture, health care, research and entrepreneurial fields individually or as a team.

PO8: *Moral and Ethical awareness*

PSO 8: Follow the global standards of codes of conduct in Life science community and practice the imbibed moral values in their profession to maintain sustainable environment and society.

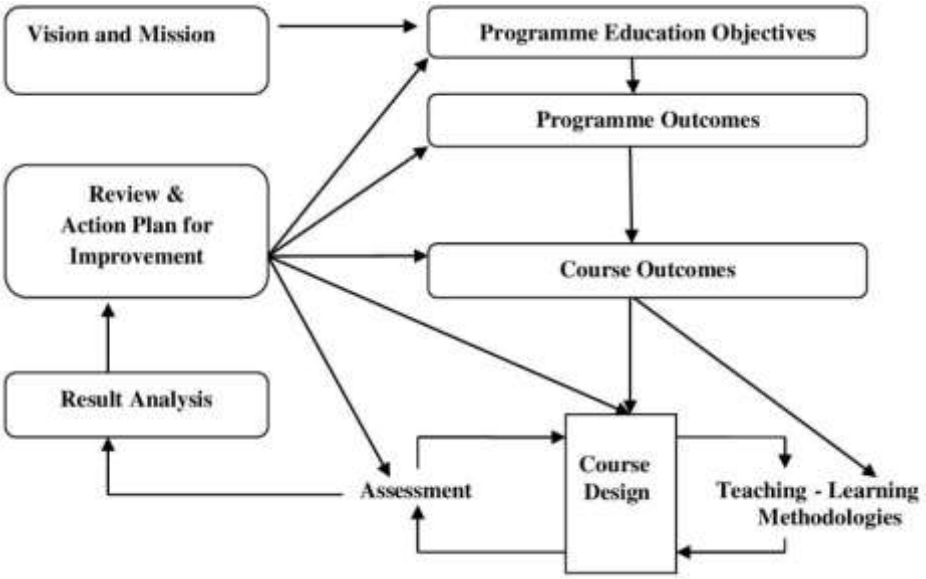
PO-PEO Mapping Matrix

Attainment of PEOs can be measured by a PO-PEO matrix. PEOs should evolve through constant feedback from alumnae, students, industry, management, *etc*. It is mandatory that each PEO should be mapped to at least one of the Pos.

PEOs / POs/PSOs	PEO1	PEO2	PEO3
PO1/PSO1	✓	✓	✓
PO2/PSO2	✓	✓	✓
PO3/PSO3	✓	✓	✓
PO4/PSO4	✓	✓	-
PO5/PSO5	-	✓	✓
PO6/PSO6	✓	✓	✓
PO7/PSO7	✓	✓	✓
PO8/PSO8	✓	✓	-

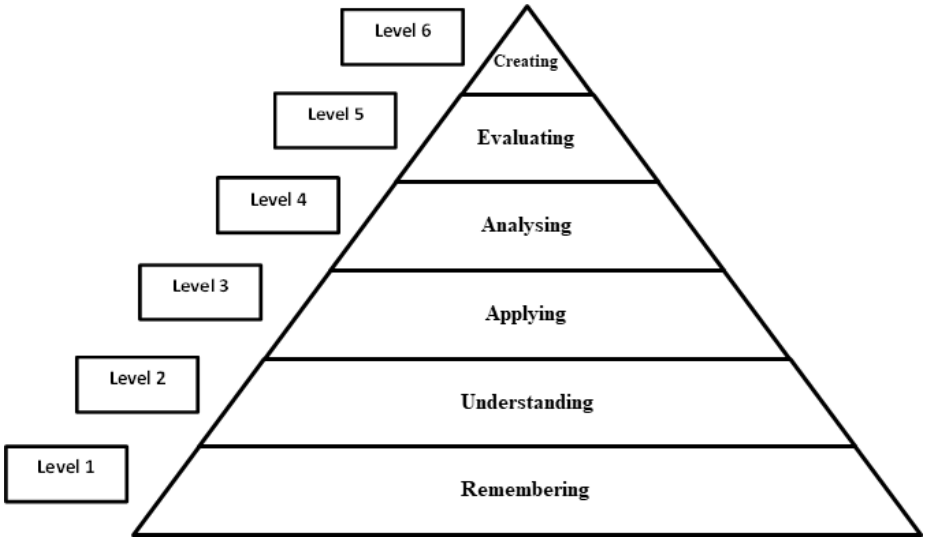
B.1.4 Course Outcomes (COs)

Course Outcomes are narrow statements restricted to the course contents given in five units. Course Outcomes describe what students would be capable of, after learning the contents of the Course. They reflect the level of knowledge gained, skills acquired and attributes developed by the students after learning of Course contents. COs are measurable, attainable and manageable in number. COs contribute to attain POs in such a way that each CO addresses at least one of the POs and also each PO is reasonably addressed by adequate number of COs.



It is important to determine the methods of assessment. A comprehensive assessment strategy may be outlined using the revised Bloom's Taxonomy levels.

BLOOM'S TAXONOMY



CO - PO Mapping of Courses

After framing the CO statements, the COs framed for each course is mapped with POs based on the relationship that exists between them. The COs which are not related to any of the POs is indicated with (-), signifying Nil. Measurement Mapping is based on Four Points Scale [High (H), Medium (M), Low (L) and Nil (-)]. For calculating weighted percentage of contribution of each Course in the attainment of the respective POs, the weights assigned for H, M and L are 3, 2 and 1 respectively.

CO-PO/PSO Mapping Table (Course Articulation Matrix)

PO/PSOs / COs	PO1/ PSO1	PO2/ PSO2	PO3/ PSO3	PO4/ PSO4	PO5/ PSO5	PO6/ PSO6	PO7/ PSO7	PO8/ PSO8
CO1								
CO2								
CO3								
CO4								
CO5								

ELIGIBILITY FOR ADMISSION

The candidate should have passed in B.Sc. Biochemistry, Zoology, Botany, Microbiology, Biotechnology (General or any Specialization) Degree from any recognized University.

DURATION OF THE PROGRAMME

The candidates shall undergo the prescribed Programme of study for a period of two academic years (four semesters).

MEDIUM OF INSTRUCTION

English

B.2 EVALUATION SCHEME

Components	Internal Assessment Marks	External Examination Marks	Total Marks
Theory/Project	25	75	**100**

B.2.1 Core Courses, Elective Courses (Discipline Specific Elective Courses, Generic Elective Courses & Non Major Elective Courses

INTERNAL ASSESSMENT

Distribution of Marks

Theory

Mode of Evaluation		Marks
Periodic Test	:	20
Assignment	:	5
Total	**:**	**25**

Three Periodic Tests - Average of the best two will be considered
Two Assignments - Better of the two will be considered

Practical

Mode of Evaluation		Marks
Practical Test	:	30
Record Performance	:	10
Total	**:**	**40**

Practical Test - Average of the two Practical Tests will be considered
Performance - Attendance and Record

Question Pattern for Periodic Test **Duration: 2 Hours**

Section	Q. No.	Types of Question	No. of Questions	No. of Questions to be answered	Marks for each Question	Total Marks
A	1 - 5	Multiple Choice Questions	5	5	1	5
B	6-9	Internal Choice – Either… or Type	4	4	5	20
C	10 - 11	Internal Choice – Either…. or Type	2	2	10	20
					Total	**45***

*The total marks obtained in the Periodic Test will be calculated for 20 marks

Summative Examination

External Assessment

Distribution of Marks

Mode of Evaluation		Marks
Summative Examination	:	60
Seminar Presentation	:	15
Total	:	**75**

Summative Examination

Question Pattern **Duration: 3 Hours**

Section	Q. No.	Types of Question	No. of Questions	No. of Questions to be answered	Marks for each Question	Total Marks
A	1 - 5	Multiple Choice Questions	5	5	1	5
B	6 - 10	Internal Choice -Either ….or Type	5	5	5	25
C	11 - 13	Internal Choice -Either …or Type	3	3	10	30
					Total	**60**

B.2.2 Project

Individual Project is compulsory for II PG Students in IV Semester.

Distribution of Marks

Mode of Evaluation		Marks
Internal Assessment	:	40
External Assessment	:	60
Total	:	**100**

Internal Assessment:

Pre-submission Presentation - 10 Marks

Review Report - 20 Marks

One Open Online Course related to the Project - 10 Marks

External Assessment:

Project Report - 40 Marks

Viva Voce - 20 Mark

B. 2.3 Skill Enhancement Course - Professional Competency Skill

Types of Question – Multiple Choice Questions Only

INTERNAL ASSESSMENT

Distribution of Marks

Theory

Mode of Evaluation		Marks
Periodic Test	:	20
Assignment	:	5
Total	**:**	**25**

Three Periodic Tests - Average of the best two will be considered

Two Assignments - Better of the two will be considered

Question Pattern for Periodic Test **Duration: 2 Hours**

Section	Q. No.	Types of Question	No. of Questions	No. of Questions to be answered	Marks for each Question	Total Marks
A	1 - 5	Multiple Choice Questions	5	5	1	5
B	6-9	Internal Choice – Either… or Type	4	4	5	20
C	10 - 11	Internal Choice – Either…. or Type	2	2	10	20
	Total					**45***

*The total marks obtained in the Periodic Test will be calculated for 20 marks

Summative Examination

External Assessment

Distribution of Marks

Mode of Evaluation		Marks
Summative Examination	**:**	60
Seminar Presentation	**:**	15
Total	**:**	**75**

Summative Examination

Question Pattern **Duration: 3 Hours**

Section	Q. No.	Types of Question	No. of Questions	No. of Questions to be answered	Marks for each Question	Total Marks
A	1 - 5	Multiple Choice Questions	5	5	1	5
B	6 - 10	Internal Choice - Either ….or Type	5	5	5	25
C	11 - 13	Internal Choice - Either …or Type	3	3	10	30
					Total	**60**

B. 2.4 Internship / Industrial Training

Internship / Industrial Training is mandatory for all the Students

- **Internship:** Students have to involve in a designated activity, working in an organization for maximum of 30 days (not less than 20 days) under the guidance of an identified mentor.
- **Industrial Training:** Students have to undertake in-plant training in industries individually or in group for maximum of 30 days (not less than 20 days)
- Internship / Industrial Training must be done during the second semester holidays

Distribution of Marks

Mode of Evaluation		Marks
Internal Assessment	:	75
External Assessment	:	25
Total	:	**100**

Internal Assessment

Mode of Evaluation		Marks
Onsite Learning/Survey	:	50
Report	:	25
Total		**75**

External Assessment

Mode of Evaluation		Marks
Viva-Voce	:	25
Total		**25**

B.2.5. Self Study - Online Course

Practice for CSIR NET-General Paper –Online
Internal Examination only

- Two Periodic Tests (Online) with Multiple Choice Questions will be conducted in III Semester.
- Model Examination will be conducted after two periodic tests.

