File Ref.No.279980/GA - IV - J1/2021/Admn

**UNIVERSITY OF CALICUT**

**Abstract**

General & Academic IV - Faculty of Science - Scheme and Syllabus of BSc Biochemistry Honours Programme-in tune with the CUFYUGP Regulations 2024, with effect from 2024 Admission onwards - Approved-Subject to ratification by the Academic Council-Implemented- Orders Issued

**G & A - IV - J**

U.O.No. 9578/2024/Admn Dated, Calicut University.P.O, 19.06.2024

*Read:*-1. U.O.No. 3103/2024/Admn dated 22/02/2024.

2. Minutes of the meeting of the Board of Studies in Biochemistry (single board) held on 14/03/2024.
3. Remarks of the Dean, Faculty of Science dated 14/06/2024.
4. Orders of the Vice Chancellor in the file of even No and dated 15/06/2024.

**ORDER**

1. The Regulations of the Calicut University Four Year UG Programmes (CUFYUGP Regulations 2024) for Affiliated Colleges, have been implemented with effect from 2024 admission onwards, vide paper read as (1).
2. The Board of Studies in Biochemistry (single board) in the meeting held on 14/03/2024, vide paper read as (2), has approved the Scheme and Syllabus of BSc Biochemistry Honours Programme in tune with CUFYUGP Regulations 2024 with effect from 2024 admission.
3. The Dean, Faculty of Science vide paper read as (3), has approved the minutes of the meeting of Board of Studies in Biochemistry (single board) held on 14/03/2024.
4. Considering the urgency, the Vice Chancellor has approved the minutes of the meeting of Biochemistry (single board) held on 14/03/2024 and accorded sanction to implement the Scheme and Syllabus of BSc Biochemistry Honours Programme in tune with CUFYUGP Regulations 2024 with effect from 2024 admissions, subject to ratification by the Academic Council.
5. The Scheme and Syllabus of BSc Biochemistry Honours Programme in tune with CUFYUGP Regulations 2024, is thus implemented with effect from 2024 admission, subject to ratification by the Academic Council.

Orders are issued accordingly. ( Syllabus appended )

Ajayakumar T.K

Assistant Registrar

To

Principals of all Affiliated Colleges

Copy to: Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE II/JCE IV/DoA/EX and EG Sections/GA I F/CHMK Library/SUVEGA/SF/DF/FC

Forwarded / By Order

Section Officer

**UNIVERSITY OF CALICUT**

# B.Sc. BIOCHEMISTRY HONOURS
# (MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

## SCHEME & SYLLABUS
**w.e.f. 2024 admission onwards**

**(CUFYUGP Regulations 2024)**

**B.Sc. BIOCHEMISTRY HONOURS**
**(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)**

## SCHEME

**PROGRAMME OUTCOMES (PO):** At the end of the graduate programme at Calicut University, a student would:

| | | |
|---|---|---|
| PO1 | Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study. | |
| PO2 | Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity | |
| PO3 | Demonstrate professional skills to navigate diverse career paths with confidence and adaptability. | |
| PO4 | Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information. | |
| PO5 | Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions. | |
| PO6 | Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well- being of society and the environment. | |
| PO7 | Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development. | |

**PROGRAMME SPECIFIC OUTCOMES (PSO):** At the end of the BSc Biochemistry Honours programme at Calicut University, a student would:

| | | |
|---|---|---|
| PSO1 | Demonstrate the core concepts in Biochemistry and thereby get expertise in modern biology | |
| PSO2 | Get instilled with basic qualities of scientific thinking and questioning through exercises that inculcate critical thinking and problem solving capabilities and can open up venues for innovative outcomes | |
| PSO3 | Get inculcated with interdisciplinary approaches, collaborative learning and developing interpersonal skills with effective communication and presentation skills | |
| PSO4 | Be competent and confident for various research, industry as well as academic careers in the field of biochemistry through the professional skills acquired through the programme | |
| PSO5 | Face the global arena and become desirable human resources in the field of academia and industry. | |

| | | |
|---|---|---|
| PSO6 | Get sensitized of their social responsibility and become skilful problem solvers to assist the society during various societal challenges such as pandemic/ disaster management, etc. and also be able to provide sustainable solutions to social and environmental problems | |

**MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS IN THE THREE-YEAR PROGRAMME IN CUFYUGP**

| Sl. No. | Academic Pathway | Major | Minor/ Other Disciplines | Foundation Courses AEC: 4 MDC: 3 SEC: 3 VAC: 3 | Intern -ship | Total Credits | Example |
|---|---|---|---|---|---|---|---|
| | | Each course has 4 credits | | Each course has 3 credits | | | |
| 1 | Single Major (A) | 68 (17 courses) | 24 (6 courses) | 39 (13 courses) | 2 | 133 | Major: Biochemistry+ six courses in different disciplines in different combinations |
| 2 | Major (A) with Multiple Disciplines (B, C) | 68 (17 courses) | 12 + 12 (3 + 3 = 6 courses) | 39 (13 courses) | 2 | 133 | 1-Major: Biochemistry+ Chemistry and Nutrition Or Chemistry and Microbiology |
| 3 | Major (A) with Minor (B) | 68 (17 courses) | 24 (6 courses) | 39 (13 courses) | 2 | 133 | Major: Biochemistry Minor: Chemistry or Nutrition or Microbiology |
| | | | | | | | |
| 4 | Double Major (A, B) | A: 48 (12 courses) B: 44 (11 courses) | - The 24 credits in the Minor stream are distributed between the two Majors. 2 MDC, 2 SEC, 2 VAC and the Internship should be in Major A. Total credits in Major A should be 48 + 20 = 68 (50% of 133) | 12 + 18 + 9 | 2 | 133 | Biochemistry and Chemistry or Microbiology double major |

| | | | | | |
|---|---|---|---|---|---|
| | | | 1 MDC, 1 SEC and 1 VAC should be in Major B. Total credits in Major B should be 44 + 9 = 53 (40% of 133) | | |
| Exit with UG Degree / Proceed to Fourth Year with 133 Credits | | | | | |

**B.Sc. BIOCHEMISTRY HONOURS PROGRAMME**

**COURSE STRUCTURE FOR PATHWAYS 1 – 3**

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor

| Semester | Course Code | Course Title | Total Hours | Hours/ Week | Credits | Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Internal | External | Total |
| 1 | BCH1CJ101/BCH1MN100 | Core Course 1 in Major- Introduction to Biochemistry | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Minor Course 1 | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | | Minor Course 2 | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | ENG1FA101(2) | Ability Enhancement Course 1– English | 60 | 4 | 3 | 25 | 50 | 75 |
| | | Ability Enhancement Course 2 – Additional Language | 45 | 3 | 3 | 25 | 50 | 75 |
| | | Multi-Disciplinary Course 1 – Other than Major | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23/ 25** | **21** | | | **525** |
| 2 | BCH2CJ101/BCH2MN100 | Core Course 2 in Major – Cell biology | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Minor Course 3 | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | | Minor Course 4 | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | ENG2FA103(2) | Ability Enhancement Course 3– English | 60 | 4 | 3 | 25 | 50 | 75 |
| | | Ability Enhancement Course 4 – Additional Language | 45 | 3 | 3 | 25 | 50 | 75 |
| | | Multi-Disciplinary Course 2 – Other than Major | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23/ 25** | **21** | | | **525** |
| 3 | BCH3CJ201/BCH3MN200 | Core Course 3 in Major – Biomolecules I | 75 | 5 | 4 | 30 | 70 | 100 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BCH3CJ 202 | Core Course 4 in Major – Biomolecules II | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Minor Course 5 | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | | Minor Course 6 | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | | Multi-Disciplinary Course 3 – Kerala Knowledge System | 45 | 3 | 3 | 25 | 50 | 75 |
| | ENG3FV 108(2) | Value-Added Course 1 – English | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23/ 25** | **22** | | | **550** |
| 4 | BCH4CJ2 01 | Core Course 5 in Major – Techniques in Biochemistry | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH4CJ2 02 | Core Course 6 in Major – Enzymology | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH4CJ2 03 | Core Course 7 in Major – Intermediary Metabolism I | 75 | 5 | 4 | 30 | 70 | 100 |
| | ENG4FV 109(2) | Value-Added Course 2 – English | 45 | 3 | 3 | 25 | 50 | 75 |
| | | Value-Added Course 3 – Additional Language | 45 | 3 | 3 | 25 | 50 | 75 |
| | ENG4FS 111(2) | Skill Enhancement Course 1 – English | 60 | 4 | 3 | 25 | 50 | 75 |
| | | **Total** | | **25** | **21** | | | **525** |
| 5 | BCH5CJ 301 | Core Course 8 in Major – Molecular Biology | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH5CJ 302 | Core Course 9 in Major – Immunology | 60 | 4 | 4 | 30 | 70 | 100 |
| | BCH5CJ 303 | Core Course 10 in Major – Intermediary Metabolism II | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Elective Course 1 in Major | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 2 in Major | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Skill Enhancement Course 2 | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **25** | **23** | | | **575** |
| 6 | BCH6CJ 301 | Core Course 11 in Major – Human Physiology | 75 | 5 | 4 | 30 | 70 | 100 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BCH6CJ 302/BCH8 MN300 | Core Course 12 in Major– Intermediary Metabolism III | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH6CJ 303/BCH8 MN301 | Core Course 13 in Major – Clinical Biochemistry | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Elective Course 3 in Major | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 4 in Major | 60 | 4 | 4 | 30 | 70 | 100 |
| | BCH6FS 113-1 | Skill Enhancement Course 3 – Biosafety and biohazards | 45 | 3 | 3 | 25 | 50 | 75 |
| | BCH6CJ 349 | Internship in Major (Credit for internship to be awarded only at the end of Semester 6) | 60 | | 2 | 50 | - | 50 |
| | | **Total** | | **25** | **25** | | | **625** |
| **Total Credits for Three Years** | | | | | **133** | | | **3325** |
| 7 | BCH7CJ 401 | Core Course 14 in Major – Genetic engineering | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH7CJ 402 | Core Course 15 in Major – Enzymes: kinetics mechanisms and regulation | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH7CJ 403 | Core Course 16 in Major – Microbial Biochemistry | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH7CJ 404 | Core Course 17 in Major – Research Methodology | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH7CJ 405 | Core Course 18 in Major – Biochemical Toxicology | 75 | 5 | 4 | 30 | 70 | 100 |
| | | **Total** | | **25** | **20** | | | **500** |
| 8 | BCH8CJ 401/BCH 8MN400 | Core Course 19 in Major – Bioinformatics | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH8CJ 402/BCH 8MN401 | Core Course 20 in Major – Nutritional Aspects of Biochemistry | 60 | 4 | 4 | 30 | 70 | 100 |
| | BCH8CJ 403/BCH 8MN402 | Core Course 21 in Major – Cancer Biology | 60 | 4 | 4 | 30 | 70 | 100 |
| | OR (instead of Core Courses 19 – 21 in Major) | | | | | | | |
| | BCH8CJ 449 | Project (in Honours programme) | 360* | 13* | 12 | 90 | 210 | 300 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BCH8CJ 499 | Project (in Honours with Research programme) | 360* | 13* | 12 | 90 | 210 | 300 |
| | | | | | | | | |
| | | Elective Course 5 in Major / Minor Course 7 | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 6 in Major / Minor Course 8 | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 7 in Major / Minor Course 9 / Major Course in any Other Discipline | 60 | 4 | 4 | 30 | 70 | 100 |
| | OR (instead of Elective Course 7 in Major, in the case of Honours with Research Programme) | | | | | | | |
| | BCH8CJ 489 | Endocrinology | 60 | 4 | 4 | 30 | 70 | 100 |
| | | **Total** | | **25** | **24** | | | **600** |
| **Total Credits for Four Years** | | | | | **177** | | | **4425** |

* The teacher should have 13 hrs/week of engagement (the hours corresponding to the three core courses) in the guidance of the Project(s) in Honours programme and Honours with Research programme, while each student should have 24 hrs/week of engagement in the Project work. Total hours are given based on the student's engagement.

## CREDIT DISTRIBUTION FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

| **Semester** | **Major Courses** | **Minor Courses** | **General Foundation Courses** | **Internship/ Project** | **Total** |
|---|---|---|---|---|---|
| 1 | 4 | 4 + 4 | 3 + 3 + 3 | - | 21 |
| 2 | 4 | 4 + 4 | 3 + 3 + 3 | - | 21 |
| 3 | 4 + 4 | 4 + 4 | 3 + 3 | - | 22 |
| 4 | 4 + 4 + 4 | - | 3 + 3 + 3 | - | 21 |
| 5 | 4 + 4 + 4 + 4 + 4 | - | 3 | - | 23 |
| 6 | 4 + 4 + 4 + 4 + 4 | - | 3 | 2 | 25 |
| **Total for Three Years** | **68** | **24** | **39** | **2** | **133** |
| 7 | 4 + 4 + 4 + 4 + 4 | - | - | - | 20 |
| 8 | 4 + 4 + 4 | 4 + 4 + 4 | - | 12* | 24 |
| * Instead of three Major courses | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Total for Four Years** | **88 + 12 = 100** | **36** | **39** | **2** | **177** |

**DISTRIBUTION OF MAJOR COURSES IN BIOCHEMISTRY**
**FOR PATHWAYS 1 – 3**

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor

| Semester | Course Code | Course Title | Hours/ Week | Credits |
|---|---|---|---|---|
| 1 | BCH1CJ 101/BCH1 MN100 | Core Course 1 in Major – Introduction to Biochemistry | 5 | 4 |
| 2 | BCH2CJ 101 | Core Course 2 in Major – Cell Biology | 5 | 4 |
| 3 | BCH3CJ 201/BCH3 MN200 | Core Course 3 in Major – Biomolecules- I | 4 | 4 |
| | BCH3CJ 202 | Core Course 4 in Major – Biomolecules- II | 5 | 4 |
| 4 | BCH41CJ 201 | Core Course 5 in Major – Techniques in Biochemistry | 5 | 4 |
| | BCH4CJ 202 | Core Course 6 in Major – Enzymology | 5 | 4 |
| | BCH4CJ 203 | Core Course 7 in Major – Intermediary metabolism- I | 5 | 4 |
| 5 | BCH5CJ 301 | Core Course 8 in Major – Molecular Biology | 5 | 4 |
| | BCH5CJ 302 | Core Course 9 in Major – Immunology | 5 | 4 |
| | BCH5CJ 303 | Core Course 10 in Major – Intermediary Metabolism II | 5 | 4 |
| | | Elective Course 1 in Major | 4 | 4 |
| | | Elective Course 2 in Major | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| **6** | BCH6CJ 301 | Core Course 11 in Major – Human Physiology | 5 | 4 |
| | BCH6CJ 302/BCH8 MN300 | Core Course 12 in Major – Intermediary Metabolism- III | 5 | 4 |
| | BCH6CJ 303/BCH8 MN301 | Core Course 13 in Major – Clinical Biochemistry | 4 | 4 |
| | | Elective Course 3 in Major | 4 | 4 |
| | | Elective Course 4 in Major | 4 | 4 |
| | BCH6CJ 349 | Internship in Major | - | 2 |
| **Total for the Three Years** | | | | **70** |
| **7** | BCH7CJ 401 | Core Course 14 in Major – Genetic Engineering | 4 | 4 |
| | BCH7CJ 402 | Core Course 15 in Major – Enzymes: kinetics mechanisms and regulation | 5 | 4 |
| | BCH7CJ 403 | Core Course 16 in Major – Microbial Biochemistry | 5 | 4 |
| | BCH7CJ 404 | Core Course 17 in Major – Research methodology | 4 | 4 |
| | BCH7CJ 405 | Core Course 18 in Major – Biochemical Toxicology | 4 | 4 |
| **8** | BCH8CJ 401/BCH 8MN400 | Core Course 19 in Major – Bioinformatics | 5 | 4 |
| | BCH8CJ 402/BCH 8MN401 | Core Course 20 in Major – – Nutritional Aspects of Biochemistry | 4 | 4 |
| | BCH8CJ 403/BCH 8MN402 | Core Course 21 in Major - Cancer Biology | 4 | 4 |
| | OR (instead of Core Courses 19 – 21 in Major) | | | |
| | BCH8CJ 449 | Project (in Honours programme) | 13 | 12 |
| | BCH8CJ 499 | Project (in Honors with Research programme) | 13 | 12 |
| | | | | |
| | | Elective Course 5 in Major | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| | | Elective Course 6 in Major | 4 | 4 |
| | | Elective Course 7 in Major | 4 | 4 |
| | OR (instead of Elective course 7 in Major, in Honors with Research programme) | | | |
| | BCH8CJ 489 | Endocrinology | 4 | 4 |
| **Total for the Four Years** | | | | **114** |

**GROUPING OF MINOR COURSES IN Biochemistry**

The minor courses given below should not be offered to who have taken Biochemistry as major discipline, they should be offered to students from other major disciplines only**.**

| Group No. | Sl. No. | Course Code | Title | Semester | Total Hrs | Hrs/ Week | Credits | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Internal | External | Total |
| **1** | | General Biochemistry- (preferable for Aquaculture and Microbiology students) | | | | | | | | |
| | 1 | BCH1MN 101 | BIOCHEMISTRY | 1 | 75 | 5 | 4 | 30 | 70 | 100 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | BCH2MN 101 | Life molecules | 2 | 75 | 5 | 4 | 30 | 70 | 100 |
| | 3 | BCH3MN 200 | Enzymology and Metabolism | 3 | 75 | 5 | 4 | 30 | 70 | 100 |

**List of Foundation Courses**

| Semester | Course Code | Course Title | Hours/ Week | Credits |
|---|---|---|---|---|
| **1** | BCH1FM105 | MDC-Food Biochemistry and Quality control | 4 | 3 |
| **2** | BCH2FM206 | MDC- Biochemistry of Lifestyle Disorders | 3 | 3 |
| **3** | BCH3FV108 | VAC- Biochemical tests for Food Adulteration | 5 | 3 |
| **4** | BCH4FV110 | VAC- Sports nutrition | 4 | 3 |
| **5** | BCH5FS112-1 | SEC- Phytochemical Analysis | 5 | 3 |
| | BCH5FS112-2 | SEC- Fish Biochemistry | 4 | 3 |
| **6** | BCH6FS113-1 | SEC- Biosafety and Biohazards | 4 | 3 |
| | BCH6FS113-2 | SEC- Sports Science & Lifestyle Disorders | 4 | 3 |

**List of Elective Courses**

| Semester | Course Code | Course Title | Hours/ Week | Credits |
|---|---|---|---|---|
| 5 | BCH5EJ301 | DSC Elective- Physical Aspects of Biochemistry | 4 | 4 |
| | BCH5EJ302 | DSC Elective-Plant Secondary Metabolites | 4 | 4 |
| | BCH5EJ303 | DSC Elective-Neurobiochemistry | 4 | 4 |
| | BCH5EJ304 | DSC Elective- Oxidative stress and Antioxidants | 4 | 4 |
| 6 | BCH6EJ301 | DSC Elective-Nano biology | 4 | 4 |
| | BCH6EJ302 | DSC Elective- Animal Developmental Biology | 4 | 4 |
| | BCH6EJ303 | DSC Elective-Analytical Biochemistry | 4 | 4 |
| | BCH6EJ304 | DSC Elective- Food Analysis | 4 | 4 |
| 8 | | | | |
| | BCH8EJ401 | DSC Elective-Genetics | 4 | 4 |
| | BCH8EJ402 | DSC Elective- Environmental Biochemistry | 4 | 4 |
| | BCH8EJ403 | DSC Elective- Environmental Studies | 4 | 4 |
| | BCH8EJ404 | DSC Elective- Intellectual Property Rights | 4 | 4 |
| | BCH8EJ405 | DSC Elective- Biostatistics | 4 | 4 |
| | BCH8EJ406 | DSC Elective- Metabolic and Non-Communicable disorders | 5 | 4 |

**COURSE STRUCTURE FOR BATCH A1(B2)**
**IN PATHWAY 5: DOUBLE MAJOR**

***A1: 68 credits in Biochemistry (Major A)*** ***B1: 68 credits in Major B***

***A2: 53 credits in Biochemistry (Major A)*** ***B2: 53 credits in Major B***

***The combinations available to the students: (A1 & B2), (B1 & A2)***

*Note: Unless the batch is specified, the course is for all the students of the class*

| Semester | Course Code | Course Title | Total Hours | Hours/ Week | Credits | Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Internal | External | Total |
| 1 | BCH1CJ101/BCH1MN100 | Core Course 1 in Major Biochemistry- Introduction to Biochemistry | 75 | 5 | 4 | 30 | 70 | 100 |
| | BBB1CJ101 | Core Course 1 in Major B – | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BCH4CJ201/BCH1CJ102 | Core Course 2 in Major Biochemistry – – Techniques in Biochemistry (for batch A1 only) | 75 | 5 | 4 | 30 | 70 | 100 |
| | ENG1FA101(2) | Ability Enhancement Course 1 – English | 60 | 4 | 3 | 25 | 50 | 75 |
| | | Ability Enhancement Course 2 – Additional Language | 45 | 3 | 3 | 25 | 50 | 75 |
| | BCH1FM105 | Multi-Disciplinary Course 1 in Biochemistry – Food Biochemistry and Quality control (for batch A1 only) | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **24/ 25** | **21** | | | **525** |
| 2 | BCH2CJ101/BCH2MN100 | Core Course 3 in Major Biochemistry – Cell Biology | 75 | 5 | 4 | 30 | 70 | 100 |
| | BBB2CJ101 | Core Course 2 in Major B – | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BBB2CJ102 / BBB1CJ102 | Core Course 3 in Major B – (for batch B2 only) | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | ENG2FA103(2) | Ability Enhancement Course 3 – English | 60 | 4 | 3 | 25 | 50 | 75 |
| | | Ability Enhancement Course 4 – Additional Language | 45 | 3 | 3 | 25 | 50 | 75 |
| | BCH2FM206 | Multi-Disciplinary Course 2 in Biochemistry – Biochemistry of Life style Disorders | 45 | 3 | 3 | 25 | 50 | 75 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Total** | | **23 – 25** | **21** | | | **525** |
| 3 | BCH3CJ 201/BCH3 MN200 | Core Course 4 in Major Biochemistry – Biomolecules I | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH3CJ 202 | Core Course 5 in Major Biochemistry – Biomolecules -II | 75 | 5 | 4 | 30 | 70 | 100 |
| | BBB3CJ 201 | Core Course 4 in Major B | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BBB3CJ 202 | Core Course 5 in Major B | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BBB3FM 106 / BBB2FM 106 | Multi-Disciplinary Course 1 in B – | 45 | 3 | 3 | 25 | 50 | 75 |
| | BCH3FV 108 | Value-Added Course 1 in Biochemistry – Biochemical tests for Food Adulteration (for batch A1 only) | 75 | 5 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23 – 25** | **22** | | | **550** |
| 4 | BCH4CJ 202/BCH4 MN201 | Core Course 6 in Major Biochemistry – Enzymology | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Core Course 6 in Major B | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BCH4CJ 203 | Core Course 7 in Major Biochemistry – – Intermediary Metabolism I (for batch A1 only) | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH4FV 110 | Value-Added Course 2 in Biochemistry - Sports nutrition | 45 | 3 | 3 | 25 | 50 | 75 |
| | BBB4FV 110 | Value-Added Course 1 in B – | 45 | 3 | 3 | 25 | 50 | 75 |
| | BCH5FS 112-1 | Skill Enhancement Course 1 in Biochemistry – Phytochemical Analysis | 75 | 5 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23/ 24** | **21** | | | **525** |
| 5 | BCH5CJ 301 | Core Course 8 in Major Biochemistry – Molecular Biology | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Core Course 7 in Major B – | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BCH5CJ 303 | Core Course 9 in Major Biochemistry – Intermediary Metabolism II – (for batch A1 only) | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Elective Course 1 in Major Biochemistry | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 1 in Major B | 60 | 4 | 4 | 30 | 70 | 100 |
| | BBB5FS 112 / BBB4FS 112 | Skill Enhancement Course 1 in B | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **24/ 25** | **23** | | | **575** |
| 6 | BCH6CJ 302/BCH8 MN300 | Core Course 10 in Major Biochemistry – Intermediary Metabolism -III | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Core Course 8 in Major B – | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BBB6CJ 305 | Core Course 9 in Major B – (for batch B2 only) | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 2 in Major Biochemistry | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 2 in Major B | 60 | 4 | 4 | 30 | 70 | 100 |
| | BCH6FS 113-1 | Skill Enhancement Course 2 in Biochemistry – Biosafety and Biohazards (for batch A1 only) | 45 | 3 | 3 | 25 | 50 | 75 |
| | BCH6CJ 349 | Internship in Major Biochemistry (Credit for internship to be awarded only at the end of Semester 6) | 60 | | 2 | 50 | - | 50 |
| | | **Total** | | **24/ 25** | **25** | | | **625** |
| **Total Credits for Three Years** | | | | | **133** | | | **3325** |

For batch A1(B2), the course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6.