Distribution of Marks

Mode of Evaluation		Marks
Periodic Test	:	25
Model Examination	:	75
Total	**:**	**100**

Two Periodic Tests - Better of the two will be considered

B.2.6. Extension Activities

Assessment by Internal Examiner only

Distribution of Marks

Mode of Evaluation		**Marks**
Attendance	:	5
Performance	:	10
Report	:	10
Total	**:**	**25***

*The marks obtained will be calculated for 100 marks

B.2.7 Transfer of credits earned through MOOC (UGC recognized Courses)

- Students can opt for minimum of
  - 12 weeks Courses for Core Courses
  - 8 weeks Courses for Elective Courses
  - 4 weeks Courses for Skill Enhancement Course
- The Online Courses opted by the students will be verified and approved by the Head of the Department and forwarded to the Controller of Examinations through the Principal.
- Students are required to register for the equivalent Online Courses through the Institution's SWAYAM-NPTEL Local Chapter after submitting a Permission letter to the Head of the Department.
- The Course should be completed before the beginning of that particular Semester in which the selected Course is offered.
- The student should submit the Course Completion Certificate immediately after receiving it, to the Department.
- The Head of the Department has to send the list of the students and their Course Completion Certificates to the Controller of Examinations through the Principal.
- The students who have submitted the Completion Certificate are exempted from appearing the Periodic Tests and Summative Examinations of the respective course but without any exemption for class attendance.
- Credits allotted for the particular Course in the Curriculum will be transferred after the completion of the Online Course
- Students can earn up to 10 credits within the mandatory credits requirements of the Degree Programme by completing UGC recognised Online Courses.

B.2.8. EXTRA CREDIT COURSES (OPTIONAL)

2.8.1 Extra Credit Course offered by the Department.

Assessment by Internal Examiner Only (To be conducted along with the III Periodic Test)

Distribution of Marks

Mode of Evaluation		**Marks**
Quiz (Multiple Choice Questions)	:	25
Model Examination	:	75
Total	**:**	**100**

Question Pattern for Model Examination

Section	**Types of Question**	**No. of Questions**	**No. of Questions to be answered**	**Marks for each Question**	**Total Marks**
A Q.No.(1-5)	Internal Choice-Either or Type	5	5	7	35
B Q.No.(6-9)	Internal Choice-Either or Type	4	4	10	40
				Total	**75**

2.8.2 Extra credit Course offered by MOOC (Massive Open Online Course)

- The Courses shall be completed within the first III Semesters of the Programme.
- The allotment of credits is as follows **(Maximum of 15 credits)**

4weeks Course - 1 credit

8 weeks Course - 2 credits

12 weeks Course - 3 credits

ELIGIBILITY FOR THE DEGREE

- The candidate will not be eligible for the Degree without completing the prescribed Courses of study and a minimum of 50% Pass marks in all the Courses.
  - No Pass minimum for Internal Assessment for all the Courses.
  - Pass minimum for External Examination is 27 marks out of 60 marks for Core Courses, Discipline Specific Elective Courses and Non-Major Elective Course.
  - Pass minimum for Practice for SET/NET - General Paper is 50 Marks.
- **Attendance**
  - The students who have attended the classes for 76 days (85%) and above are permitted to appear for the Summative Examinations without any condition.
  - The students who have only 60-75days (66% -84%) of attendance are permitted to appear for the Summative Examinations after paying the required fine amount

and fulfilling other conditions according to the respective cases.

- The students who have attended the classes for 59 days and less – upto 45 days (50% - 65%) can appear for the Summative Examinations only after getting special permission from the Principal.
- The students who have attended the classes for 44 days or less (<50%) cannot appear for the Summative Examinations and have to repeat the whole semester.
- For Certificate, Diploma, Advanced Diploma and Post Graduate Diploma Programmes, the students require 75% of attendance to appear for the Theory/Practical Examinations.

B.3 ASSESSMENT MANAGEMENT PLAN

An Assessment Management Plan that details the assessment strategy both at the Programme and the Course levels is prepared. The continuous assessment is implemented using an assessment rubric to interpret and grade students.

B.3.1 Assessment Process for CO Attainment

Assessment is one or more processes carried out by the institution that identify, collect and prepare data to evaluate the achievement of Course Outcomes and Programme Outcomes. Course Outcome is evaluated based on the performance of students in the Continuous Internal Assessments and in End Semester Examination of a course. Target levels of attainment shall be fixed by the Course teacher and Heads of the respective departments.

Direct Assessment (Rubric based) - Conventional assessment tools such as Term Test, Assignment, Quiz and End Semester Summative Examination are used.

Indirect Assessment - Done through Course Exit Survey.

CO Assessment Rubrics

For the evaluation and assessment of COs and POs, rubrics are used. Internal assessment contributes 40% and End Semester assessment contributes 60% to the total attainment of a CO for the theory courses. For the practical courses, internal assessment contributes 50% and Semester assessment contributes 50% to the total attainment of a CO. Once the Course Outcome is measured, the PO can be measured using a CO-PO matrix.

CO Attainment

Direct CO Attainment

Course Outcomes of all courses are assessed and the CO - wise marks obtained by

all the students are recorded for all the assessment tools. The respective CO attainment level is evaluated based on set attainment rubrics.

Target Setting for Assessment Method

For setting up the target of internal assessment tools, 55% of the maximum mark is fixed as target. For setting up the target of End Semester Examination, the average mark of the class shall be set as target.

Formula for Attainment for each CO

Attainment = Percentage of students who have scored more than the target marks

$$\text{Percentage of Attainment} = \frac{\text{Number of Students who Scored more than the Target}}{\text{Total Number of Students}} \times 100$$

Attainment Levels of COs

Assessment Methods	Attainment Levels	
Internal Assessment	Level 1	50% of students scoring more than set target marks in Internal Assessment tools
	Level 2	55% of students scoring more than set target marks in Internal Assessment tools
	Level 3	60% of students scoring more than set target marks in internal Assessment tools
End Semester Summative Examination	Level 1	50% of students scoring more than average marks in End Semester Summative Examination
	Level 2	55% of students scoring more than average marks in End Semester Summative Examination
	Level 3	60% of students scoring more than average marks in End Semester Summative Examination

Indirect CO Attainment

At the end of each Course, an exit survey is conducted to collect the opinion of the students on attainment of Course Outcomes. A questionnaire is designed to reflect the views of the students about the Course Outcomes.

Overall CO Attainment=75% of Direct CO Attainment + 25 % of Indirect CO Attainment

In each Course, the level of attainment of each CO is compared with the predefined targets. If the target is not reached, the Course teacher takes necessary steps for the improvement to reach the target.

For continuous improvement, if the target is reached, the Course teacher can set the target as a value greater than the CO attainment of the previous year.

B.3.2 Assessment Process for Overall PO Attainment

With the help of CO - PO mapping, the PO attainment is calculated. PO assessment is done by giving 75% weightage to direct assessment and 25% weightage to indirect assessment. Direct assessment is based on CO attainment, where 75% weightage is given to attainment through End Semester Examination and 25 % weightage is given to attainment through Internal assessments. Indirect assessment is done through Graduate Exit Survey and participation of students in Co-curricular/Extra-curricular activities.

PO Assessment Tools

Mode of Assessment	Assessment Tool	Description
Direct Attainment (Weightage -75%)	CO Assessment	This is computed from the calculated CO Attainment value for each Course.
Indirect Attainment (Weightage - 25%)	Graduate Exit Survey 10%	At the end of the Programme, Graduate Exit Survey is collected from the graduates and it gives the opinion of the graduates on attainment of Programme Outcomes.
	Co-curricular / Extra-curricular activities 15%	For participation in Co-curricular/Extra-curricular activities during the period of their study.

Programme Articulation Matrix (PAM)

Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
Average Direct PO Attainment									
Direct PO Attainment in percentage									

Indirect Attainment of POs for all Courses

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
Graduate Exit Survey								
Indirect PO Attainment								

Attainments of POs for all Courses

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
Direct Attainment(Weightage - 75%)								
Indirect Attainment(Weightage - 25%)								
Overall PO Attainment								

Overall PO Attainment= 75% of Direct PO Attainment +
25% of Indirect PO Attainment (Graduate Exit Survey & Participation in Co- curricular and Extra-curricular Activities)

Expected Level of Attainment for each of the Programme Outcomes

POs	Level of Attainment
Attainment Value ≥70%	Excellent
60% ≤ Attainment Value < 70%	Very Good
50% ≤ Attainment Value < 60%	Good
40% ≤ Attainment Value < 50%	Satisfactory
Attainment Value <40%	Not Satisfactory

Level of PO Attainment

Graduation Batch	Overall PO Attainment (in percentage)	Whether Expected Level of PO is Achieved? (Yes/No)

B.3.3 Assessment Process for PEOs

The curriculum is designed so that all the courses contribute to the achievement of PEOs. The attainment of PEOs is measured after 3 years of completion of the Programme only through Indirect methods.

Target for PEO Attainment

Assessment Criteria	Target (UG)	Target (PG)
Record of Employment	15% of the class strength	30 % of the class strength
Progression to Higher Education	50% of the class strength	5 % of the class strength
Record of Entrepreneurship	2 % of the class strength	5 % of the class strength

Attainment of PEOs

Assessment Criteria & Tool	Weightage
Record of Employment	10
Progression to Higher Education	20
Record of Entrepreneurship	10
Feedback from Alumnae	30
Feedback from Parents	10
Feedback from Employers	20
Total Attainment	**100**

$$\text{Percentage of PEO Attainment from Employment} = \frac{\text{Number of Students who have got Employment}}{\text{Target}} \times 100$$

$$\text{Percentage of PEO Attainment from Higher Education} = \frac{\text{Number of Students who pursue Higher Education}}{\text{Target}} \times 100$$

$$\text{Percentage of PEO Attainment from Entrepreneurship} = \frac{\text{Number of Students who have become Entrepreneurs}}{\text{Target}} \times 100$$

Expected Level of Attainment for each of the Programme Educational Objectives

POs	Level of Attainment
Attainment Value ≥70%	Excellent
60% ≤ Attainment Value < 70%	Very Good
50% ≤ Attainment Value < 60%	Good
40% ≤ Attainment Value < 50%	Satisfactory
Attainment Value <40%	Not Satisfactory

Level of PEO Attainment

Graduation Batch	Overall PEO Attainment (in percentage)	Whether Expected Level of PEO is Achieved? (Yes/No)