* The course code of the same course as used for the pathways 1 – 4

**CREDIT DISTRIBUTION FOR BATCH A1(B2)**

**IN PATHWAY 5: DOUBLE MAJOR**

| Semester | Major Courses in Biochemistry | General Foundation Courses in Biochemistry | Internship/ Project in Biochemistry | Major Courses in B | General Foundation Courses in B | AEC | Total |
|---|---|---|---|---|---|---|---|
| 1 | 4 + 4 | 3 | - | 4 | - | 3 + 3 | 21 |
| 2 | 4 | 3 | - | 4 + 4 | - | 3 + 3 | 21 |
| 3 | 4 + 4 | 3 | - | 4 + 4 | 3 | - | 22 |
| 4 | 4 + 4 | 3 + 3 | - | 4 | 3 | - | 21 |
| 5 | 4 + 4 + 4 | - | - | 4 + 4 | 3 | - | 23 |
| 6 | 4 + 4 | 3 | 2 | 4 + 4 + 4 | - | - | 25 |
| **Total for Three Years** | **48** | **18** | **2** | **44** | **9** | **12** | **133** |
| | **68** | | | **53** | | **12** | **133** |
| | | | | | | | |
| | Major Courses in Biochemistry | Minor Courses | | | | | |
| 7 | 4 + 4 + 4 + 4 + 4 | - | | | - | - | 20 |
| 8 | 4 + 4 + 4 | 4 + 4 + 4 | 12* | | - | - | 24 |
| * Instead of three Major courses | | | | | | | |
| **Total for Four Years** | **88 + 12 = 100** | **12** | | | | | **177** |

**COURSE STRUCTURE FOR BATCH B1(A2)**
**IN PATHWAY 5: DOUBLE MAJOR**

***A1: 68 credits in Biochemistry (Major A)*** ***B1: 68 credits in Major B***

***A2: 53 credits in Biochemistry (Major A)*** ***B2: 53 credits in Major B***

***The combinations available to the students: (A1 & B2), (B1 & A2)***

*Note: Unless the batch is specified, the course is for all the students of the class*

| **Semester** | **Course Code** | **Course Title** | **Total Hours** | **Hours/ Week** | **Credits** | **Marks** | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | **Internal** | **External** | **Total** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | BCH1CJ 101/BCH1 MN100 | Core Course 1 in Major Biochemistry – - Introduction to Biochemistry | 75 | 5 | 4 | 30 | 70 | 100 |
| | BBB1CJ 101 | Core Course 1 in Major B – | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BBB1CJ 102 / BBB2CJ 102 | Core Course 2 in Major B – (for batch B1 only) | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | ENG1FA 101(2) | Ability Enhancement Course 1 – English | 60 | 4 | 3 | 25 | 50 | 75 |
| | | Ability Enhancement Course 2 – Additional Language | 45 | 3 | 3 | 25 | 50 | 75 |
| | BBB1FM 105 | Multi-Disciplinary Course 1 in B – (for batch B1 only) | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23 – 25** | **21** | | | **525** |
| 2 | BCH3CJ 201/BCH3 MN200/B CH2CJ 101 | Core Course 2 in Major Biochemistry –Biomolecules – I | 75 | 5 | 4 | 30 | 70 | 100 |
| | BBB2CJ 101 | Core Course 3 in Major B – | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BCH3CJ 202/BCH2 CJ102 | Core Course 3 in Major Biochemistry – Biomolecules II (for batch A2 only) | 75 | 5 | 4 | 30 | 70 | 100 |
| | ENG2FA 103(2) | Ability Enhancement Course 3 – English | 60 | 4 | 3 | 25 | 50 | 75 |
| | | Ability Enhancement Course 4 – Additional Language | 45 | 3 | 3 | 25 | 50 | 75 |
| | BCH2FM 206 | Multi-Disciplinary Course 1 in Biochemistry – – Biochemistry of Life style Disorders | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **24/ 25** | **21** | | | **525** |
| 3 | BCH4CJ 202/BCH3 CJ201 | Core Course 4 in Major Biochemistry – Enzymology | 75 | 5 | 4 | 30 | 70 | 100 |
| | BCH4CJ 203/BCH3 CJ202 | Core Course 5 in Major Biochemistry – Intermediary Metabolism I | 75 | 5 | 4 | 30 | 70 | 100 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BBB3CJ 201 | Core Course 4 in Major B | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BBB3CJ 202 | Core Course 5 in Major B | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BBB3FM 106 / BBB2FM 106 | Multi-Disciplinary Course 2 in B – | 45 | 3 | 3 | 25 | 50 | 75 |
| | BBB3FV 108 | Value-Added Course 1 in B – (for batch B1 only) | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23 – 25** | **22** | | | **550** |
| 4 | BCH4CJ 201 | Core Course 6 in Major Biochemistry – Techniques in Biochemistry | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Core Course 6 in Major B | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | | Core Course 7 in Major B – (for batch B1 only) | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BCH4FV 110 | Value-Added Course 1 in Biochemistry – Sports nutrition | 45 | 3 | 3 | 25 | 50 | 75 |
| | BBB4FV 110 | Value-Added Course 2 in B – | 45 | 3 | 3 | 25 | 50 | 75 |
| | BCH5FS 112-1 | Skill Enhancement Course 1 in Biochemistry – Phytochemical Analysis | 45 | 4 | 3 | 25 | 50 | 75 |
| | | **Total** | | **22 – 24** | **21** | | | **525** |
| 5 | BCH5CJ 303 | Core Course 7 in Major Biochemistry – Intermediary Metabolism II | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Core Course 8 in Major B – | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | | Core Course 9 in Major B – (for batch B1 only) | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 1 in Major Biochemistry | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 1 in Major B | 60 | 4 | 4 | 30 | 70 | 100 |
| | BBB5FS 112 / BBB4FS 112 | Skill Enhancement Course 1 in B | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **24/ 25** | **23** | | | **575** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | BCH6CJ 302/BCH8 MN300 | Core Course 8 in Major Biochemistry – Intermediary Metabolism III | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Core Course 10 in Major B – | 60/ 75 | 4/ 5 | 4 | 30 | 70 | 100 |
| | BCH6CJ 303/BCH8 MN301 | Core Course 9 in Major Biochemistry – Clinical Biochemistry (for batch A2 only) | 75 | 5 | 4 | 30 | 70 | 100 |
| | | Elective Course 2 in Major Biochemistry | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 2 in Major B | 60 | 4 | 4 | 30 | 70 | 100 |
| | BBB6FS 113 | Skill Enhancement Course 2 in B – (for batch B1 only) | 45 | 3 | 3 | 25 | 50 | 75 |
| | BBB6CJ 349 | Internship in Major B (Credit for internship to be awarded only at the end of Semester 6) | 60 | | 2 | 50 | - | 50 |
| | | **Total** | | **24/ 25** | **25** | | | **625** |
| **Total Credits for Three Years** | | | | | **133** | | | **3325** |

To continue to study Biochemistry in semesters 7 and 8, batch B1(A2) needs to earn additional 15 credits in Biochemistry to make the total credits of 68. Suppose this condition is achieved, and the student of batch B1(A2) proceeds to the next semesters to study Biochemistry. The course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6, taking into account the number of courses in Biochemistry taken online to earn the additional 15 credits.

* The course code of the same course as used for the pathways 1 – 4

**CREDIT DISTRIBUTION FOR BATCH B1(A2)**
**IN PATHWAY 5: DOUBLE MAJOR**

| Semester | Major Courses in B | General Foundation Courses in B | Internship/ Project in B | Major Courses in Biochemistry | General Foundation Courses in Biochemistry | AEC | Total |
|---|---|---|---|---|---|---|---|
| 1 | 4 + 4 | 3 | - | 4 | - | 3 + 3 | 21 |
| 2 | 4 | - | - | 4 + 4 | 3 | 3 + 3 | 21 |
| 3 | 4 + 4 | 3 + 3 | - | 4 + 4 | - | - | 22 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | 4 + 4 | 3 | - | 4 | 3 + 3 | - | 21 |
| 5 | 4 + 4 + 4 | 3 | - | 4 + 4 | - | - | 23 |
| 6 | 4 + 4 | 3 | 2 | 4 + 4 + 4 | - | - | 25 |
| **Total for Three Years** | **48** | **18** | **2** | **44** | **9** | **12** | **133** |
| | **68** | | | **53** | | **12** | **133** |
| | | | | | | | |
| | Major Courses in B | Minor Courses | | | | | |
| 7 | 4 + 4 + 4 + 4 + 4 | - | | | - | - | 20 |
| 8 | 4 + 4 + 4 | 4 + 4 + 4 | 12* | | - | - | 24 |
| * Instead of three Major courses | | | | | | | |
| **Total for Four Years** | **88 + 12 = 100** | **12** | | | | | **177** |

## EVALUATION SCHEME

1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.
2. The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.
    - In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
    - In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth

module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.

**3.** All the 3-credit courses (General Foundational Courses) in Biochemistry are with only theory component. Out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.

| Sl. No. | Nature of the Course | | Internal Evaluation in Marks (about 30% of the total) | | External Exam on 4 modules (Marks) | Total Marks |
|---|---|---|---|---|---|---|
| | | | Open-ended module / Practical | On the other 4 modules | | |
| 1 | 4-credit course | only theory (5 modules) | 10 | 20 | 70 | 100 |
| 2 | 4-credit course | Theory (4 modules) + Practical | 20 | 10 | 70 | 100 |
| 3 | 3-credit course | only theory (5 modules) | 5 | 20 | 50 | 75 |

## 1. MAJOR AND MINOR COURSES

### 1.1. INTERNAL EVALUATION OF THEORY COMPONENT

| Sl. No. | Components of Internal Evaluation of Theory Part of a Major / Minor Course | Internal Marks for the Theory Part of a Major / Minor Course of 4-credits | | | |
|---|---|---|---|---|---|
| | | Theory Only | | Theory + Practical | |
| | | 4 Theory Modules | Open-ended Module | 4 Theory Modules | Practical |
| 1 | Test paper/ Mid-semester Exam | 10 | 4 | 5 | - |
| 2 | Seminar/ Viva/ Quiz | 6 | 4 | 3 | - |
| 3 | Assignment | 4 | 2 | 2 | - |
| | | 20 | 10 | 10 | 20* |
| | Total | 30 | | 30 | |

* Refer the table in section 1.2 for the evaluation of practical component

## 1.2. EVALUATION OF PRACTICAL COMPONENT

The evaluation of practical component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practical by the teacher-in-charge shall carry a weightage of 50%.
- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.
- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.
- Those who passed in continuous evaluation alone will be permitted to appear for the end-semester examination and viva-voce.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be as given below:

| Sl. No. | Evaluation of Practical Component of Credit-1 in a Major / Minor Course | Marks for Practical | Weightage |
|---|---|---|---|
| 1 | Continuous evaluation of practical/ exercise performed in practical classes by the students | 10 | 50% |
| 2 | End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council | 7 | 35% |
| 3 | Evaluation of the Practical records submitted for the end semester viva–voce examination by the teacher-in-charge and additional examiner | 3 | 15% |
| | Total Marks | 20 | |

## 1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

**PATTERN OF QUESTION PAPER FOR MAJOR AND MINOR COURSES**

| Duration | Type | Total No. of Questions | No. of Questions to be Answered | Marks for Each Question | Ceiling of Marks |
|---|---|---|---|---|---|
| 2 Hours | Short Answer | 10 | 8 – 10 | 3 | 24 |
| | Paragraph/ Problem | 8 | 6 – 8 | 6 | 36 |
| | Essay | 2 | 1 | 10 | 10 |
| | | | | Total Marks | 70 |

## 2. INTERNSHIP

- All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.
- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

## 2.1. GUIDELINES FOR INTERNSHIP

1. Internship can be in Biochemistry or allied disciplines.
2. There should be minimum 60 hrs. of engagement from the student in the Internship.
3. Summer vacations and other holidays can be used for completing the Internship.
4. In BSc. Biochemistry Honours programme, institute/ industry visit or study tour is a requirement for the completion of Internship. Visit to minimum one national research institute, research laboratory and place of scientific importance should be part of the study tour. A brief report of the study tour has to be submitted with photos and analysis.
5. The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough

work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.

6. The log book and the typed report must be submitted at the end of the Internship.
7. The institution at which the Internship will be carried out should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honors programme.

## 2.2. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honors programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.
- The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

| Sl. No. | Components of Evaluation of Internship | | Marks for Internship 2 Credits | Weightage |
|---|---|---|---|---|
| 1 | Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by the Department Council | Acquisition of skill set | 10 | 40% |
| 2 | | Interim Presentation and Viva-voce | 5 | |
| 3 | | Punctuality and Log Book | 5 | |
| 4 | Report of Institute Visit/ Study Tour | | 5 | 10% |
| 5 | End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council | Quality of the work | 6 | 35% |
| 6 | | Presentation of the work | 5 | |
| 7 | | Viva-voce | 6 | |
| 8 | Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva–voce examination before the committee internally constituted by the Department Council | | 8 | 15% |
| | Total Marks | | 50 | |

## 3. PROJECT

### 3.1. PROJECT IN HONOURS PROGRAMME

- In Honors programme, the student has the option to do a Project of 12-credits instead of three Core Courses in Major in semester 8.
- The Project can be done in the same institution/ any other higher educational institution (HEI)/ research centre/ training centre.
- The Project in Honors programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

### 3.2. PROJECT IN HONORS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) is allowed for those belonging to SC/ ST/ OBC (non-creamy layer)/ Differently-Abled/ Economically Weaker Section (EWS)/ other categories of candidates as per the decision of the UGC from time to time.
- In Honors with Research programme, the student has to do a mandatory Research Project of 12-credits instead of three Core Courses in Major in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty members with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximum five students in Honours with Research stream.

- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research, and infrastructural facilities available.
- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

### 3.3. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME AND HONOURS WITH RESEARCH PROGRAMME

1. Project can be in Biochemistry or allied disciplines.
2. Project should be done individually.
3. Project work can be of experimental/ theoretical/ computational in nature.
4. There should be minimum 360 hrs. of engagement from the student in the Project work in Honors programme as well as in Honors with Research programme.
5. There should be minimum 13 hrs./week of engagement (the hours corresponding to the three core courses in Major in semester 8) from the teacher in the guidance of the Project(s) in Honors programme and Honors with Research programme.
6. The various steps in project works are the following:
    - Wide review of a topic.
    - Investigation on a problem in systematic way using appropriate techniques.
    - Systematic recording of the work.
    - Reporting the results with interpretation in a standard documented form.
    - Presenting the results before the examiners.
7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.

9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honors programme.

### 3.4. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honors programme as well as that in Honors with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honors programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the University.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

| Components of Evaluation of Project | Marks for the Project (Honours/ Honours with Research) | Weightage |
|---|---|---|
| Continuous evaluation of project work through interim presentations and reports by the committee internally constituted by the Department Council | 90 | 30% |
| End-semester viva-voce examination to be conducted by the external examiner appointed by the university | 150 | 50% |

| | | |
|---|---|---|
| Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce examination conducted by the external examiner | 60 | 20% |
| Total Marks | 300 | |

**INTERNAL EVALUATION OF PROJECT**

| Sl. No | Components of Evaluation of Project | Marks for the Project (Honours/ Honours with Research) |
|---|---|---|
| 1 | Skill in doing project work | 30 |
| 2 | Interim Presentation and Viva-Voce | 20 |
| 3 | Punctuality and Log book | 20 |
| 4 | Scheme/ Organization of Project Report | 20 |
| | Total Marks | 90 |

**EXTERNAL EVALUATION OF PROJECT**

| Sl. No | Components of Evaluation of Project | Marks for the Project (Honours/ Honours with Research) 12 credits |
|---|---|---|
| 1 | Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research | 50 |
| 2 | Presentation of the Project | 50 |
| 3 | Project Report (typed copy), Log Book and References | 60 |
| 4 | Viva-Voce | 50 |
| | Total Marks | 210 |

## 4. GENERAL FOUNDATION COURSES

- All the General Foundation Courses (3-credits) in Biochemistry are with only theory component.

### 4.1. INTERNAL EVALUATION

| Sl. No. | Components of Internal Evaluation of a General Foundation Course in Biochemistry | Internal Marks of a General Foundation Course of 3-credits in Biochemistry | |
|---|---|---|---|
| | | 4 Theory Modules | Open-ended Module |
| 1 | Test paper/ Mid-semester Exam | 10 | 2 |

| | | | |
|---|---|---|---|
| 2 | Seminar/ Viva/ Quiz | 6 | 2 |
| 3 | Assignment | 4 | 1 |
| | | 20 | 5 |
| | Total | 25 | |

### 4.2. EXTERNAL EVALUATION

External evaluation carries about 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

**PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES**

| Duration | Type | Total No. of Questions | No. of Questions to be Answered | Marks for Each Question | Ceiling of Marks |
|---|---|---|---|---|---|
| 1.5 Hours | Short Answer | 10 | 8 – 10 | 2 | 16 |
| | Paragraph/ Problem | 5 | 4 – 5 | 6 | 24 |
| | Essay | 2 | 1 | 10 | 10 |
| | | | | Total Marks | 50 |

## 5. LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester.
- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.
- Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

**LETTER GRADES AND GRADE POINTS**

| Sl. No. | Percentage of Marks (Internal & External Put Together) | Description | Letter Grade | Grade Point | Range of Grade Points | Class |
|---|---|---|---|---|---|---|
| 1 | 95% and above | Outstanding | O | 10 | 9.50 – 10 | |
| 2 | Above 85% and below 95% | Excellent | A+ | 9 | 8.50 – 9. 49 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 75% to below 85% | Very Good | A | 8 | 7.50 – 8.49 | First Class with Distinction |
| 4 | 65% to below 75% | Good | B+ | 7 | 6.50 – 7.49 | First Class |
| 5 | 55% to below 65% | Above Average | B | 6 | 5.50 – 6.49 | |
| 6 | 45% to below 55% | Average | C | 5 | 4.50 – 5.49 | Second Class |
| 7 | 35% to below 45% aggregate (internal and external put together) with a minimum of 30% in external valuation | Pass | P | 4 | 3.50 – 4.49 | Third Class |
| 8 | Below an aggregate of 35% or below 30% in external evaluation | Fail | F | 0 | 0 – 3.49 | Fail |
| 9 | Not attending the examination | Absent | Ab | 0 | 0 | Fail |

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.
- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree Honors or UG Degree Honors with Research, as the case may be.

### 5.1. COMPUTATION OF SGPA AND CGPA

- The following method shall be used to compute the Semester Grade Point Average (SGPA):

  The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

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

  where Ci is the number of credits of the $i^{th}$ course and Gi is the grade point scored by the student in the $i^{th}$ course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

$$\text{SGPA} = \frac{\text{Sum of the credit points of all the courses in a semester}}{\text{Total credits in that semester}}$$

**ILLUSTRATION – COMPUTATION OF SGPA**

| **Semester** | **Course** | **Credit** | **Letter Grade** | **Grade point** | **Credit Point** (Credit x Grade) |
|---|---|---|---|---|---|
| I | Course 1 | 3 | A | 8 | 3 x 8 = 24 |
| I | Course 2 | 4 | B+ | 7 | 4 x 7 = 28 |
| I | Course 3 | 3 | B | 6 | 3 x 6 = 18 |
| I | Course 4 | 3 | O | 10 | 3 x 10 = 30 |
| I | Course 5 | 3 | C | 5 | 3 x 5 = 15 |
| I | Course 6 | 4 | B | 6 | 4 x 6 = 24 |
| | Total | 20 | | | 139 |
| | SGPA | | | | 139/20 = 6.950 |

- The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.

  CGPA for the three-year programme in CUFYUGP shall be calculated by the following formula.

$$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in six semesters}}{\text{Total credits in six semesters (133)}}$$

  CGPA for the four-year programme in CUFYUGP shall be calculated by the following formula.

$$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in eight semesters}}{\text{Total credits in eight semesters (177)}}$$

- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the University shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

**SYLLABUS**

## SEMESTER I

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | INTRODUCTION TO BIOCHEMISTRY | | | | |
| Type of Course | DSC /Major / Minor | | | | |
| Semester | I | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course provides an in-depth understanding of the methods and tools used in science, covering types of knowledge, the definition of science, experimentation principles, scientific instruments, and examples of significant experiments in biochemistry. It also delves into the molecular logic of life, cellular foundations of biochemistry, chemical and physical foundations, and practical applications, including the origin of biomolecules, cell structure and function, molecular organization, and the role of energy in metabolism. Practical sessions complement theoretical learning, enabling hands-on experience with scientific concepts and techniques. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Recognize the basic characteristics of science | U | C | Instructor-created exams / Quiz |
| CO2 | Get familiarized with the methods and tools of science and the design of scientific experiments | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Recognize the molecular logic of life and identify Biochemistry as a discipline | U | C | Seminar Presentation / Group Tutorial Work |

| | | | | |
|---|---|---|---|---|
| CO4 | Highlight the cellular, chemical and physical foundations of Biochemistry. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Identify the genetic and evolutionary foundations of Biochemistry | U | C | One Minute Reflection Writing assignments |
| CO6 | Explain the biochemical reactions that lead to the origin of life on earth. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Methods and Tools in Science** | | |
| | 1 | Types of Knowledge: Practical, theoretical and scientific knowledge | 1 |
| | 2 | Definition of Science and non-science, pseudo-science, laws of science, basis of scientific laws and factual truths. | 2 |
| | 3 | Revolutions in science with special focus on the field of biochemistry. Hypotheses. | 2 |
| | 4 | Theories and laws in science-observations, evidence and proof. Posing a question; formulation of hypothesis; hypothetico-deductive model and inductive model | 1 |
| II | **Experimentation in Science** | | |
| | 5 | Design of an experiment; experimentation; observation, data collection; interpretation and deduction. Necessity of units and dimensions; repeatability and replication. | 3 |
| | 6 | Scientific instruments: choice and selection of *instruments*, sensitivity of instruments, accuracy, precision and errors, Types of instrumentation, historical development and evolution of scientific instruments. | 3 |
| | 7 | Examples of great experiments in science to illustrate how various tools were applied to answer a question [Mendel's studies of genetic traits in pea plants, | 2 |
| | 8 | Thomas Hunt Morgan's work with fruit flies, Griffith's Experiment about Genetics-DNA as genetic material, Meselson-Stahl experiment etc- outline only] | 2 |
| III | **The molecular logic of life and Cellular foundations of Biochemistry** | | |
| | 9 | Origin of biomolecules, distinguishing features of living organisms. Definition of Biochemistry and how it explores the molecular logic of life. | 2 |

| | | | |
|---|---|---|---|
| | 10 | History of Biochemistry, Contribution of various scientists to the development of Biochemistry, their discoveries and classical experiments. | 1 |
| | 11 | Nature and scope of Biochemistry. | 1 |
| | 12 | Cell as the structural and functional unit of living organisms | 1 |
| | 13 | The universal features of living cells, prokaryotes and eukaryotes, classification of organisms according to how they obtain the energy and carbon they need for synthesizing cellular material | 4 |
| | 14 | The organic compounds from which most cellular materials are constructed | 1 |
| | 15 | Supramolecular complexes | 1 |
| | 16 | Bonds common in biomolecules and their strengths. | 1 |
| | 17 | Structural hierarchy in the molecular organization of cells. | 2 |
| **IV** | **Chemical and Physical foundations of Biochemistry** | | |
| | 18 | Bonding versatility of carbon, formation of different functional groups. | 2 |
| | 19 | Role of functional groups in defining the biological and chemical personalities of biomolecules. | 2 |
| | 20 | Small organic molecules in cells, macromolecules as major cellular constituents. | 2 |
| | 21 | Concepts of molecular weight and molecular mass and their units, | 2 |
| | 22 | Equilibrium and steady state, living cells as open systems, energy inter conversion in living organisms, role of ATP in metabolism, regulation of metabolism to achieve cellular economy and balance. | 4 |
| **V (Open module)** | **Practicals** | | **30 hrs** |
| | 25 | Familiarize scientific weighing using weighing bottle and electronic balance | |
| | 26 | Preparation of standard solutions | |
| | 27 | Percentage solutions W/V, V/V, W/W etc. preparation | |
| | 28 | Molar and mole fraction - solutions- preparation | |
| | 29 | Normal solutions | |
| | 30 | Quantitative transfer of materials, accuracy in transfer (to find out percentage error.) | |
| | 31 | Familiarize experimental designs- variables in experiments. | |
| | 32 | Learn the functions of light microscope. | |

**REFERENCES**

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2. Worldviews: An Introduction to the History and Philosophy of Science by Richard DeWitt (2004) Publisher: Wiley-Blackwell 1SBN-10: 140511620X, ISBN-13:978-1405116206
3. Lehninger Principles of Biochemistry by D.L. Nelson and M. M. Cox.: Worth Publishers, Madisons Avenue New York, USA.
4. Biochemistry, 5th edn. Lubert Stryer W.H. Freeman and company, U.S.A.
5. Fundamentals of Molecular Spectroscopy - C.N. Banwell, (Tata-McGraw Hill).
6. Biochemistry [with Cdrom] (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
7. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: Mcgraw-hill Book Company-Koga ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757
8. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson ISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365
9. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis Visit Amazon's Julian Lewis Pagesearch resultsLearn about Author Central, Martin Raff, Keith Roberts, Peter Walter Publisher: Garland Science; 5 edition ISBN-10: 0815341059 ISBN-13: 978-0815341055.
10. Genes XI by Benjamin Lewin (2008) Publisher: J&b ISBN:0763752223 ISBN-13: 9780763752224, 978-0763752224.
11. Molecular Biology Of The Gene 5/e (s) by James D Watson, Tania A Baker, Stephen P Bell (2008) Publisher: Dorling Kindersley (India) Pvt Ltd ISBN: 8177581813 ISBN-13: 9788177581812, 978-8177581812.
12. Cell and Molecular Biology, 3e (2003) by Karp Publisher: Jw.ISBN: 0471268909 ISBN-13: 9780471268901, 978-0471268901.