C. PROCESS OF REDEFINING THE PROGRMME EDUCATIONAL OBJECTIVES

The college has always been involving the key stakeholders in collecting information and suggestions with regard to curriculum development and curriculum revision. Based on the information collected, the objectives of the Programme are defined, refined and are inscribed in the form of PEOs. The level of attainment of PEOs defined earlier will be analysed and will identify the need for redefining PEOs. Based on identified changes in terms of curriculum, regulations and PEOs, the administrative system like Board of Studies, Academic Council and Governing Body may recommend appropriate actions. As per the Outcome Based Education Framework implemented from the Academic Year 2020 - 2021, the following are the Programme Structure, the Programme Contents and the Course Contents of M.Sc. Biochemistry Programme

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VIRUDHUNAGAR
Quality Education with Wisdom and Values

MASTER OF BIOCHEMISTRY (7015)

Outcome Based Education with Choice Base Credit System
Programme Structure - Allotment of Hours and Credits
for those who join in the Academic Year 2024-2025

Components	Semester				Total Number of Hours (Credits)
	I	II	III	IV	
Core Course	6 (5)	6 (5)	6 (5)	6 (5)	24 (20)
Core Course	6 (5)	6 (5)	6 (5)	6 (5)	24 (20)
Core Course	-	-	6 (5)	-	6 (5)
Core Course Practical	6 (4)	6 (4)	6 (4)	-	18 (12)
Project	-	-	-	6 (5)	6(5)
Elective Course (DSEC)	6 (3)	4 (3)	3 (3)	-	13 (9)
Elective Course (Generic)	6 (3)	4 (3)	-	-	10 (6)
Elective Course(NME)	-	4 (2)	3 (2)	-	7 (4)
Elective Course- (Industry / Entrepreneurship)	-	-		6 (3)	6 (3)
Skill Enhancement Course/ Professional Competency Skill	-	-	-	6 (3)	6 (3)
Self Study Course	-	-	0 (1)	-	0 (1)
Internship/Industrial Activity	-	-	0 (2)	-	0 (2)
Extension Activity	-	-	-	0 (1)	0 (1)
Total	**30 (20)**	**30 (22)**	**30 (27)**	**30 (22)**	**120 (91)**
Extra Credit Course(Optional) - Offered by the Department	-	-	0(2)	-	0(2)
Extra Credit Course(Optional) - MOOC	-	-	-	-	Limited to a maximum of 15 credits

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M.Sc. Biochemistry -SEMESTER III

S.No.	Components	Title of the Course	Course Code	Hours Per Week	Credits	Exam. Hours	Marks		
							Int.	Ext.	Total
1	Core Course -5	Industrial Microbiology	24PBCC31	6	5	3	25	75	100
2	Core Course -6	Molecular Biology	24PBCC32	6	5	3	25	75	100
3	Core Course -7	Enzymology	24PBCC33	6	5	3	25	75	100
4	Core Course Practical -3	Laboratory course on Enzymology, Microbiology and Cell Biology	24PBCC31P	6	4	6	40	60	100
5	Discipline Specific Elective-3	Biostatistics and Data Science	24PBCE31	3	3	3	25	75	100
6	Elective Course NME	Molecular Basis of Diseases And Therapeutic Strategies	24PBCN31	3	2	3	25	75	100
7	Self Study Course	Practice for CSIR/NET-General Paper	24PGOL32	-	1	-	100	-	100
8	Internship/Industrial Activity	Internship	24PBCI31	-	2	-	75	25	100
			Total		**27**				**800**
9	Extra Credit Course	Gene Editing, Cell and Gene therapy	24PBCO31	-	2	3	100	-	100

M.Sc. Biochemistry -SEMESTER IV

S.No.	Components	Title of the Course	Course Code	Hours Per Week	Credits	Exam. Hours	Marks		
							Int.	Ext.	Total
1.	Core Course -8	Pharmaceutical Biochemistry	24PBCC41	6	5	3	25	75	100
2	Core Course -9	Biochemical Toxicology	24PBCC42	6	5	3	25	75	100
3.	Core Course -10	Project	24PBCC43PR	6	5	-	40	60	100
4.	Elective Course- 8 (Industry / Entrepreneurship)	Biosafety, Lab Safety And IPR	24PBCE41	6	3	3	25	75	100
5.	Skill Enhancement Course/ Professional Competency Skill-2	Preparation for Competitive Examinations - Life Sciences	24PBCS41	6	3	3	25	75	100
6.	Extension Activity	Extension Activities	-	-	1	-	100	-	100
Total				**30**	**22**				**600**

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M.Sc. BIOCHEMISTRY
(2024-2025 onwards)

Semester III	**INDUSTRIAL MICROBIOLOGY**	Hours/Week: 6	
Core Course-5		Credits: 5	
24PBCC31		Internal 25	External 75

COURSES OUTCOMES

On successful completion of the course, the students should be able to:

CO1: Understand the knowledge of various kinds of microorganisms, significance and role of microorganisms in various industries[K2]

CO2: Illustrate the central roles of microorganisms in nature, and the importance of microorganisms in industries and in food preservation [K3]

CO3: Apply the Knowledge regarding basic, advanced and applicable concepts in emerging areas of Industrial Microbiology (K3)

CO4: Analyze the microbial strains and methods used in fermentation technology and food microbiology (K4)

CO5: Examine the theoretical and practical understanding of industrial microbiology (K4)

UNIT-I

Structure of bacteria, fungi and viruses and their classification. Types and characteristics of microorganisms used in Industry (a) Food Industry (b) Chemical Industry (c) Pharmaceutical Industry. (**18 hours)**

UNIT-II

Fundamentals and principles of microbial fermentation techniques – application in industry and pharmaceutical Biochemistry. Fermentation – types, techniques, design and operation of fermenters including addition of medium. Types and characteristics of microorganisms, environmental conditions required for the growth and metabolism of industrially and pharmaceutically important microbes. Sterilization methods in fermentation

techniques, air, gas, culture medium sterilization. Steam-filtration and chemicals. Types and constituents of fermentative culture medium and conditions of fermentations, Antifoaming devices.

(**18 hours)**

UNIT-III

Recovery and estimation of products of fermentation- Production of ethanol, acetic acid, glycerol, acetone, butanol and citric acid by fermentation. Production of Enzymes- amylase, protease, lipase,Production of pharmaceuticals by fermentation– penicillin, streptomycin, tetracycline, riboflavin, vitamin B12.Beverages-wine, beer and malt beverages. (**18 hours)**

UNIT-IV

Food Microbiology: Production of dairy products-bread, cheese and yoghurt (preparation and their types). Food borne diseases- Bacterial and Non- Bacterial. Food preservation - Principles–Physical methods: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, Chemical methods - salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins. (**18 hours)**

UNIT-V

Agricultural Microbiology: General Properties of soil, microorganisms in soil – decomposition of organic matter in soil. Biogeochemical cycles, nitrogen fixation, Production of bio fertilizers and its field applications – Rhizobium, azotobacter, blue green algae, mycorrhizae, azospirilium, Production of biofuels (biogas- methane), soil inoculants. .

(**18 hours)**

Textbooks

1. Matthews, K. R., Kniel, K. E., & Montville, T. J. (2017). *Food microbiology: An introduction* (4th ed.). American Society for Microbiology.
2. Charles, B. W. (2005). *Food, fermentation and micro-organisms* (2nd ed.). Blackwell Science Ltd.
3. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2001). *Microbiology* (5th ed.). McGraw Hill Book Company.

4. Ananthanarayanan, R., & Paniker, C. K. J. (2020). *Textbook of microbiology* (11th ed.). Universities Press (India) Pvt. Ltd.
5. Frazier, W. C., & Westhoff, D. C. (1992). *Food microbiology* (3rd ed.). Tata McGraw-Hill Publishing Company Ltd.
6. Gould, G. W. (Ed.). (1995). *New methods of food preservation* (1st ed.). Springer.
7. American Society for Microbiology. (2014). *Manual of industrial microbiology and biotechnology* (3rd ed.).

Reference Books

1. Casida, L. E. (1991). *Industrial microbiology* (1st ed.). Wiley Eastern Limited.
2. Crueger, W., & Crueger, A. (2000). *Biotechnology: A textbook of industrial microbiology* (2nd ed.). Panima Publishing Co.
3. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2006). *Principles of fermentation technology* (2nd ed.). Wiley Eastern.
4. Willey, J., Sherwood, L., & Woolverton, C. J. (2016). *Prescott's microbiology* (10th ed.). McGraw-Hill Education.
5. Pelczar, M. J. (2023). *Microbiology* (5th ed.).

Course Code 24PBCC31	PO1		PO2	PO3		PO4	PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2	PSO3 3.a	PSO3 3.b	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	3	2	2	3	2	2	2	3	2
CO 2	3	2	2	1	3	2	2	2	2	3
CO 3	2	2	3	3	2	2	2	2	2	2
CO 4	2	3	2	2	2	2	1	2	2	2
CO 5	2	3	2	3	2	2	2	2	2	2

Strong (3) Medium (2) Low (1)

Dr.P.Annapoorani — **Head of the Department**

Mrs.M.Rajakumari — **Course Designer**

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M.Sc. BIOCHEMISTRY
(2024-2025 onwards)

Semester: III	**MOLECULAR BIOLOGY**	Hours/Week: 6	
Core Course-6		Credits: 5	
Course Code **24PBCC32**		Internal 25	External 75

After completion of the course, the students should be able to:

CO1: Understand the organization of genomes, the molecular basis of DNA replication, recombination and transposition, the significance of these processes, DNA damage and repair, and molecular mechanisms in gene expression and regulation [K2]

CO2: Apply the knowledge on genome organization , gene expression, regulation, DNA mutation and repair [K3]

CO3: make use of the perceived knowledge about gene and protein expression for various molecular biology experimental approaches [K3]

CO4 : Analyze the expression of genes and proteins during the molecular events . [K4]

CO5: Examine the genome organization, replication, transcription, translation and regulation process in depth and develop an interest to pursue high quality research. [K4]

UNIT-I

Mendel‟s laws of inheritance-dominance-complete, incomplete and co- dominance, multiple alleles-gene mapping in haploids and diploids, recombination mapping- restriction mapping- modes of gene information transfer in bacterial- conjugation, transformation and transduction. The bacterial chromosome, the eukaryotic genome- chromosome structure – Histones, Nucleosome, chromatin- heterochromatin, euchromatin, chromatin remodeling, DNAase hypersensitive sites, genome organization – the C-value paradox, reassociation kinetics, repetitive sequences, gene amplification, telomeres, pseudogenes, split genes, organelle genomes – mitochondrial and chloroplast genome. **(18 hours)**

UNIT-II

DNA replication and repair: Enzymes of replication, prokaryotic replication mechanisms, primosome & replisomes, eukaryotic DNA replication, the role of topoisomerases and telomerase, regulation of replication, difference between prokaryotic and eukaryotic replication. Mutations - Types of mutations, mechanisms of mutations, mutagenic agents. DNA repair mechanisms – Direct repair, excision repair, mismatch repair, recombination repair, SOS response, eukaryotic repair systems. Recombination and mobile genetic elements- the Holliday model, the general recombination in E.coli, site specific recombination, transposons and retroposons.