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | - | - | - | - | 3 | 3 | - | - | - | - |
| CO2 | 1 | 3 | 3 | 2 | 1 | - | - | 3 | 3 | - | - | - |
| CO3 | 3 | 1 | 3 | - | - | 2 | - | 2 | - | 2 | - | 1 |
| CO4 | 3 | 2 | 2 | 3 | - | - | 3 | 1 | 1 | 3 | - | 2 |
| CO5 | 3 | 2 | - | - | - | 1 | - | 2 | 1 | 1 | 3 | 3 |
| CO6 | 3 | - | - | - | - | 2 | 3 | 2 | 2 | 1 | 3 | - |

**Correlation Levels:**

| Level | Correlation |
|---|---|

| | |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

**SEMESTER II**

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Cell Biology | | | | |
| Type of Course | Major / Minor | | | | |
| Semester | II | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | +2 Biology | | | | |
| Course Summary | This course delves into the cell and its ultrastructure, covering the cell theory, differences between prokaryotic and eukaryotic cells, subcellular organelles, and membrane transport mechanisms including diffusion, facilitated transport, active transport, and ion channels. It also explores | | | | |

| | |
|---|---|
| | cell-cell interactions, the cell cycle, cell death processes like apoptosis, and practical sessions focusing on microscopy, cell identification, cell counting, identification of dead cells, observation of cell division, and transport experiments using dialysis membranes. Additionally, students get the opportunity to visit an institution to study flow cytometry. |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Recall and define the fundamental concept of a cell and describe the detailed structure and functions of the cell. | U | C | Instructor-created exams / Quiz |
| CO2 | Comprehend the transport of molecules across the cell. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Comprehend biochemical events involved in cellular communications | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Distinguish different phases and biochemical events involved in the cell cycle and distinguish complex pathways involved in programmed cell death | U | C | Instructor-created exams / Home Assignments |
| CO5 | Understand the cancer cell | U | C | One Minute Reflection Writing assignments |
| CO6 | Basics skills to handle microscopes | Ap | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Cell & Ultra structure** | | |
| | 1 | Cell theory, Definition of cell | 2 |
| | 2 | Overview of the difference between prokaryotic and eukaryotic cells | 2 |
| | 3 | Detailed structure of prokaryotic and eukaryotic cells | 2 |
| Ultra S | 4 | Sub cellular organelles | 2 |
| | 5 | Marker enzymes | 2 |

| | | | |
|---|---|---|---|
| **II** | **Membrane transport** | | |
| | 6 | Definition of transport across membranes | 3 |
| | 7 | Simple diffusion and factors influencing it | 3 |
| | 8 | Facilitated transport: Symport, Uniport, Antiport | 3 |
| | 9 | Active transport: Primary active transport; Na+-K+ ATPase and secondary active transport | 3 |
| | 10 | Ion channels and ionospheres | 3 |
| **III** | **Cell-Cell Interactions** | | |
| | 11 | Cell-cell adhesion | 2 |
| | 12 | Cadherin and desmosomes | 2 |
| | 13 | Gap junctions and tight junctions | 2 |
| | 14 | Cell-matrix interaction | 2 |
| | 15 | A brief overview of cell signalling | 2 |
| **IV** | **Cell Cycle and cell death** | | |
| | 16 | Overview of the cell cycle | 1 |
| | 17 | G1, S, G2, and M phases | 2 |
| | 18 | Cell division: Mitosis and Meiosis | 2 |
| | 19 | Apoptosis | 1 |
| | 20 | Apoptosis pathways | 2 |
| | 21 | Differences between apoptosis and necrosis | 1 |
| | 22 | Cell cycle analysis | 1 |
| **V (open module)** | **Practicals** | | **30 hrs** |
| | 23 | Microscopy and cell identification | |
| | 24 | Differentiating Prokaryotic and Eukaryotic cells | |
| | 25 | Cell count using Hemocytometer ( Using Yeast cells) | |
| | 26 | Identification of dead cells ( using dyes) | |
| | 27 | Cell division, mitosis ( using onion root tips) | |
| | 28 | Transport of solute using dialysis membrane | |
| | 29 | Institutional visit to study flow cytometer | |

**References**


**1.** Cooper GM. The Cell: A Molecular Approach. 2nd edition. Sunderland (MA): Sinauer Associates; 2000

2. Gerald Karp. WIE Cell and Molecular Biology: Concepts and Experiments, 5th Edition, John Wiley & Sons. 2007.

3. Lodish H, Berk A, Zipursky SL, et al. Molecular Cell Biology. 6th edition. New York: W. H. Freeman; 2007.

4. E.D.P. Robertis and De Robertis, Cell and Molecular Biology. Published by Lippincott Williams & Wilkins, 1981.

5. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter. “Molecular Biology of the Cell” (Sixth Edition), WW Norton & Co.

6. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. "Essential Cell Biology" Fifth Edition. WW Norton & Co.

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | 1 |
| CO2 | - | 3 | - | - | - | - | - | 3 | - | - | - | - |
| CO3 | - | - | 3 | - | - | - | - | - | 3 | - | - | - |
| CO4 | - | - | - | 3 | - | - | - | - | - | 3 | - | - |
| CO5 | - | - | - | - | 3 | - | - | - | - | - | 3 | - |
| CO6 | 1 | - | - | - | - | 3 | 1 | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

## SEMESTER III

| Programme | B. Sc. Biochemistry | | | | |
|---|---|---|---|---|---|
| Course Code | | | | | |
| Course Title | Biomolecules I | | | | |
| Type of Course | Major / Minor | | | | |
| Semester | III | | | | |
| Academic Level | 200 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2- | 75 |
| Pre-requisites | +2 level chemistry background | | | | |
| Course Summary | This course offers a comprehensive understanding of biomolecules, covering carbohydrates, amino acids, lipids, vitamins, and minerals. It explores the classification, structures, isomerism, reactions, and derivatives of carbohydrates; the sources, structures, classifications, and properties of amino acids; the definition, sources, functions, and classifications of lipids; and the definition, classifications, sources, functions, and deficiency disorders of vitamins and minerals. Practical sessions complement theoretical learning, focusing on the general and specific reactions of biomolecules, systematic analysis, and estimation methods. Additionally, students gain hands-on experience with techniques such as paper chromatography and TLC for amino acid separation. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Define the structure, properties, classification, general reactions and roles of carbohydrates. | U | C | Instructor-created exams / Quiz |
| CO2 | Describe the structure and characterization of sugar derivatives. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Explain the structure and functions of disaccharides. | U | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Describe the classification structure and functions of polysaccharides. Describe the structure, physical properties, classification and acid base properties of amino acids. | U | P | Instructor-created exams / Home Assignments |
| CO5 | Explain the structure, properties, major classes and roles of lipids. | U | P | One Minute Reflection Writing assignments |
| CO6 | Define the structure, properties, classification, general reactions and roles of carbohydrates. | Ap | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Carbohydrates** | | |
| | 1 | Classification of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, hexoses, and heptoses (with special emphasis to important members). Linear and cyclic structure, | 3 |
| | 2 | Rule of the ring (Structures of glucose, galactose, mannose, ribose, and fructose). Isomerism of carbohydrates: structural isomerism and stereoisomerism,'d' and 'l', 'D' and 'L' forms of compounds. Glyceraldehyde as an example. R and S nomenclature of enantiomers. | 3 |
| | 3 | Examples of epimers. Mutarotation and its explanation, anomeric forms. Basic reactions: Reactions and characteristics of aldehyde and keto group: Reduction,Oxidation, Reaction with strong acids (dehydration) and alkalies on sugars (tautomerization or enolization), reactions of sugars due to hydroxyl group, formation of esters, osazone formation. | 3 |
| | 4 | Sugar derivatives, Sugar derivatives: sugar alcohols, sugar acids, amino sugars, deoxysugars, sugar derivatives, glucosamine, | 2 |

| | | | |
|---|---|---|---|
| | | galactosamine, muramic acid, N- acetyl neuraminic acid and their relevance. | |
| | 5 | Disaccharides Disaccharides: concept of reducing and non-reducing sugars, structure (Fischer and Haworth projections), occurrence, chemistry, and functions of sucrose, lactose, maltose, isomaltose, and cellobiose. Inversion of sucrose Polysaccharides | 2 |
| | 6 | Polysaccharides, Classification, Homopolysaccharides: occurrence, structure, chemistry, and functions of cellulose, starch, glycogen, chitin, and inulin (with an explanation to the ends of the linear polymer of sugars). Heteropolysaccharides: occurrence, types, composition, and function. | 2 |
| **II** | **Aminoacids** | | |
| | 6 | Definition of alpha-amino acids. Sources and structure of biologically relevant amino acids. Stereoisomerism: | 2 |
| | 7 | .Structure and classification of amino acids based on polarity (with name, structure and additional functional groups). | 2 |
| | 8 | Three letter and single letter abbreviations of amino acids. Optical properties of amino acids: L- and D-forms of amino acids | 2 |
| | 9 | Essential and nonessential amino acids. | 2 |
| | 10 | General reactions of amino acids- side chain, carboxyl, and the amino group. Zwitter ions and isoelectric pH. Ionization of amino acids. Titration curve of amino acid and its significance. | 2 |
| | 11 | Amino acids derivatives: γ-amino butyric acid (GABA), dopamine, histamine, thyroxin. | 2 |
| **III** | **Lipids** | | |
| | 12 | Definition, sources, functions and major classes of storage and structural lipids. | 1 |
| | 13 | Classification of lipids with structure and examples- simple lipids; (triacylglycerol), Compound lipids: storage and membrane lipids. | 1 |
| | 14 | Structure and functions of phospholipids and glycolipids, derived lipids. | 1 |
| | 15 | Difference between fats and oils. | 1 |
| | 16 | Chemical-based classification of fatty acids with examples-sources and structure. | 1 |
| | 17 | Physical and chemical properties of fatty acids. Saponification number, acid number, and iodine number and their application. | 1 |
| | 18 | Structure of the following fatty acids - short-chain, medium-chain and long-chain fatty acids. Sources of each fatty acid and its relative size. Fatty acids present in coconut oil, groundnut oil, sunflower oil, and fish oil. | 2 |
| | 19 | Essential and non-essential fatty acids with examples. Steroids: Sources, Structure of steroid nucleus, cholesterol, ergosterol, stigmasterol, calciferol. Eicosanoids–definition & classes only | 2 |

| | | | |
|---|---|---|---|
| **IV** | **Vitamins & Minerals** | | |
| | 20 | Definition, classification- fat-soluble and water-soluble, sources, | 2 |
| | 21 | Chemical nature (without structure), Functions, deficiency disorders | 3 |
| | 22 | Macro minerals (Ca, P, Mg, Na, K, Cl) sources, daily requirements, functions, deficiency diseases, Trace elements, - their sources, daily requirements, functions, and deficiency diseases | 3 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | General reactions of Carbohydrates, Aminoacids, Proteins, and lipids | |
| | 2 | Specific reactions of sugars, amino acids, | |
| | 3 | Systematic analysis of biomolecules | |
| | 4 | Saponification number, Iodine number | |
| | 5 | Estimation of carbohydrates by colorimetric methods | |
| | 6 | Separation of amino acids by paper chromatography, TLC | |

**References**

1. D.L. Nelson and M. M. Cox. Lehninger's Principles of Biochemistry: Worth Publishers, Madisons Avenue New York, USA.

2. Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg. Biochemistry. 9th edition, W. H. Freeman and Company • New York, 2019.

3. Voet, Donald, and Judith G. Voet. Biochemistry. New York: J. Wiley & Sons, 1995.

4. A.C. Deb, Fundamentals of Biochemistry, 7th Edition, New Central Book Agency-Kolkata, 2001.

5. Debajyoti Das. Biochemistry, Academic Publishers, 1978.

6. J. L. Jain, Sunjay Jain, and Nitin Jain. Fundamentals of Biochemistry Publishers: S. Chand & Co Ltd. New Delhi. 2008

7. U. Satyanarayana, U. Chakrapani. Biochemistry, Books and Allied (P) Ltd., Calcutta, Latest Edition, 2013.

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | 3 |
| CO2 | - | 2 | - | - | - | - | - | 3 | - | - | - | - |
| CO3 | - | - | 2 | - | - | - | - | - | 3 | - | - | - |
| CO4 | - | - | - | 3 | - | - | - | - | - | 2 | - | - |
| CO5 | - | - | - | - | 3 | - | - | - | - | - | 3 | - |
| CO6 | 3 | - | - | - | - | 3 | 1 | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Biomolecules II | | | | |
| Type of Course | Major / Minor | | | | |
| Semester | III | | | | |
| Academic Level | 200 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | | | | | |
| Course Summary | The course covers the fundamentals of peptides, proteins, and nucleic acids. It delves into their structures, classifications, sequencing methods, and chemical properties through theoretical and practical modules. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Describe features and structure of peptide. Define proteins and peptides. | A | C | Instructor-created exams / Quiz |
| CO2 | Explain different classification of proteins. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Analyze the hierarchy of protein - primary secondary tertiary and quaternary structure and distinguish features of globular and fibrous proteins. | A | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Demonstrate chemical reactions of proteins. | A | P | Instructor-created exams / Home Assignments |
| CO5 | Describe the fundamentals of nucleic acid chemistry, function and classification. | A | P | One Minute Reflection Writing assignments |

| | | | | |
|---|---|---|---|---|
| CO6 | Explain structural features of DNA and RNA | A | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Peptides** | | |
| | 1 | Peptides Formation of the Peptide, peptide bond, features of peptides- peptide plane, dihedral (torsion) angles- Phi And Psi. | 2 |
| | 2 | Oligopeptides: Structure and functions of naturally occurring Oligopeptides-glutathione, Oxytocin, vasopressin, and insulin. | 2 |
| | 3 | Polypeptide, N and C terminals, cyclic peptides | 2 |
| | 4 | Make polypeptides with 5 amino acids (Compulsory exercise) | 2 |
| II | **Proteins Classification** | | |
| | 7 | Classification based on solubility (simple proteins, albumins, globulins, prolamins, glutelins, protamines, albuminoids), classification based on composition (simple and conjugated proteins). | 3 |
| | 8 | Classification based on function (catalytic proteins - enzymes, regulatory proteins - hormones, protective proteins – antibodies, storage proteins, transport proteins, structural proteins, secretory proteins, exotic proteins, toxic proteins). | 3 |
| | 9 | Classification based on size and shape (globular proteins, fibrous proteins, and intermediate proteins) | 2 |
| | 10 | Classification based on the location of the protein in the cell (membrane-bound proteins- translocase, soluble cytosol proteins, matrix proteins, lysosomal proteins). | 2 |
| III | **Protein structure** | | |
| | 11 | Primary structure of protein: definition, elucidation of primary structure- N-terminus identification- Sanger's method, using Dansyl chloride, Edman degradation (explain with different steps). C-terminal identification- enzymatic digestion, using Cyanogen bromide (CNBr). | 3 |
| | 12 | Secondary structure: Definition, the structure of C terminal and N terminals of protein. Modern methods of protein sequencing, Confirmation, types of secondary structures- alpha, beta, turn or bends, loops, helixes, parallel and antiparallel beta-pleated sheet. Alpha helix, Ramachandran's plot, Ramachandran number, Sources and examples related to secondary structures- keratin, collagen. Outline the structure of collagen. | 3 |

| | | | |
|---|---|---|---|
| | 13 | Tertiary structure: Definition, tertiary forces (ionic, hydrophobic interaction, van der Waals forces, and electrostatic bonds). Protein denaturation and renaturation (explain with Ribonuclease enzyme). Examples - structures of myoglobin and hemoglobin. | 3 |
| | 14 | Quaternary structures of proteins. Definition, Protein with quaternary structure- example- human hemoglobin, DNA polymerase. | 3 |
| | 15 | Protein folding, Reactions of proteins: Chemical reactions, precipitation reactions - salt and heavy metal precipitation of proteins. Colour reactions for proteins | 3 |
| **IV** | **Nucleic acids** | | |
| | 16 | Nucleic acids -types. Structural organization of nucleic acids: | 1 |
| | 17 | Primary structure (Bases, sugars and phosphoric acid): Structure of common purine and pyrimidine bases, tautomeric forms of bases, Structure of sugar, and phosphoric acid, the structure of nucleosides and nucleotides (Ribonucleotides and Deoxynucleotides) | 1 |
| | 18 | Unusual bases in nucleic acids. cAMP structure. Primary structure of DNA and RNA. Polynucleotide: Structure, a diagrammatic representation of DNA polynucleotide and RNA polynucleotide. Linkages in nucleoside and nucleotide: Phosphodiester bond (structure) and 5' and 3' ends of the polynucleotide (structure).<br>Secondary structure of nucleotides | 2 |
| | 19 | Three-dimensional structure of nucleic acids- Physical and chemical properties of DNA, Chargaff's base pair rule, X-ray Diffraction studies, Double helical structure of DNA: basic ideas of Watson and Crick model. Hydrogen bonding. | 2 |
| | 20 | Watson and Crick base pair and Hoogsteen base pair. A, B, and Z forms of DNA, physical properties of DNA (glycosidic bond-anti and syn conformation and endo-exo confirmation of sugars and confirmation of heterocyclic base). Nucleic acids: DNA and RNA: hyperchromic effect, Tm-values, cot curves, and their significance | 2 |
| | 21 | Types of RNA (tRNA, rRNA, mRNA). Elementary study of the structures of these RNAs. Sequencing of DNA: basic principles of the methods: Maxam–Gilbert (chemical sequencing) and Sanger dideoxy sequencing (chain-termination method) | 2 |
| | 22 | Sequencing of DNA: basic principles of the methods: Maxim–Gilbert (chemical sequencing) and Sanger dideoxy sequencing (chain-termination method | 2 |
| **V (open module)** | **Practicals** | | **30Hr** |
| | 1 | Color reactions of proteins | |
| | 2 | Precipitation of proteins | |
| | 3 | Denaturation of proteins | |
| | 4 | Estimation of proteins by colorimetric methods | |

| | | | |
|---|---|---|---|
| | 5 | Extraction of total proteins from natural sources. | |

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1. D.L. Nelson and M. M. Cox. Lehninger's Principles of Biochemistry: Worth Publishers, Madisons Avenue New York, USA.

2. Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg. Biochemistry. 9th edition, W. H. Freeman and Company • New York, 2019.

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**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | - | 3 | 3 | - | - | - | - |
| CO2 | 2 | 1 | - | - | - | - | - | 3 | 3 | - | - | - |
| CO3 | 2 | 1 | 2 | - | - | - | - | - | 3 | - | - | - |
| CO4 | 2 | 1 | - | 2 | - | - | 3 | 1 | 1 | 3 | - | - |
| CO5 | 2 | 1 | - | - | 2 | - | - | 2 | 1 | 1 | 3 | - |
| CO6 | 2 | 1 | - | - | - | 2 | - | 2 | 2 | 1 | 3 | - |

**Correlation Levels:**

| Level | Correlation |
|---|---|

| | |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

**SEMESTER IV**

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Techniques in Biochemistry | | | | |
| Type of Course | Major | | | | |
| Semester | IV | | | | |
| Academic Level | 200 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | +2 level science | | | | |
| Course Summary | This course covers a range of laboratory techniques essential for biological and biochemical research. It starts with cell disruption | | | | |

| | |
|---|---|
| | methods, including tissue homogenization and extraction techniques. The focus then shifts to chromatography techniques like partition, adsorption, ion-exchange, and gel filtration chromatography. Electrophoresis methods, including gel electrophoresis and isoelectric focusing, are explored in detail. Additionally, centrifugation, colorimetry, spectrophotometry, and radioisotopic methods are discussed, providing students with a comprehensive understanding of analytical techniques commonly used in biological research. Practical sessions complement theoretical knowledge, offering hands-on experience in applying these techniques. |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand various techniques used in biochemical separation and analysis. | A | C | Instructor-created exams / Quiz |
| CO2 | Outline the principles and applications of chromatography techniques. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Comprehend the principles and applications of different electrophoresis techniques. | A | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Comprehend the principles and applications of different centrifugation, Colorimetric and spectrophotometric techniques. | A | P | Instructor-created exams / Home Assignments |
| CO5 | Identify importance and applications of the techniques in Biochemistry | A | P | One Minute Reflection Writing assignments |
| CO6 | Understand the basics of Radio isotopic techniques used in Biochemistry | A | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Cell disruption techniques** | | |

| | | | |
|---|---|---|---|
| | 1 | Methods of tissue homogenization-Mortar and pestle, mechanical, ultra sonication, freeze-thaw homogenization | 2 |
| | 2 | Salt and organic solvent extraction and fractionation | 1 |
| | 3 | Dialysis, Reverse dialysis, ultrafiltration. | 2 |
| | 4 | Lyophilisation | 1 |
| **II** | **Chromatography(The principle, procedure, and application of the following chromatographic techniques)** | | |
| | 5 | Partition chromatography ( Paper, TLC, HPLC, HPTLC) | 2 |
| | 6 | Adsorption chromatography, (Column , Gas) | 2 |
| | 7 | Ion-exchange chromatography | 2 |
| | 8 | Gel filtration chromatography | 2 |
| | 9 | Dye –Ligand chromatography | 1 |
| | 10 | Flash chromatography | 1 |
| **III** | **Electrophoresis** | | |
| | 11 | The principle, procedure, and application of zone electrophoresis - Paper electrophoresis, membrane electrophoresis | 3 |
| | 12 | Gel electrophoresis, PAGE and SDS-PAGE | 2 |
| | 13 | Isoelectric focusing, high voltage electrophoresis, pulse-field electrophoresis, immune electrophoresis | 3 |
| | 14 | 2D gel electrophoresis | 2 |
| | 15 | Zymography | 2 |
| **IV** | **Centrifugation, Colorimetry and spectrophotometry** | | |
| | 16 | Principle of sedimentation technique. Relationship with rpm and radius of rotation. RCF centrifugal force (×g). Different types of centrifuge and rotors. | 2 |
| | 17 | The principle, procedure, and application of differential centrifugation, density gradient centrifugation Ultracentrifugation, rate zonal centrifugation, isopycnic centrifugation | 3 |
| | 18 | Laws of light absorption -Beer-Lamberts law. UV and visible absorption spectra, molar extinction coefficient and quantitation. Principle and instrumentation of colorimetry | 3 |
| | 19 | Spectrophotometry. AAS and emission spectrometry | 2 |
| | 20 | Nephelometry, Fluorimetry | 2 |
| | 21 | Radio isotopic methods<br>Isotopes, isobars, ionizing and nonionizing radiations.<br>Principle and application of RIA. | 3 |
| | 22 | Measurement of radioactivity by GM counter and Scintillation counter. Autoradiography | 2 |
| **V** | **Practicals** | | **30** |
| | 1 | Dialysis using membrane | |

| | | | |
|---|---|---|---|
| **(open module)** | 2 | Separation of amino acids by paper and TLC | |
| | 3 | Separation of serum protein by agarose gel electrophoresis (Demonstration) | |
| | 4 | Proof of Beers lamberts law using colorimeter | |
| | 5 | Training to use spectrophotometer. | |

**REFERENCES**


1. Pranab Kumar Banerjee. Introduction to Biophysics by Publishers: S. Chand & Company Ltd.2008.

2. Friefelder D. Physical Biochemistry- Application to Biochemistry and Molecular Biology. WH Freeman and Company

3. Ed. K. Wilson and J. Walker. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.

4. Cooper T.G. The Tools of Biochemistry. John Wiley and Sons Publication.

5. Upadhyay A, Upadhyay K and Nath. Biophysical chemistry. Principles and Techniques: N., Himalaya publishing house.

6. Cark Jr J. M. and Switzer R.L, Experimental Biochemistry. W.H. Freeman and company.

7. Chatwal. G and Anand.S. Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Mumbai, India.


**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | 3 | 3 | - | 3 | - | - | 3 | 3 | - |
| CO2 | 3 | - | - | - | 3 | - | 3 | - | - | - | 3 | - |
| CO3 | - | - | 3 | - | 3 | - | - | - | 3 | - | 3 | - |
| CO4 | - | - | - | 3 | 3 | - | - | - | - | 3 | 3 | - |
| CO5 | - | - | - | - | 3 | - | - | - | - | - | 3 | - |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO6 | - | - | - | - | - | 3 | - | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| | |
|---|---|
| Programme | B. Sc. Biochemistry |
| Course Code | |
| Course Title | Enzymology |
| Type of Course | Major / Minor |
| Semester | IV |
| Academic Level | 200 |

| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
|---|---|---|---|---|---|
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | +2 level chemistry and Biology | | | | |
| Course Summary | The course provides an overview of enzymology, covering the history of enzymes, their classification, and activity. It explores various types of enzymes, including isoenzymes, and delves into the role of coenzymes, cofactors, and prosthetic groups in enzyme function. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the basics of enzymology, including history and classification | A | C | Instructor-created exams / Quiz |
| CO2 | Differentiate the terms coenzyme, prosthetic group. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Understand the fundamentals of enzyme kinetics | A | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Describe enzyme inhibition and regulation | A | P | Instructor-created exams / Home Assignments |
| CO5 | Demonstrate the basics of enzyme reaction mechanism. | A | P | One Minute Reflection Writing assignments |
| CO6 | Perform enzyme assay in laboratory. | A | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Enzymes** | | |
| | 1 | History of enzymology, Proteins as enzymes. | 2 |
| | 2 | Briefly mention about ribozymes and abzymes, examples | 2 |
| | 3 | Isoenzymes, examples, applications | 2 |
| | 4 | Definition and examples of holoenzyme, apoenzyme and prosthetic group | 2 |