(18 hours)

UNIT-III

Transcription – Prokaryotic transcription-subunits of RNA polymerase, E. coli promoters, sigma factor and promoter recognition, alternative sigma factors, initiation, elongation, Rho-dependent and independent termination of transcription. Eukaryotic transcription- Initiation, promoter elements, RNA polymerases, transcription factors, regulatory sequences in eukaryotic protein – coding genes, CpG islands, enhancers.

Translation – organization of the ribosome, the genetic code, evidence for a triplet code, deciphering the genetic code, wobble hypothesis, deviation in the genetic code, unusual codons. activation, initiation, elongation and termination of translation in E. coli. The role of tRNA and rRNA, suppressor tRNAs and inhibitors of protein synthesis., Comparison of prokaryotic translation with eukaryotic translation. **(18 hours)**

UNIT-IV

Regulation of gene expression in prokaryotes-– Positive and negative control, the lac operon, identification of operator and regulator sequences by mutations, induction and repression, Foot-printing and gel-shift assays for identification of protein-DNA interactions. Catabolite repression. Trp operon – Attenuation, alternative secondary structures of trp mRNA.

Regulation of gene expression in eukaryotes- Response elements, DNA-binding motifs, steroid receptors, association of methylation and histone acetylation with gene expression. **(18 hours)**

UNIT-V

Post transcriptional modifications in eukaryotes- RNA processing- mRNA 5‟ capping and 3‟poly-adenylation, introns and exons, RNA splicing,- spliceosome assembly, alternative splicing, processing of tRNA and rRNA, self-splicing, ribozymes, RNA editing- substitution and insertion/deletion editing, Genome editing-CRISPR- Cas technology.

Post translational modification of proteins- Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation, Protein sorting – signal peptides, transport of secretory proteins, Golgi and post-golgi sorting, coated vesicles, targeting of mitochondrial, lysosomal and nuclear proteins, Protein degradation-Ubiquitination of proteins, Protein folding-chaperones.

(**18 hours)**

Textbooks

1. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's genes XII* (12th ed.). Prentice Hall.
2. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2007). *Molecular biology of the gene* (6th ed.). Cold Spring Harbor Laboratory Press.
3. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2019). *Essential cell biology* (3rd ed.). Garland Science.
4. Lodish, H., & Berk, A. (2016). *Molecular cell biology* (8th ed.). W.H. Freeman & Co.

Reference Books

1. Wolfe, S. L. (1993). *Molecular and cellular biology* (1st ed.). Cengage Learning Inc.
2. Darnell, J., Lodish, H., & Baltimore, D. (1986). *Molecular cell biology* (1st ed.). W.H. Freeman & Company.
3. Brown, T. A. (2006). *Genomes* (3rd ed.). Garland Science Inc.
4. Becker, W. M., Kleinsmith, L. J., & Harden, J. (2000). *The world of the cell* (4th ed.). Addison Wesley Longman Inc.

Course Code 24PBCC32	**PO1**		**PO2**	**PO3**		**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
	PSO 1a	**PSO 1b**	**PSO 2**	**PSO 3a**	**PSO 3b**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**
CO1	3	2	2	3	3	3	2	3	3	2
CO2	3	3	2	2	2	3	2	3	2	2
CO3	2	2		2	2	3	2	3		2
CO4	3	2	2	3	3	2	3	3	2	2
CO5	3	3	2	3	2	3	3	3	2	2

Strong (3) **Medium (2)** **Low** (1)

Dr.P.Annapoorani
Head of the Department

Dr.P.Annapoorani
Course Designer

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VIRUDHUNAGAR - 626 001

M.Sc. Biochemistry
(2024-2025 onwards)

Semester III	**ENZYMOLOGY**	Hours/Week: 6	
Core Course - 7		Credits: 5	
Course Code **24PBCC33**		Internal 25	External 75

On successful completion of this course, students should be able to:

CO1: Describe the classification, kinetics, catalytic mechanisms and techniques involved in enzymology (K2)

CO2: apply the appropriate methods for the isolation, purification, immobilization and the study of enzymes (K3)

CO3: sketch the enzyme classification, kinetics, catalysis and technology in enzymology (K3)

CO4: Analyze the enzyme classification and nomenclature, catalysis, kinetics and technology. (K4)

CO5: Compare the kinetics, methods of inhibition,isolation,purification and identification techniques of enzymes (K4)

Unit I

Introduction to enzymes and features of catalysis: A short history of the discovery of enzymes and how they became powerful biochemical tools. Holoenzyme, apoenzyme, cofactors, coenzyme, prosthetic groups, Classification and Nomenclature, Specificity of enzyme action-group specificity, absolute specificity, substrate specificity, stereochemical specificity. Active site, Identification of amino acids at the active site-trapping of ES complex, identification using chemical modification of amino acid side chains and by site-directedmutagenesis

Mechanisms of enzyme catalysis: acid-base catalysis, covalent catalysis, electrostatic

catalysis, metal ion catalysis, proximity and orientation effects, Low barrier H-bonds, Structural flexibility Mechanism of action of chymotrypsin.

(**18 hours)**

Unit II

Enzyme techniques: Isolation and purification of enzymes - Importance of enzyme purification, methods of purification- choice of source , extraction, fractionation methods- based on size or mass (centrifugation, gel filtration); based on polarity (ion-exchange chromatography, electrophoresis, isoelectric focusing, hydrophobic interaction chromatography); based on solubility (change in pH, change in ionic strength); based on specific binding sites (affinity chromatography) ,choice of methods, Criteria of purity of enzymes. Enzyme units - Katal, IU. Measurement of enzyme activity - discontinuous, continuous, coupled assays; stopped flow method and its applications. Isoenzymes and their separation by electrophoresis with special reference to LDH **(18 Hours)**

Unit III

Enzyme kinetics I: Thermodynamics of enzyme action, Activation energy, transition-state theory, steady-state kinetics & pre-steady-state kinetics.Single substrate enzyme catalyzed reactions -assumptions, Michaelis-Menten and Briggs-Haldane kinetics, derivation of Michaelis-Menten equation . Double reciprocal (Lineweaver-Burk) and single reciprocal (Eadie -Hofstee) linear plots, their advantages and limitations. Analysis of kinetic data- determination of Km, Vmax, kcat, and their physiological significance, Importance of kcat/Km. Enzyme inhibition: Irreversible inhibition. Reversible inhibition-Competitive, uncompetitive ,noncompetitive, mixed and substrate inhibition. Michaelis -Menten equation in the presence of competitive, uncompetitive and non-competitive inhibitors. Graphical analysis - Diagnostic plots for the determination of inhibition type. Therapeutic use of enzyme inhibitors-Aspirin, statins (irreversible inhibitors), Methotrexate (competitive inhibitor), Etoposide (non-competitive inhibitor), camptothecin (uncompetitive inhibitor).

Demonstration :Using Microsoft Excel to Plot and Analyze Kinetic Data **(18 Hours)**

Unit IV

Enzyme kinetics II: Allosteric enzymes: Cooperativity, MWC and KNF models of allosteric enzymes, Sigmoidal kinetics taking ATCase as an example. Regulation of amount and catalytic activity by - extracellular signal, transcription, stability of mRNA, rate of translation and degradation, compartmentation, pH, temperature, substrate concentration, allosteric effectors, covalent modification.Regulation of glycogen synthase and glycogen phosphorylase .Feedback inhibition-sequential, concerted, cumulative, enzyme-multiplicity with examples.

Bi - Substrate reactions: Single Displacement reactions (SDR) (Ordered and Random bi bi mechanisms), Double Displacement reactions (DDR) (Ping pong mechanism), Examples, Cleland's representation of bisubstrate reactions, Graphical analysis (diagnostic plots) to differentiate SDR from DDR**.** **(18 Hours)**

Unit V

Enzyme technology: Immobilization of enzymes – methods - Reversible immobilization (Adsorption, Affinity binding), Irreversible immobilization (Covalent coupling, Entrapment and Microencapsulation, Crosslinking, Advantages and Disadvantages of each method, Properties of immobilized enzymes,. Designer enzymes- ribozymes and deoxyribozymes, abzymes, synzymes. Enzymes as therapeutic agents-therapeutic use of asparaginase and streptokinase. Industrial application of enzymes -rennin, lipases, lactases, invertase, pectinases, papain. **(18 Hours)**

Textbooks

1. Palmer, T., & Bonner, P. (2007). *Enzymes: Biochemistry, biotechnology and clinical chemistry* (2nd ed.). New Delhi: Affiliated East-West Press Pvt. Ltd.
2. Price, N. C., & Stevens, L. (2003). *Fundamentals of enzymology* (3rd ed.). New York: Oxford University Press.

Reference Books

1. Voet, D., & Voet, J. G. (2011). *Voet's biochemistry* (Adapted ed.). India: Wiley.
2. Nelson, D. L., & Cox, M. M. (2021). *Lehninger principles of biochemistry* (8th ed.). New York: W.H. Freeman & Co.
3. Berg, J. M., Stryer, L., & Gatto, G. (2015). *Biochemistry* (8th ed.). New York: W.H. Freeman & Co.
4. Cook, P. F., & Cleland, W. W. (2007). *Enzyme kinetics and mechanism*. London: Garland Science.

Course Code **24PBCC33**	**PO1**		**PO2**	**PO3**		**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
	PSO 1a	**PSO 1b**	**PSO 2**	**PSO 3a**	**PSO 3b**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**
CO1	3	3	1	2	2	1	3	1	1	1
CO2	3	3	1	2	2	1	3	1	1	1
CO3	3	2	1	2	2	1	3	1	1	1
CO4	3	3	2	2	2	1	3	2	1	1
CO5	3	3	2	2	2	1	2	2	2	1

Strong (3) **Medium (2)** **Low** (1)

Dr.P.Annapoorani
Head of the Department

Dr.Sinthia Ganeshan
Course Designer

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M.Sc. Biochemistry

(2024-2025 onwards)

Semester III	**LABORATORY COURSE ON ENZYMOLOGY, MICROBIOLOGY AND CELL BIOLOGY**	Hours/Week: 6	
Core Course Practical -3		Credits: 4	
Course Code **24PBCC31P**		Internal 40	External 60

On successful completion of this course, students should be able to

CO1 : understand the techniques used in the isolation, purification and estimation of different biomolecules that are widely employed in research [K2]

CO2 : explain the Principle, Instrumentation and method of estimating the biomolecules and chromatographic techniques [K2]

CO3 : sketch the flowchart for the estimation of various biomolecules [K3]

CO4 : observe and calculate the results for the estimation and chromatographic separation of various macro and biomolecules and complete the record work.[K3]

CO5 : analyze the outcomes of the sample analysis using biochemical techniques. [K4]

Unit-I:

Enzymology

Alkaline Phosphatase

a. Isolation of Alkaline Phosphatase from goat kidney.
b. Purification of alkaline phosphatase
c. Checking the purity using SDS-PAGE
d. Determination of optimum pH and temperature of alkaline phosphatase.
e. Determination of specific activity and Km of alkaline phosphatase.
f. Effect of activators and inhibitors on the activity of alkaline phosphatase.