| | | | |
|---|---|---|---|
| **II** | **Classification of enzymes and Enzyme activity** | | |
| | 7 | Classical nomenclature of enzymes, examples, demerits. IUBMB system of classification and nomenclature of enzymes (seven classes), Class and subclass with one example | 3 |
| | 8 | Enzyme activity and Specific activity- definition and significance. Units of activity: International unit (IU) and Ketal units | 3 |
| | 9 | Enzyme specificity, substrate, geometrical, optical, coenzyme, co factor specificities with examples | 3 |
| **III** | **Coenzymes and cofactors** | | |
| | 10 | Definition and examples of metalloenzymes, coenzymes, prosthetic groups. | 3 |
| | 11 | Coenzyme functions- NAD, NADP+, FAD, FMN, lipoic acid, TPP, pyridoxal phosphate and biotin(structure and one reaction each). | 3 |
| | 12 | Co factors, metal cofactors , examples and associated enzymes. | 3 |
| **IV** | **Basics of Enzyme kinetics &mechanism** | | |
| | 13 | Rate of reactions, Order of enzyme catalysed reactions | 1 |
| | 14 | Progressive curve , its features | 1 |
| | 15 | M M equation, its importance, Km value, its units and relevance, | 2 |
| | 16 | Double reciprocal plot, importance & advantage | 2 |
| | 17 | Factors affecting the velocity of enzyme catalysed reactions Enzyme inhibition, types, with examples, kinetics | 2 |
| | 18 | Enzyme inhibition, types, with examples, kinetics | 2 |
| | 19 | Regulation of enzyme, Allosteric & Covalent regulation with example | 2 |
| | 20 | Basic concepts of mechanism- acid base catalysis, covalent catalysis, stress and strain, induced fit models, Concept of active site, 'Lock and key' model of Emil Fischer. | 2 |
| | 21 | Enzyme purification | 2 |
| | 22 | Immobilized enzymes | 1 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | Identification of different enzymes and their functions | |
| | 2 | Familiarize yourself with the enzymology lab - equipment, basic practices etc. | |
| | 3 | Assay of enzymes- Amylase, trypsin to express activity, specific activity, IU & Katal etc. | |
| | 4 | Assay of clinical enzymes using kits. | |

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1. Nelson, D. L., and Cox, M.M. Lehninger Principles of Biochemistry, 6th Edition, W.H. Freeman and Company, N.Y., USA.

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4. Stryer, L. Biochemistry Pub.W.H. Freeman

5. Voet, D. and. Voet, J. G, Biochemistry, 4th Edition, John Wiley & Sons Inc. New York

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | 1 |
| CO2 | 1 | - | - | 1 | - | - | - | - | 1 | - | - | - |
| CO3 | 1 | - | - | - | - | - | - | - | - | - | 1 | - |
| CO4 | - | 2 | - | - | - | - | - | 1 | - | - | - | - |
| CO5 | - | 1 | - | - | - | - | - | - | - | - | - | - |
| CO6 | - | - | - | 2 | - | 3 | - | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| Programme | B. Sc. Biochemistry | | | | |
|---|---|---|---|---|---|
| Course Code | | | | | |
| Course Title | Intermediary Metabolism I | | | | |
| Type of Course | Major / Minor / | | | | |
| Semester | IV | | | | |
| Academic Level | 200 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | Basic knowledge in organic chemistry, Biology, Biomolecules and enzymology | | | | |
| Course Summary | This course provides an in-depth exploration of metabolism, covering both anaerobic carbohydrate metabolism and lipid catabolism. It begins with an introduction to metabolism, discussing its definition, stages, and compartmentalization in cells. The anaerobic metabolism of carbohydrates is then extensively studied, including glycolysis, gluconeogenesis, starch degradation, and glycogen synthesis. Lipid catabolism is examined in detail, focusing on fatty acid oxidation, ketone body metabolism, and disorders associated with fatty acid catabolism. The catabolism of amino acids is also covered, encompassing various metabolic pathways and the urea cycle. Practical sessions provide hands-on experience in studying metabolic processes. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understanding of the importance of metabolic | U | C | Instructor-created exams / Quiz |

| | | | | |
|---|---|---|---|---|
| | pathways in living cells and methods adopted to trace them out. | | | |
| CO2 | Differentiate the aerobic & anaerobic phase of carbohydrate metabolism. | A | C | Viva Voce |
| CO3 | Explain catabolism of fatty acids. | A | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Acquire the knowledge in amino acids catabolism and urea cycle | A | C | Instructor-created exams / Home Assignments |
| CO5 | Understand metabolic disorders. | | | One Minute Reflection Writing assignments |
| CO6 | Assay and estimate metabolites and enzymes | A | P | Practical Assignment / Observation of Practical Skills |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to metabolism** | | |
| | 1 | Definition of metabolism. Catabolism and anabolism | 2 |
| | 2 | Three stages of metabolism. Introduction to metabolic pathways, | 2 |
| | 3 | Compartmentalization of metabolic pathways in cells | 2 |
| | 4 | Techniques to study metabolism | 2 |
| **II** | **Anaerobic metabolism of Carbohydrates** | | |
| | 5 | Anaerobic phase: Glycolytic pathway with structures, energetics, and regulation of Glycolysis.. Reciprocal regulation of glycolysis and gluconeogenesis. | 2 |
| | 6 | HMP shunt and its significance. Cori cycle. | 1 |
| | 7 | The fate of pyruvate under anaerobic condition. Alcoholic Fermentation, | 1 |
| | 8 | Starch degradation, Glycogen breakdown | 1 |
| | 9 | Hydrolysis of dietary disaccharides and polysaccharides, | 1 |
| | 10 | Entry of other monosaccharides to the glycolytic pathway: galactose/ fructose metabolism | 1 |

| | | | |
|---|---|---|---|
| | 11 | Gluconeogenesis: from pyruvate, from amino acids (without structure) and from propionyl CoA and its regulation | 2 |
| | 12 | Glycogen synthesis and regulation. | 2 |
| | 13 | Glyoxylate pathway, Importance. | 1 |
| **III** | **Catabolism of lipids** | | |
| | 14 | Transport of fatty acids into mitochondria | 1 |
| | 15 | β.- oxidation of fatty acids. β-oxidation of palmitic acid and its energy balance sheet. | 2 |
| | 13 | Regulation of fatty acid oxidation, ketone body metabolism, ketoacidosis | 3 |
| | 14 | Degradation of unsaturated fatty acids | 1 |
| | 15 | Degradation of branched chain aminoacids | 1 |
| | 16 | Disorders of fatty acids catabolism | 2 |
| **IV** | **Catabolism of amino acids** | | |
| | 17 | Transamination, oxidative deamination, reductive amination, non-oxidative deamination and decarboxylation of amino acids. Role of pyridoxal phosphate. | 3 |
| | 18 | Metabolic fates of amino acids- glucogenic, ketogenic and gluco-ketogenic amino acids (structures not needed.) | 2 |
| | 18 | Branched chain amino acids degradation (outlines) | 2 |
| | 19 | Role of glutamate dehydrogenase | 2 |
| | 20 | Urea cycle, importance | 2 |
| | 21 | Disorders of amino acids catabolism | 2 |
| | 22 | Importance of physiologically active amines | 2 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | Assay of glucokinase | |
| | 2 | Assay of LDH | |
| | 3 | Estimation of lipid profile | |
| | 4 | Estimation Serum total protein | |
| | 5 | Estimation of serum total cholesterol | |
| | 6 | Estimation of serum TG | |
| | 7 | Estimation of serum urea | |

**REFERENCES**

1. Nelson, D. L. and Cox, M.M. Lehninger Principles of Biochemistry, 6th Edition, W.H. Freeman and Company, N.Y., USA.

2. Stryer, L. Biochemistry Pub.W.H. Freeman

3. Voet, D. and. Voet, J. G, Biochemistry, 4th Edition, John Wiley & Sons Inc. New York

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7. Debajyoti Das. Biochemistry, Academic Publishers, 1978.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| CO2 | 1 | - | 2 | - | - | - | - | - | - | - | - | - |
| CO3 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| CO4 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | - | - | - | - | - | - | 1 | - | - | - | - | - |
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | - |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

**SEMESTER V**

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Molecular Biology | | | | |
| Type of Course | Major | | | | |
| Semester | V | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | A good knowledge in cell biology, biomolecules, genetic materials and enzymology | | | | |
| Course Summary | This course delves into the intricacies of genome organization and transposons, exploring topics such as chromatin structure, DNA as genetic material, and the mechanics of transposition. It progresses to cover DNA replication, transcription, translation, and the regulation of gene expression in both prokaryotic and eukaryotic systems, culminating in a comprehensive examination of mutations, mutagens, DNA repair mechanisms, and the role of genetics in cancer development. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Describe the genome organization, the concept | A | C | Instructor-created exams / Quiz |

| | | | | |
|---|---|---|---|---|
| | of the central dogma, chromosome structure and transposable elements | | | |
| CO2 | Master the core concepts in the replication of DNA· | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Explore and compare the prokaryotic and eukaryotic transcription. | A | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Identify the basic processes involved in gene expression and its regulation, to analyze genetic code, enzymology, inhibitors of protein synthesis, differentiation of prokaryotic and eukaryotic translation, post-translational modification | A | C | Instructor-created exams / Home Assignments |
| CO5 | Distinguish mutational changes in genetic material and how the systems repair them and to analyse the molecular basis of mutation, | A | C | One Minute Reflection Writing assignments |
| CO6 | Apply the Ames test for detection of mutation· | Ap | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Genome Organization and Transposons** | | |
| | 1 | Introduction to genome organization | 1 |
| | 2 | Chromatin structure and organization | 1 |
| | 3 | Centromere, telomere, exons, and introns | 2 |
| | 4 | Identification of DNA as genetic material. Griffith, Avery, McLeod, and McCarty's experiments, Hershey and Chase experiment. | 2 |
| | 5 | The chemical nature of the gene, Definition of a gene, C-value paradox. | 2 |

| | | | |
|---|---|---|---|
| | 6 | Prokaryotic transposable elements, IS elements, Composite transposons, Tn-3 elements, Modes of transposition (brief study). | 2 |
| **II** | **Replication of DNA** | | |
| | 5 | Central dogma, Replication, types, importance. | 2 |
| | 6 | Semiconservative mode of DNA replication- proof | 2 |
| | 7 | Replication fork, Enzymology, chemistry, and events of DNA replication, Fidelity of DNA replication | 2 |
| | 8 | Inhibitors | 2 |
| | 9 | Differences between Prokaryotic and Eukaryotic Replication - Comparative study | 2 |
| **III** | **Transcription** | | |
| | 10 | Transcription in Prokaryotes, Detailed theory, enzymology, chemistry, and events of transcription. | 2 |
| | 11 | Inhibitors of transcription | 1 |
| | 12 | Differences between Prokaryotic and Eukaryotic Transcription, Comparative analysis. | 2 |
| | 13 | Brief mention of post-transcriptional processing. | 2 |
| | 14 | Specifications of m-RNA, tRNA, rRNA | 1 |
| **IV** | **Translation and Regulation of Gene Expression** | | **17** |
| | 15 | Genetic Code and Translation, Definition and features of genetic code, Triplet code, codon, genetic code word chart, and wobble hypothesis. | 2 |
| | 16 | Translation in Prokaryotes- Enzymology, chemistry, and events of protein synthesis, Inhibitors of protein synthesis | 2 |
| | 17 | Differences between Prokaryotic and Eukaryotic Translation-comparative study, Brief mention of post-translational modifications Regulation of Gene Expression in Prokaryotes, Operon concept, Lac operon, Tryptophan operon | 3 |
| | 18 | . Types of Mutations- Induced versus spontaneous mutations, Back versus suppressor mutations | 2 |

| | | | |
|---|---|---|---|
| | 19 | Mutagens and Molecular Basis of Mutations- Physical, chemical and biological mutagens, Detection of mutations: Ames test | 2 |
| | 20 | DNA Repair Mechanisms-Direct repair: DNA photolyases Mismatch repair, Base excision repair, Nucleotide excision repair, SOS repair | 2 |
| | 21 | DNA Mutation, Repair and Cytogenetics of Cancer Cytogenetics of Cancer (Brief Account). Overview of Cytogenetics. | 2 |
| | 22 | Basics of Cancer Genetics- A brief introduction to oncogenes and tumor suppressor genes. A brief study on the role of genetic mutations in cancer development with a few specific examples of genetic mutations in well-known cancer types. | 2 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | Isolation of DNA (onion/other sources) | |
| | 2 | Estimation of DNA | |
| | 3 | Separation of DNA by Agarose gel electrophoresis | |
| | 4 | SDS PAGE-Protein separation | |
| | 5 | Polymerase Chain Reaction ( Demonstration) | |