Assay of enzymes

a. Salivary Amylase
b. Acid Phosphatase

Unit-II:

Microbiology

a. Safety measures and Good Laboratory Practices in microbiology laboratory
b. Sterilization,Culture and inoculum preparation
c. Biochemical characterization
d. Staining of bacteria – Gram Staining

Unit-III:

Physiology & Cell Biology

a. Test for blood grouping (Haemagglutination), ELISA
b. Peripheral Blood smear –Staining and Interpretation

Unit-IV:

Group Experiments

a. Separation of proteins based on molecular weight by SDS PAGE
b. Agarose gel electrophoresis of genomic DNA

Unit-V:

Industrial visit can be organized to students through Academia –Industry collaborative Program

Reading List
(Print and Online)

1. https://www.researchgate.net/publication/337146254_Kinetic_studies_with_alkaline_phosphatase
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4846332/
3. https://www.ijsr.net/archive/v3i8/MDIwMTU0MDk=.pdf
4. https://www.researchgate.net/publication/349318898_ABC_of_ Periheral_smear
5. https://ncdc.gov.in/WriteReadData/l892s/File608.pdf
6. https://www.ncbi.nlm.nih.gov/books/NBK562156/

Self-Study

1. Preparation of Buffers and pH measurement
2. Michaelis-Menten equation and Lineweaver Burk plot

Books Recommended

1. Plummer, D. (2001). *An introduction to practical biochemistry* (3rd ed.). New Delhi: McGraw Hill Education (India) Pvt. Ltd.
2. Jayaraman, J. (2011). *Laboratory manual in biochemistry*. New Delhi: New Age Publishers.
3. Price, N. C., & Stevens, L. (2003). *Fundamentals of enzymology* (3rd ed.). Oxford: Oxford University Press.
4. Copeland, R. A. (2000). *Enzymes: A practical introduction to structure, mechanism, and data analysis*. Weinheim: Wiley-VCH.
5. Cappuccino, J. G., & Sherman, N. (2005). *Microbiology: A laboratory manual*. Boston: Pearson Education Inc.
6. Bisswanger, H. (2011). *Practical enzymology* (2nd rev. ed.). Oxford: Wiley-Blackwell.

Course Code 24PBCC31P	**PO1**		**PO2**	**PO3**		**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
	PSO 1a	**PSO 1b**	**PSO 2**	**PSO 3a**	**PSO 3b**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**
CO1	3	3	2	3	3	3	2	1	2	2
CO2	3	3	2	2	2	3	2	1	2	2
CO3	3	3	2	3	3	3	2	1	2	2
CO4	3	3	2	3	3	3	2	1	2	2
CO5	3	3	2	3	3	3	2	1	2	2

Strong (3) **Medium (2)** **Low** (1)

Dr.P.Annapoorani

Dr.P.Annapoorani

Head of the Department

Dr.R.Salini

Course Designers

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M.Sc. Biochemistry
(2024-2025 onwards)

Semester III	**BIOSTATISTICS AND DATA SCIENCE**	Hours/Week: 3	
Discipline Specific Elective Course – 3		Credits: 3	
Course Code **24PBCE31**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course the students will be able to

CO1. understand the basic concepts of data collection, sampling methods, data analysis and data science. [K2]

CO2: calculate the measures of central tendency, dispersion, students t test , ANOVA , Chi square test to analyse the significance of various research.[K3]

CO3: a p p l y effective statistical methods for data analysis and interpretation.[K3]

CO4: assess the general theory of data science and data analysis as they apply to confidence intervals, effect sizes and hypothesis testing. [K4]

CO5: explore advanced data science concepts including machine learning, deep learning, AI techniques, and predictive analytics for applications in biological studies [K4]

Unit I

Nature of biological and clinical experiments – Collection of data in experiment- Primary and secondary data. Methods of data collection. Classification and tabulation. Different forms of diagrams and graphs related to biological studies. Measures of Averages- Mean, Median, and mode. Use of these measures in biological studies. **(9 Hours)**

Unit II

Measures of Dispersion for biological characters – Quartile deviation, Mean deviation, Standard deviation and coefficient of variation. Measures of skewness and kurtosis. Correlation and regression – Rank correlation – Regression equation. Simple problems based on biochemical data. **(9 Hours)**

Unit III

Basic concepts of sampling- Simple random sample stratified sample and systemic sampling. Sampling distribution and standard error. Test of significance based on large samples. Test for mean, difference of means, proportions and equality of proportions. (**9 hours)**

Unit IV

Small sample tests – Students„t‟ test for mean, difference of two way means, tests for correlation and regression coefficients. Chi-square test for goodness of a non independence of attributes. F test for equality of variances. ANOVA- one way and two way. Basic concept related to biological studies. (**9 hours)**

Unit V

Introduction to Data Science, Definition of data science, importance, and basic applications, Machine Learning Algorithms, Deep Learning, Artificial Neural Networks and their Application, Reinforcement Learning, Natural Language Processing Artificial Intelligence (AI), Data Visualization, Data Analysis, Optimization Techniques, Big Data, Predictive Analysis. Application of AI in medical, health and pharma industries. **(9 hours)**

TEXT BOOKS

1. Satguru Prasad. (2018). *Elements of Biostatistics*,3rd edition, Rastogi Publications
2. Khan and Khanum. (1994). Fundamentals of Biostatistics,Ukaaz Publication.
3. Gupta, S. P. (2008). *Statistical methods* (36th ed.). New Delhi: Sultan Chand & Sons.
4. Kothari, R. C. (1993). *Research methodology* (5th ed.). New Delhi: Wiley Eastern Limited.

REFERENCE BOOKS

1. Zar, J. H. (1984). *Biostatistical methods*. Prentice Hall International.
2. Sundar Rao, P. S. S., Jesudian, G., & Richard, J. (1987). *An introduction to biostatistics* (2nd ed.). Vellore, India: Prestographik.
3. Warren, J., Gregory, E., & Grant, R. (2004). *Statistical methods in bioinformatics* (1st ed.). Springer.
4. Milton, J. S. (1992). *Statistical methods in the biological and health sciences* (2nd ed.). McGraw Hill.
5. Rosner, B. (2005). *Fundamentals of biostatistics*. Duxbury Press.
6. Cielen, D., Meysman, A. D. B., & Ali, M. (2016). *Introducing data science*. Manning Publications.

Course Code 24PBCE31	PO1		PO2	PO3		PO4	PO5	PO6	PO7	PO8
	PSO 1a	PSO 1b	PSO 2	PSO 3a	PSO 3b	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	2	2	2	2	1	2	3	2	2	2
CO 2	2	2	3	2	2	2	2	2	2	2
CO 3	3	1	3	2	2	2	2	2	2	2
CO 4	3	2	3	3	3	2	2	2	3	3
CO 5	1	3	2	2	1	2	2	2	2	1

Strong (3) Medium (2) Low (1)

Dr.P.Annapoorani
Head of the Department

Mrs.M.Sharmila devi
Course Designer

V.V.VANNIAPERUMAL COLLEGE FOR WOMEN
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VIRUDHUNAGAR
Quality Education with Wisdom and Values

M.Sc. Biochemistry
(2024-2025 onwards)

Semester III	**MOLECULAR BASIS OF DISEASES AND THERAPEUTIC STRATEGIES**	Hours/Week: 3	
Non Major Elective-2		Credits: 2	
Course Code **24PBCN31**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1 : recall the fundamental concepts of diabetes, cancer, neurodegenerative disorders, renal diseases and cardiovascular diseases including their pathophysiology, diagnosis and treatment. [K1]

CO2 : explain the molecular mechanisms, diagnostic techniques and treatment strategies for diabetes, cancer, neurodegenerative, renal, and cardiovascular diseases. [K2]

CO3 : describe the pathophysiology, complications and management approaches for diabetes, cancer, neurodegenerative, renal and cardiovascular diseases. [K2]

CO4 : apply diagnostic and therapeutic knowledge to assess and manage diabetes, cancer, neurodegenerative, renal and cardiovascular diseases. [K3]

CO5 : analyze the molecular and clinical aspects of diabetes, cancer, neurodegenerative, renal and cardiovascular diseases for effective diagnosis and treatment. [K4]

UNIT I

Mechanism of blood sugar regulation in human body: Pathophysiology of Type I and II diabetes, Diabetes – investigation methods for the diagnosis of diabetes. Nutritional care. Complications related to diabetes – Diabetic cardiovascular disease, retinopathy, neuropathy and nephropathy. Cellular and molecular mechanism of development of diabetes- Management of type I and Type II diabetes, drugs for the treatment of diabetes. **(9Hours)**

UNIT II

Biology of cancer: Overview of hallmarks of cancer. Tumorigenesis, Tumor progression and mechanism of Metastasis. Proto-oncogene to oncogene. Oncogene- myc and src family. Tumor suppressor gene-Rb and p53 pathway in cancer. Molecular techniques in cancer diagnosis. Treatment of cancer- surgery, radiotherapy, chemotherapy, hormonal treatment, and biological therapy. Introduction to personalized medicine. **(9 Hours)**

UNIT III

Brain- neuronal network- memory- Neurogenerative diseases- Parkinson and Alzheimer Disease- molecular understanding of the neurodegenerative diseases- treatment modalities. **(9 Hours)**

UNIT IV

Acute and chronic renal failure, glomerular diseases–glomerulonephritis, nephritic syndrome, diabetes insipidus, diagnosis of kidney disease.

(9 Hours)

UNIT V

Introduction to cardiovascular diseases, Lipids and lipoproteins in coronary heart disease-cardiac enzymes, Molecular changes during cardiac remodeling – hypertrophy of hearts – heart failure-treatment modalities. **(9 Hours)**

Reading List (Print and Online)

1. Barr, A. J. (2018). *The biochemical basis of disease*. Portland Press.
2. Biology Discussion. *Biochemical basis of diseases*. https://www.biologydiscussion.com/diseases-2/biochemical-basis-of-diseases/44276

Text Books

1. Thomas, H., & Gillham, B. (1989). *Wills' biochemical basis of medicine* (2nd ed.). Elsevier.
2. Feuer, G., & de la Iglesia, F. (2021). *Molecular biochemistry of human diseases*. CRC Press.

Reference Books

1. Harrison, T. R. (1994). *Principles of internal medicine* (13th ed.). McGraw-Hill Companies.
2. Sonntag, O., & Oswald, M. (2002). *Tietz fundamentals of clinical chemistry* (5th ed.). W.B. Saunders.

Course code (24PBCN31)	PO1		PO2	PO3		PO4	PO5	PO6	PO7	PO8
	1a	1b	2	3a	3b	4	5	6	7	8
CO 1	2	2	2	2	2	2	2	2	1	2
CO 2	2	2	2	2	2	2	3	2	2	2
CO 3	2	2	2	2	2	3	2	2	3	2
CO 4	2	2	2	2	2	2	2	2	2	2
CO 5	2	2	2	2	2	2	2	2	2	2

Strong (3) Medium (2) Low (1)

Dr.P.Annapoorani
Head of the Department

Dr.R.Salini
Course Designer

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M.Sc. BIOCHEMISTRY
(2024-2025 onwards)

Semester III	**PRACTICE FOR CSIR NET – GENERAL PAPER**	Hours/Week:-	
Self Study Course		Credits: 1	
24PGOL32		Internal 100	External -

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1 : explain various concepts related to numbers, quantitative comparison, monetary problems and logical reasoning. [K2]

CO2 : apply the analytical skills and logical reasoning in solving problems related to competitive examinations. [K3]

CO3 : solve typical problems, geometrical type problems, daily life problems in a effective manner. [K3]

CO4 : analyze the techniques used in solving complicated real life problems. [K4]

CO5 : examine the data using logical reasoning and observational ability. [K4]

UNIT I

Typical Problems- Series formation

Numerical Ability- Numbers

UNIT II

Geometrical Type Problems

Mensuration and quantitative comparison

UNIT III

Typical Problems- Moving locomotive problem

Numerical Ability- Distance and Directions

UNIT IV

Daily Life Problems

Finding the X – Average - Monetary problems

UNIT V

Logical Reasoning

Data interpretation – Observational ability – Logical puzzles

BOOKS FOR STUDY:

Christy Varghese (2016).,*CSR – NET, General aptitude –A new outlook,* Lilly publishing house, Changanacherry, Kerala

REFERENCE BOOKS

1. Pradip Kumar Ray, General Aptitude Theory ,CSIR NET, Previous question and answer with explanation and hint to solve, Notion Press, India
2. Ram Mohan Pandey (2021)., *CSIR-UGC-NET General Aptitude Theory and Practice*, Pathfinder Publication, a unit of Pathfinder Academy Pvt. Ltd., India.

Unit	Chapter	Section/Page Number
1	4	142-162
	5	163-192
2	12	272-294
3	3	132-141
	7	206-220
4	8	221-230
	9	231-239
	10	240-249
5	13	295-309
	14	310-323
	15	324-332

Course code 24PGOL32	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	-	2	-	-
CO2	3	3	3	3	-	2	-	-
CO3	3	3	3	3	-	3	-	-
CO4	3	2	3	3	-	3	-	-
CO5	3	2	3	3	-	3	-	-

Strong (3) **Medium (2)** **Low** (1)

Dr. M. C. Maheshwari
Head of the Department

Dr. T. Anitha
Course Designer

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M.Sc. Biochemistry
(2024-2025 onwards)

Semester III	**INTERNSHIP**	**Hours/Week: -**	
Part IV		**Credits: 2**	
Course Code 24PBCI31		**Internal 75**	**External 25**

COURSE OUTCOMES

On completion of the Internship students will be able to

CO1: relate their theoretical insights with hands-on experience. [K3]

CO2: demonstrate technical skills to their respective field of study. [K3]

CO3: apply the attributes such as observational skills, team spirit and inter personal skills built through site visits. [K3]

CO4: exhibit the written communication skills acquired through internship [K4]

CO5: analyze the observations and results and communicate their academic and technological knowledge appropriately oral means. [K5]

Guidelines/ Regulations:

- Each student must go for Internship training in a reputed Industry/Company/ Organization/ Educational Institution/ Clinical Laboratory/ Hospital.
- Students should produce the Completion Certificate after the Completion of Internship period.
- A report of 15 – 20 pages must be submitted by each student after the completion of the Internship period.
- External Viva-voce examination will be conducted.

Course code 24PBCI31	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	3	3	3	-	1
CO2	3	2	2	3	2	3	-	-
CO3	3	2	-	2	2	3	-	2
CO4	3	3	2	2	3	2	3	1
CO5	3	2	3	2	3	-	-	1

Strong (3) Medium (2) Low (1)

Dr.P.Annapoorani
Head of the Department

Dr. P. Annapoorani
Course Designer

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M.Sc. BIOCHEMISTRY
(2024-2025 onwards)

Semester III	**GENE EDITING ,CELL AND GENE THERAPY**	Hours/Week: -
Extra Credit Course		Credits: 2
Course Code **24PBCO31**		Internal 100

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1 : explain the principles of gene editing, gene and cell therapy, vectors for gene delivery, stem cell technology and regulatory aspects of gene therapy.

CO2 : describe the mechanisms of gene editing, therapeutic strategies in gene and cell therapy, types of gene delivery systems and the applications of stem cells in regenerative medicine.

CO3 : apply knowledge of gene editing tools, gene therapy approaches and stem cell technologies for disease treatment and tissue regeneration.

CO4 : utilize different vectors, delivery methods, and stem cell-based techniques in experimental gene therapies and regenerative medicine.

CO5 : analyze the ethical, safety, and technological challenges associated with gene editing, gene therapy, and pluripotent stem cell-based replacement therapies.

UNIT-I

Gene Editing: Basis of gene editing, DNA repair mechanisms, Double strand DNA breaks, Nonhomologous End-Joining (NHEJ), Homology directed repair, Programmable nucleases for gene editing, Meganucleases, Zinc-Finger nucleases, Transcription Activator-Like Effector Nucleases (TALEN), CRISPR-Cas systems, gene editing using CRISPR-Cas, drawbacks and major challenges to present gene editing techniques, gene editing for human disease therapy

UNIT –II

Gene and cell therapy: Basics of Gene and cell therapy, types of gene therapy, gene therapy strategies, therapeutic targets for gene therapy, choice of the therapeutic target, administration routes, delivery systems, expression of transgene, persistence of the gene therapy, cell targeting, immunological response to the therapy, ethical and legal issues, concerns about gene and cell therapy.

UNIT-III

Vectors for Gene therapy: Non-viral and viral vectors for gene therapy, Physical methods of gene delivery, Polymer, Lipid and inorganic material based chemical systems for gene delivery, Viral vectors, Lentiviral, Adenoviral, Adeno-associated virus, Herpes Simplex virus, vaccinia, baculoviral vectors for gene delivery, choice of viral vector and oncolytic virus. Gene therapy applications, Gene therapy for cancer, suicide and oncolytic gene therapy.

UNIT –IV

Stem cells and tissue regeneration: Adult and fetal stem cells, embryonic stem cells, cell reprogramming, induced pluripotent stem cells (iPSC), Chemically induced pluripotent stem cells (CiPSC), reprogramming factors, iPSC derived progenitors „cells, Organoids, three dimensional (3D) bioprinting.

UNIT-V

Regulatory and Ethical Considerations of stem cell and Gene Therapy, pluripotent stem cell- based cell replacement therapies. Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies. Technological challenges towards development of pluripotent stem cell-based cell replacement therapies.

Textbooks

1. Marshak, D. R., Gardner, R. L., & Gottlieb, D. (Eds.). (2002). *Stem cell biology*. Cold Spring Harbor Laboratory Press.
2. Booth, C. (1998). *Stem cell biology and gene therapy*. Academic Press.
3. Battler, A. (Ed.). (2006). *Stem cell and gene-based therapy: Frontiers in regenerative medicine*. Springer.

Reference Books

1. Pasternak, J. J. (2005). *An introduction to human molecular genetics* (2nd ed.). Wiley-Liss.
2. Kresina, T. F. (2001). *An introduction to molecular medicine and gene therapy* (1st ed.). Wiley-Liss.
3. Strachan, T., & Read, A. (2010). *Human molecular genetics* (4th ed.). Garland Science.
4. Sell, S. (Ed.). (2003). *Stem cells handbook*. Humana Press.

Course Code 24PBCO31	PO1		PO2	PO3		PO4	PO5	PO6	PO7	PO8
	PSO 1a	PSO 1b	PSO 2	PSO 3a	PSO 3b	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	2	3	3	3	3	3	3	3	3	3
CO 2	3	2	2	2	2	2	2	2	2	2
CO 3	2	2	2	2	2	3	2	3	3	2
CO 4	2	2	2	2	2	2	2	2	2	2
CO 5	2	2	2	1	1	1	1	2	3	3

Strong (3) Medium (2) Low (1)

Dr.P.Annapoorani
Head of the Department

Dr.R.Salini
Course Designer

V.V.VANNIAPERUMAL COLLEGE FOR WOMEN
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M.Sc. Biochemistry
(2024-2025 onwards)

Semester IV	**PHARMACEUTICAL BIOCHEMISTRY**	Hours/Week: 6	
Core Course - 8		Credits: 5	
Course Code **24PBCC41**		Internal 25	External 75

COURSE OUTCOMES

On successful completion of this course, students should be able to:

CO1 : explain the fundamental concepts of drug discovery, bioinformatics in drug development, drug metabolism, biochemical mechanisms of drug action and clinical trials. K2]

CO2 : apply computational and experimental techniques including molecular docking, pharmacokinetics, receptor binding assays and biochemical screening to identify and evaluate drug candidates.K3]

CO3 : utilize the knowledge of drug metabolism, receptor interactions, antibiotic mechanisms and chemotherapy strategies to assess drug efficacy, potency and resistance.[K3]

CO4 : analyze the biochemical and molecular mechanisms of drug action, pharmacological assays, toxicity prediction and resistance patterns to optimize drug development strategies. [K4]

CO5 : inference the integration of drug discovery, computational modeling, metabolism studies, clinical trials, and regulatory aspects in developing safe and effective therapeutics. [K4]

Unit I

Drug discovery and development, drug target identification and validation, Hit identification, General principles of screening, correlations between various animal models and human situations, Correlation between in-vitro and in-vivo screens; Special emphasis on cell-based assay, biochemical assay, radiological binding assay, Pharmacological assay, In vitro, In vivo & Ex-vivo experiments, lead optimization, preclinical studies

(18 Hours)

Unit II

Drug metabolism & interactions:Drug-receptor interactions, receptor theories and drug action, Xenobiotics, xenobiotics phases (Phase-I, Phase-II and Phase-III), role of cytochrome P450 oxidases and glutathione S-transferases in drug metabolism, factors affecting drug metabolism, Enzymes as a drug target, Kinase inhibitors, ATPase inhibitors, drug protein interaction, DrugDNA interaction. Basic ligand concepts-agonist, antagonist, partial agonist, inverse agonist, efficiency and potency. Forces involved in drug-receptor complexes. Receptor classification – the four super families. Receptor binding assays- measurement of Kd, Bmax and IC50. Drug intolerance and drug allergy.

(18 Hours)

Unit III

Clinical trials (Phase-I, Phase-II, Phase-III and Phase-IV clinical trial). Main features of clinical trials, including methodological and organizational considerations and the principles of trial conduct and reporting. Key designs surrounding design, sample size, delivery and assessment of clinical trials. **(18 Hours)**

Unit IV

Biochemical mode of action of antibiotics- penicillin and chloramphenicol, actions of alkaloids, antiviral and antimalarial substances. Biochemical mechanism of drug resistance-sulphonamides. Drug potency and drug efficacy. General principles of chemotherapy: chemotherapy of parasitic infections, fungal infections, viral diseases. Introduction to immunomodulators and chemotherapy of cancer. **(18 Hours)**

Unit V

Bioinformatics approaches for drug development:Identification of potential molecules, chemical compound library preparation, Identification of target in pathogen, Ligand & protein preparation, Molecular docking, Binding free energy estimation, High throughput virtual screening, Docking protocol validation and enrichment analysis, Single point energy calculation, Pharmacokinetics and Pharmacodynamics, ADME & toxicity prediction, Molecular dynamic simulation, Rule of three and five, Lipinsky rule, Pharmacophore development, Quantitative structure activity relationship, 3D-QSAR, Techniques of developing a pharmacophore map covering both ligand based and receptor based approaches.

(18 Hours)

Textbooks

1. Krogsgaard-Larsen, P., Liljefors, T., & Madsen, U. (Eds.). (2002). *Textbook of drug design*. Taylor & Francis.
2. Gad, S. C. (Ed.). (2005). *Drug discovery handbook*. Wiley-Interscience.

Reference Books

1. Charifson, P. (Ed.). (1997). *Practical application of computer-aided drug design*. Marcel Dekker Inc.
2. Kubinyi, H., & Ledien, A. (2011). *3D QSAR in drug design: Theory, methods, and applications*.
3. Borchardt, R. T., Kerns, E. H., Lipinski, C. A., Thakker, D. R., & Wang, B. (2004). *Pharmaceutical profiling in drug discovery for lead selection*. AAPS Press.
4. Rang, H. P. (2006). *Drug discovery and development: Technology in transition* (1st ed.). Elsevier Ltd.
5. Kenakin, T. P. (2012). *Pharmacology in drug discovery* (1st ed.). Elsevier.

Course Code **24PBCC41**	**PO1**		**PO2**	**PO3**		**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
	PSO 1a	**PSO 1b**	**PSO 2**	**PSO 3a**	**PSO 3b**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**
CO1	3	3	1	2	2	1	3	1	1	1
CO2	3	3	1	2	2	1	3	1	1	1
CO3	3	2	1	2	2	1	3	1	1	1
CO4	3	3	2	2	2	1	3	2	1	1
CO5	3	3	2	2	2	1	2	2	2	1

Strong (3) Medium (2) Low (1)

Dr.P.Annapoorani — **Head of the Department**

Dr.R.Salini — **Course Designer**

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M.Sc. Biochemistry

(2024-2025 onwards)

Semester IV	**BIOCHEMICAL TOXICOLOGY**	Hours/Week: 6	
Core Course - 9		Credits: 5	
Course Code **24PBCC42**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1: Understand the terms and basic principles of toxicology and dose- response relationships, mechanism of toxic effects of toxicants and factors affecting disposition of toxicants. [K2]

CO2: identify the mechanism of toxicity and clinical symptoms with underlying physiological disturbances and toxicological drug testing procedures based on in vitro and animal studies [K3]

CO3: apply pharmacokinetic and pharmacodynamics principles that impact administration, ADME, efficacy, potency, effectiveness and biological activity of drugs and toxins.[K3]

CO4: analyse the types of toxicology, toxicants, metals and its disposition, responses in target organ, non-organ directed toxicity. [K4]

CO5: examine the techniques and methods of toxicity and fate of toxicants in human beings [K4]

Unit-I

Fundamentals of Toxicology and dose-Response Relationships:

Introduction Biomarkers Criteria of Toxicity New Technologies Evaluation of Toxicity Interactions; Dose Response; Measurement of Dose-Response; Relationships Linear Dose Response Hormesis; Hazard and Risk Assessment Duration and Frequency of Exposure and Effects. **(18 Hours)**

Unit-II

Factors Affecting Toxic Responses: Disposition: Absorption ,Sites of absorption, distribution, Excretion; Metabolism: types of Metabolic change phase I reactions; Phase 2 reactions; control of Metabolism, Toxication vs. Detoxication. **(18 Hours)**

Unit-III

Toxicity testing; Test protocol, Genetic toxicity testing & Mutagenesis assay: In vitro test systems: bacterial mutation tests-Reversion test,Ames test, Fluctuation test, and Eukaryotic mutation test. In vivo test system Mammalian mutation test-Host mediated assay and Dominant Lethal test. Biochemical basis of toxicity: Mechanism of toxicity: Disturbance of excitable membrane function, Altered Calcium homeostasis, Covalent binding to cellular macromolecules & genotoxicity, Tissue specific toxicity **(18 Hours)**

Unit-IV

Toxic Responses to Foreign Compounds: Direct Toxic Action: Tissue Lesions; Mechanism and response in cellular toxicity, pharmacological, physiological and Biochemical effects; Developmental Toxicology- Teratogenesis; Immunotoxicity Genetic Toxicity; Chemical Carcinogenesis. **(18 Hours)**

Unit-V

Biochemical Mechanisms of Toxicity: Tissue Lesions: Liver Necrosis; kidney Damage; Lung Damage, Liver damage, Cardiac damage; Neurotoxicity; Exaggerated and Unwanted pharmacological effects; Physiological effects; Biochemical Effects: Lethal Synthesis and Incorporation, Interaction with specific Protein Receptors; Teratogenesis; Immunotoxicity; multi-Organ Toxicity. **(18 Hours)**

Reading List (Print and Online)

1. Preclinical Safety Evaluation of Biopharmaceuticals: A Science-Based Approach to Facilitating Clinical Trials by Joy A. Cavagnaro

2. A Comprehensive Guide to Toxicology in Nonclinical Drug Development 2nd Edition by Ali S. Faqi

Text Books

1. Stine, K. E., & Brown, T. M. (2006). *Principles of toxicology* (2nd ed.). CRC Press.
2. Timbrell, J. A. (2008). *Principles of biochemical toxicology*. CRC Press.
3. Zakrzewski, S. F. (2002). *Environmental toxicology*. Oxford University Press, USA.
4. Klaassen, C. D. (Ed.). (1992). *Casarett & Doull's toxicology: The basic science of poisons* (8th ed.). McGraw-Hill.
5. Hodgson, E. (2004). *A textbook of modern toxicology* (3rd ed.). John Wiley & Sons, Inc.

Reference Books

1. Marrs, T. C., & Turner, P. (1995). *General and applied toxicology*. Macmillan Press Ltd.
2. Williams, R. T. (1947). *Detoxification mechanisms*. J. Wiley & Sons.
3. Albert, A. (1979). *Selective toxicity*. Springer.

Course Code 24PBCC42	**PO1**		**PO2**	**PO3**		**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
	PSO 1.a	**PSO 1.b**	**PSO 2**	**PSO 3.a**	**PSO 3.b**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**
CO 1	3	3	2	2	3	2	2	2	3	2
CO 2	3	2	2	2	3	2	2	2	2	3
CO 3	2	2	3	3	2	2	2	2	2	2
CO 4	2	3	2	2	2	2	2	2	1	2
CO 5	2	3	2	2	2	2	1	2	2	2

Strong (3) **Medium (2)** **Low (1)**

Dr.P.Annapoorani
Head of the Department

Mrs.M.Rajakumari
Course Designer

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M.Sc. Biochemistry

(2024-2025 onwards)

Semester IV	**PROJECT**	Hours/Week: 6	
Core Course - 10		Credits: 5	
Course Code **24PBCC43PR**		Internal 40	External 60

Course Outcomes
On successful completion of this course, students should be able to:

CO1: discover the inter disciplinary knowledge to carry out project the work for the welfare of the society [K2]

CO2: Make use of literature review through existing digital platform to formulate the project work.[K3]

CO3: demonstrate proficiency in conducting literature reviews, gathering relevant data, and synthesizing information from multiple sources to inform their project. [K3]

CO4 : Develop an insight into the experiments carried out during the project work and conclude the findings with the existing results. [K4]

CO5 : analyse their own work and the work of others, identifying strengths, limitations, and areas for improvement [K5]

Project Specialisation Areas

- ✓ Clinical Biochemistry
- ✓ Molecular Biology
- ✓ Pharmacology
- ✓ Nanotechnology
- ✓ Microbiology
- ✓ Plant Biochemistry

- ✓ Marine Biology
- ✓ Environmental Biochemistry
- ✓ Nutritional Biochemistry
- ✓ Bioinformatics and Computational Biology
- ✓ Immunology
- ✓ Structural Biology
- ✓ Chemical Biology

Project Guidelines

● Project will be done by the final year students in the fourth semester under the guidance of respective guides.

● For projects internal marks will be awarded by the respective guide and external marks will be awarded in the external examinations held at the end of the semester.

● Only individual projects should be allotted.

● The report of the project must be in the prescribed form. It should be typed neatly in MS word (12 pt, Times New Roman, 1.5 spacing)

● The format of the project report should have the following components.

- ❖ First page should contain:
  Title of the project report
  Name of the candidate
  Register number
  Name of the supervisor
  Address of the institution
  Month & year of submission
- ❖ Contents
- ❖ Certificate by supervisor
- ❖ Declaration by candidate
- ❖ Acknowledgement
- ❖ Chapters
- ❖ References

- The project report should be written in 30 - 40 pages.
- Three copies of the project report with binding should be submitted.

Course Code 24PBCC43PR	PO1		PO2	PO3		PO4	PO5	PO6	PO7	PO8
	PSO 1a	PSO 1b	PSO 2	PSO 3a	PSO 3b	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	3	3	3	2	2	2	3	3	3
CO 2	3	2	3	2	3	3	3	2	2	2
CO 3	3	3	3	3	3	3	3	2	2	2
CO 4	3	2	2	3	3	3	3	3	3	3
CO 5	3	3	3	3	2	2	3	3	3	3

Strong (3) Medium (2) Low (1)

Dr.P.Annapoorani
Head of the Department

Dr.P.Annapoorani
Dr.R.Renuka
Course Designers

V.V.VANNIAPERUMAL COLLEGE FOR WOMEN
(Belonging to Virudhunagar Hindu Nadars)
An Autonomous Institution Affiliated to Madurai Kamaraj University, Madurai
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VIRUDHUNAGAR
Quality Education with Wisdom and Values

M.Sc. Biochemistry
(2024-2025 onwards)

Semester IV	**BIOSAFETY, LAB SAFETY AND IPR**	Hours/Week: 6	
Elective Course		Credits: 3	
Course Code **24PBCE41**		Internal 25	External 75

On successful completion of this course, students should be able to:

CO1: understand the biosafety, bioethics and Intellectual Property Rights concepts [K2]

CO2: illustrate about biosafety, laboratory safety and bioethics related to molecular technologies, GMOs IPR and patent filing [K3]

CO3: apply the concept of biosafety guidelines, bioethics, patenting and process of filing for a patent for the welfare of the environment and beneficial to the human beings [K3]

CO4: analyze biosafety, laboratory safety guidelines, regulatory compliances, patent and bioethics for the benefit of humankind [K4]

CO5: assess the importance of biosafety practices and guidelines, IPR, bioethics in research and development [K4]

Unit I

Biosafety: Historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; recommended biosafety levels for infectious agents and infected animals; biosafety guidelines - government of India, roles of IBSC, RCGM, GEAC etc. for GMO applications in food and agriculture; environmental release of GMOs; risk assessment; risk management and communication; national regulations and international agreements. **(18 Hours)**

Unit II

Laboratory safety - Chemical, electrical and fire hazards; handling and manipulating human or animal cells and tissues, toxic, corrosive or mutagenic solvents and reagents; mouth pipetting, and inhalation exposures to infectious aerosols, Safe handling of syringe needles or other contaminated sharps, spills and splashes onto skin and mucous membranes. Health aspects; toxicology, allergenicity, antibiotic resistance.

History of biosafety microbiology and molecular biology, Risk assessment, Personal protective equipment, Laboratory facilities and safety equipment, Disinfection, decontamination, and sterilization, Regulatory compliance, Laboratory security and emergency response and administrative controls. **(18 Hours)**

Unit III

Intellectual Property Rights (IPR): Introduction to patents, types of patents, process involved in patenting in India, trademarks, copyright, industrial design, trade secrets, traditional knowledge, geographical indications, history of national and international treaties and conventions on patents, WTO, GATT, WIPO, Budapest Treaty, Patent Cooperation Treaty (PCT) and TRIPS. Patent databases: Searching international databases; analysis and report formation. Indian Patent Act 1970; recent amendments; filing of a patent application; precautions before patenting disclosure/non-disclosure; procedure for filing a PCT application. The patentability of microorganisms-claims, Characterization and repeatability disposition in the culture collections, legal protection for plants and other higher organisms, new plant varieties by rights, tissue culture protocols. **(18 Hours)**

Unit IV

Patent filing and infringement: Patent application- forms and guidelines, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and convention patent applications, International patenting-requirement, financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US. Research Patenting: Patenting by researchers and scientists-University/organizational rules in India and abroad. Detailed information on patenting biological products, Case studies on patents (basmati rice, turmeric, neem etc.), and patent infringement. **(18 Hours)**

Unit V

Bioethics:Introduction to bioethics, human genome project and its ethical issues, genetic manipulations and their ethical issues, ethical issues in GMOs, foods and crops in developed and developing countries, environmental release of GMOs, ethical issues involved in stem cell research and use, use of animals in research experiments, animal cloning, human cloning and their ethical aspects, testing of drugs on human volunteers. (18 Hours)

Text Books

1. Shree Krishna, V. (2007). *Bioethics and biosafety in biotechnology*. New Age International Pvt. Ltd. Publishers.
2. Goel, D., & Parashar, S. (2013). *IPR, biosafety and bioethics*. Pearson Education.
3. Freshney, R. I. (2016). *Culture of animal cells: A manual of basic technique and specialized applications* (6th ed.). John Wiley & Sons.
4. Universal Law Publishing Co. Pvt. Ltd. (2007). *Indian Patent Act 1970: Acts & Rules (Bare Act)*.(3rd ed.). John Wiley & Sons, Inc.

Reference Books

1. Centers for Disease Control and Prevention (CDC). (2020). *Biosafety in microbiological and biomedical laboratories* (6th ed.). https://www.cdc.gov/labs/pdf/SF19_308133-A_BMBL6_00-BOOK-WEB-final3.pdf
2. Kankanala, C. (2007). *Genetic patent law & strategy* (1st ed.). Manupatra Information Solutions Pvt. Ltd.

Course Code 24PBCE41	PO1		PO2	PO3		PO4	PO5	PO6	PO7	PO8
	PSO 1a	PSO 1b	PSO 2	PSO 3a	PSO 3b	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	3	2	2	1	1	1	1	1	2
CO 2	3	3	2	2	1	1	1	1	2	2
CO 3	3	3	3	3	2	3	3	2	2	3
CO 4	3	3	3	3	2	3	3	2	1	3
CO 5	3	3	3	3	2	3	3	2	1	3

Strong (3) Medium (2) Low (1)

Dr.P.Annapoorani
Head of the Department

Dr.R.Salini
Course Designer

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M.Sc. Biochemistry

(2024-2025 onwards)

Semester IV	**PREPARATION FOR COMPETITIVE EXAMINATIONS - LIFE SCIENCES**	Hours/Week: 6	
Skill enhancement course - Professional Competency Skill -2		Credits: 3	
Course Code **24PBCS41**		Internal 25	External 75

Course Outcomes

On successful completion of this course, students should be able to

CO1 : Recall the Basic Biological Concepts including biochemistry, inheritance biology, plant physiology, genetics, ecology, evolution and diversity life forms.[K1]

CO2: summarize the advanced topics such as biochemistry, inheritance biology, plant physiology genetics, ecology, evolution and diversity life forms. [K2]

CO3: Explain the concepts from multiple life sciences disciplines and interdisciplinary approaches to address complex biological questions and challenges.[K2]

CO4 : Interpret ecological principles and population dynamics, assess community interactions and biodiversity, and evaluate conservation strategies with examples from Indian ecosystems. [K3]

CO5 : Categorize life science concepts and develop expertise in a specific area of life sciences [K4]

Unit-I:

Microscopic techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy. Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT .

Immunology - Innate and adaptive immune system- Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activationand differentiation of B and T cells, B and T cell receptors, humoral and cell- mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines. **(18 Hours)**

Unit-II:

Inheritance biology : Mendelian principles : Dominance, segregation, independent assortment.Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests. Extensions of Mendelian principles : Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance : Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics : Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. Human genetics : Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics : Polygenic inheritance, heritability and its measurements, QTL mapping. Mutation : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes : Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination : Homologous and non-homologous recombination including transposition. (**18 Hours)**

Unit-III:

Ecological principles: The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamentaland realized niche; resource partitioning; character displacement. **Population** Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax. Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

(**18 Hours)**

Unit-IV:

Evolution and behaviour : Emergence of evolutionary thoughts-Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis. Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers andpolymers; Concept of Oparin and Haldane; Experiement of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.Molecular Evolution:Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular

tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence. The Mechanisms: Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in genefrequency through natural selection, migration and random genetic drift; Adaptive radiation;Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; **(18 Hours)**

Unit-V:

Diversity of life forms: Principles & methods of taxonomy- Concepts of species and hierarchical taxa, biological nomenclature, classical & quantititative methods of taxonomy of plants, animals and microorganisms. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs& systems.Outline classification of plants, animals & microorganisms: Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa. Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species. Comman Indian mammals, birds. Seasonality and phenology of the subcontinent.Organisms of health & agricultural importance: Common parasites and pathogens of humans, domestic animals and crops. Organisms of conservation concern: Rare, endangered species. Conservation strategies.

System physiology – plant : Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO2 fixation-C3, C4 and CAM pathways. Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway. Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis. Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. **(18 Hours)**

Text Books

1. Nelson, D. L., Cox, M. M. (2017). *Lehninger principles of biochemistry* (7th ed.). W.H. Freeman and Sapling Learning. ISBN: 978-1-4641-2611-6.
2. Prescott, L. M. (2011). *Prescott's microbiology* (8th ed.). McGraw Hill Education. ISBN-13: 978-0071313674.

3. Jayaraman, J. (2011). *Laboratory manual in biochemistry*. New Age Publishers.
4. Griffith, A. F., Doebley, J., Peichel, C., David, A., Wassarman, D. A. (2020). *An introduction to genetic analysis* (12th ed.). W.H. Freeman & Co.
5. Devlin, R. M. (1983). *Plant physiology* (4th ed.). PWS Publishers.
6. Punt, J., Stranford, S., Jones, P., & Owen, J. (2018). *Kuby immunology* (8th ed.). W.H. Freeman.
7. Sharma, P., & Bali, N. P. (2018). *Trueman's UGC CSIR-NET life sciences* (1st ed.). Danika Publishing Company.

Reference Books

1. Taiz, L., & Zeiger, E. (2010). *Plant physiology* (5th ed.). Sinauer Associates, Inc.
2. Gilbert, S. F. (2006). *Developmental biology* (8th ed.). Sinauer Associates, Inc.
3. Voet, D., & Voet, J. G. (2010). *Biochemistry* (4th ed.). John Wiley & Sons, Inc.
4. Metzler, D. E. (2003). *The chemical reactions of living cells* (2nd ed.). Academic Press.
5. Zubay, G. L. (1999). *Biochemistry* (4th ed.). McGraw-Hill.
6. Stryer, L. (2010). *Biochemistry* (7th ed.). W.H. Freeman.
7. Futuyma, D. (2022). *Evolution* (5th ed.). Oxford University Press.
8. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). *Roitt's essential immunology* (13th ed.). Wiley-Blackwell.

Course Code 24PBCS41	PO1		PO2	PO3		PO4	PO5	PO6	PO7	PO8
	PSO 1a	PSO 1b	PSO 2	PSO 3a	PSO 3b	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
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CO2	3	3	3	3	3	3	3	2	2	2
CO3	3	3	3	3	3	3	3	2	2	2
CO4	3	3	3	3	3	3	3	2	2	2
CO5	3	3	3	3	3	3	3	2	2	2

Strong (3) Medium (2) Low (1)

Dr.P.Annapoorani — **Head of the Department**

Mrs.M.Sharmila devi — **Course Designer**