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**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| CO2 | 2 | 2 | - | - | - | - | - | 3 | - | - | - | - |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 1 | - | 1 | - | - | - | - | - | 3 | - | - | - |
| CO4 | 3 | - | - | - | - | - | 2 | - | - | 3 | - | - |
| CO5 | 2 | - | - | - | - | - | - | - | - | - | 3 | - |
| CO6 | 1 | 1 | - | - | - | 3 | - | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Immunology | | | | |
| Type of Course | Major | | | | |
| Semester | V | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | Good knowledge in biology, biochemistry | | | | |
| Course Summary | This course provides a comprehensive overview of the immune system, starting with the fundamentals of immunity and the collaboration between innate and adaptive mechanisms. It covers the structure, functions, and properties of immune cells, along with the organs of the immune system. The curriculum delves into antigens, antibodies, and major histocompatibility complexes, exploring humoral and cell-mediated immune responses, complement systems, immunodeficiency diseases, hypersensitivity, autoimmunity, and the study of vaccines, offering a holistic understanding of immunology. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Recognize the basics of immunology, describe the basic mechanism and functional role of innate and adaptive immunity. | A | C | Instructor-created exams / Quiz |
| CO2 | Analyse Antigens, antibodies & MHCs | An | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Explain Humoral & cell-mediated immune responses and describe complement system | A | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Explain the mechanisms involved in different types of hypersensitivity and diseases associated with immune function. | Ap | C | Instructor-created exams / Home Assignments |
| CO5 | Demonstrate keen knowledge in autoimmune diseases | | | One Minute Reflection Writing assignments |

| | | | | |
|---|---|---|---|---|
| CO6 | Evaluate the role of vaccines. | E | C | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Overview of the immune system** | | |
| | 1 | Immunity, types of immunity: innate, acquired, passive & active. Barriers of innate immunity. | 3 |
| | 2 | Collaboration of Innate and adaptive mechanisms for an effective immune response | 3 |
| | 3 | Hematopoiesis. Structure, functions and properties of Immune cells: Stem cell, T cell, B cell, NK cell, macrophage, neutrophil, eosinophil, basophil, mast cell, dendritic cell. | 3 |
| | 4 | Organs of the Immune system: Primary and secondary lymphoid organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT Cells | 3 |
| **II** | **Antigens, antibodies & MHCs** | | |
| | 5 | Antigens: Factors that influence immunogenicity, epitopes, haptens.<br>Practical : Haemagglutination reaction | 2 |
| | 6 | Immunoglobulins: Structure of immunoglobulins, Classes of immunoglobulins and their functions | 2 |
| | 7 | Production of Monoclonal antibodies and application | 2 |
| | 8 | Major histocompatibility complex (elementary study): Structure, Peptide interaction with<br>MHC, MHC restriction | 2 |
| | 9 | Processing and presentation of antigens. | 2 |
| | 10 | Antigen-antibody interactions: Precipitation reaction, Immunodiffusion, agglutination | 2 |
| | 11 | ELISA, RIA, Immunoprecipitation, Immunofluorescence. Western blotting | 2 |
| **III** | **Humoral & cell-mediated immune responses** | | |
| | 12 | T-Cell & B-cell receptors. Humoral & cell-mediated immune responses. Cytokines | 2 |
| | 13 | Structure and function, classification, and types of cytokines according to the function | 2 |
| | 14 | Cytokine related diseases. | 2 |

| | | | |
|---|---|---|---|
| | 15 | Complement system: The function of complement, the complement components, Complement activation pathways. Complement deficiencies. | 2 |
| | 16 | Immunodeficiency diseases, Phagocytic, humoral and cell-mediated deficiencies. | 2 |
| **IV** | **Hypersensitivity and autoimmunity** | | |
| | 17 | Hypersensitivity- Gell and Coombs classification- IgE mediated Type I hypersensitivity, Antibody-mediated cytotoxic (Type II) hypersensitivity, Immune complex-mediated (Type III) Hypersensitivity,. | 2 |
| | 18 | DTH (delayed-type hypersensitivity T cells) (Type IV) hypersensitivity | 2 |
| | 19 | Autoimmunity: autoantibodies and their devastative role. Autoimmune diseases- Definition | 2 |
| | 20 | Classification -organ-specific and systemic autoimmune diseases - systemic lupus erythematous, Multiple sclerosis, Rheumatoid arthritis, scleroderma, Myasthenia Gravies | 2 |
| | 21 | Insulin dependent diabetic mellitus. Tumor & transplantation immunology – brief outline study | 1 |
| | 22 | Emerging autoimmune disorders | 1 |
| **V (Open module)** | **Vaccines** | | |
| | 23 | Types of vaccines. | 2 |
| | 24 | Vaccines from whole organisms, Polysaccharide vaccines | 2 |
| | 25 | Toxoids as vaccines | 2 |
| | 26 | Vaccines from recombination vectors | 2 |
| | 27 | DNA as vaccines | 2 |
| | 28 | Vaccines from synthetic peptides. | 2 |

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**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | - | - | - | - | 3 | - | 2 | 1 | 3 | - |
| CO2 | 2 | 3 | - | - | - | - | 3 | - | 2 | 1 | 3 | - |
| CO3 | - | - | 1 | - | - | - | 3 | - | 2 | 1 | 3 | - |
| CO4 | - | - | 2 | 3 | - | - | 3 | - | 2 | 1 | 3 | - |
| CO5 | - | 1 | - | - | - | - | 3 | - | 2 | 1 | 3 | - |
| CO6 | - | - | - | 3 | - | - | 3 | - | 2 | 1 | 3 | - |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar

- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Intermediary Metabolism II | | | | |
| Type of Course | Major | | | | |
| Semester | V | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | Basics of metabolism | | | | |
| Course Summary | This course offers a detailed exploration of bioenergetics of metabolic reactions, beginning with thermodynamics and the role of free energy in biological systems, leading to an understanding of ATP as the universal energy currency. It then delves into mitochondrial oxidation, the electron transport chain, oxidative phosphorylation, lipid synthesis, protein degradation, and the metabolism of biogenic amines, providing insights into cellular energy production and metabolism. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Fundamental energetics of biochemical processes and chemical logic of metabolic pathways. | U | C | Instructor-created exams / Quiz |
| CO2 | Knowledge on the concepts to illustrate how enzymes and redox carriers and the oxidative phosphorylation machinery occur. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | To evaluate coupled reactions and their role in metabolism and Chemiosmotic hypothesis of ATP synthesis. | E | P | Seminar Presentation / Group Tutorial Work |
| CO4 | To describe the transportation of reducing potentials into mitochondria. | A | P | Instructor-created exams / Home Assignments |
| CO5 | To describe Inhibitors of ETC and inhibitors and uncouplers of oxidative phosphorylation. | A | P | One Minute Reflection Writing assignments |
| CO6 | To Illustrate the catabolism of lipids, Metabolism of ketone bodies and amino acids | A | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Bioenergetics** | | |
| | 1 | Introduction, Thermodynamics (Brief study) and relevance in the biological system (Brief study). Free energy change. Difference between $\Delta G$ and $\Delta G^{o}$. | 2 |
| | 2 | The requirement of free energy for cells, coupling reactions, ATP cycle | 1 |
| | 3 | Phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard free energy of ATP hydrolysis, other phosphorylated compounds and thioesters | 2 |
| | 4 | ATP as universal energy currency in the biological system, | 1 |
| | 5 | Role of high energy phosphates in energy transfer-redox potential, biological oxidation | 2 |

| | | | |
|---|---|---|---|
| **II** | **Mitochondrial Oxidation and Electron Transport Chain** | | |
| | 5 | Ultra Structure of mitochondria | 2 |
| | 6 | Pyruvate oxidation and formation of reducing equivalents in TCA cycle, inhibitors | 3 |
| | 7 | Electron transport chain - its organization (sequence of electron carriers: NADH ubiquinone dehydrogenase, Succinate dehydrogenase, cytochrome reductase, and cytochrome oxidase) | 3 |
| | 8 | Events of electron transport chain | 2 |
| | 9 | Inhibitors of ETC | 2 |
| | 10 | The amphibole nature of TCA cycle | 3 |
| **III** | **Oxidative Phosphorylation** | | |
| | 11 | Oxidative phosphorylation and mechanism of ATP synthesis. | 2 |
| | 12 | Peter Mitchell's chemiosmotic hypothesis (an outline) P/O ratio, Proton motive force. FoF1 ATP synthase - structure | 2 |
| | 13 | Regulation of oxidative phosphorylation. Inhibitors and uncouplers. | 1 |
| | 14 | Transport of reducing potentials into mitochondria and metabolite transporters in mitochondria. | 2 |
| | 15 | Control of ATP production | 2 |
| | 16 | Thermogenesis. | 1 |
| **IV** | **Lipid synthesis, Protein degradation &Metabolism of Biogenic amines** | | |
| | 17 | Fatty acid synthesis overview, Fatty acid synthase complex | 2 |
| | 18 | The events of fatty acid synthesis, Elongases and desaturases, Inhibitors | 2 |
| | 19 | The transport of mitochondrial acetyl co A to cytosol, Disorders of fatty acids synthesis | 2 |
| | 20 | Catabolism of amino acids Protein Degradation<br>Protein degradation, Proteasome mediated cellular protein degradation, ubiquitin and proteases | 2 |
| | 21 | Metabolism of biogenic amines<br>Fate of carbon skeleton of amino acids | 2 |
| | 22 | One carbon metabolism, functions & biosynthesis of polyamines.<br>Functions of biogenic amines(brief study) | 2 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | Assay of Transaminases | |
| | 2 | Estimation of inorganic phosphate | |
| | 3 | Estimation of serum urea | |

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**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO2 | 3 | 2 | - | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO3 | 3 | 2 | - | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO4 | 3 | 2 | - | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO5 | 3 | 2 | - | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO6 | 3 | 2 | - | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)

- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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**SEMESTER VI**

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Human Physiology | | | | |
| Type of Course | Major | | | | |
| Semester | VI | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | Basics of human body systems and functions | | | | |
| Course Summary | The course provides a comprehensive understanding of human body function, covering topics such as digestion, blood biochemistry, cardiac function, respiration, renal function, muscle physiology, and endocrinology. From the molecular mechanisms of muscle contraction to the hormonal regulation of various physiological processes, students will gain practical skills in laboratory techniques to analyze blood components, urine volume, and hemoglobin levels, enhancing their understanding of human physiology through hands-on experience. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Develop an overview of the concepts of normal biological functions in the human body. | U | C | Instructor-created exams / Quiz |
| CO2 | Evaluate functions of major human organs and explain the role in the maintenance of healthy individuals | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Explain the interplay between different organ systems and how organs and cells interact to maintain biological equilibrium in the face of a variable and changing environment. | U | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Obtain critical knowledge of circulation, biochemistry of blood, muscle function and movement, respiration, kidney, osmoregulation, bones and neuronal function . | U | P | Instructor-created exams / Home Assignments |
| CO5 | Evaluate the endocrine system and function. | U | P | One Minute Reflection Writing assignments |
| CO6 | Pursue further studies in physiology and related fields as well as multi-disciplinary subjects that require an understanding of physiology of humans. | A | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Introduction to physiology & Digestion and absorption** | | |
| | 1 | Functional organization of the human body: extracellular and intracellular fluids, constituents and characteristics of extracellular fluid, homeostasis. . | 2 |

| | | | |
|---|---|---|---|
| | 2 | An overview of coordination between major functional systems of the human body | 2 |
| | 3 | Functions of different gastrointestinal organs in digestion and absorption, secretion of digestive fluids and enzymes, activation of digestive enzymes, gastrointestinal hormones, epithelial transport of solutes. | 2 |
| | 4 | Digestion and absorption of carbohydrates, proteins, lipids, vitamins and minerals, composition, types, and function of bile, enterohepatic circulation | 2 |
| **II** | **Biochemistry of Blood & cardiac function** | | |
| | 5 | Constituents of blood, types of blood cells, components of plasma, plasma proteins-types, and functions. Serum, composition. | 2 |
| | 6 | Formation of blood cells, blood groups, bleeding time | 1 |
| | 7 | Mechanism of blood clotting (intrinsic and extrinsic pathway). | 2 |
| | 8 | Clotting time, Clotting factors and anticoagulants | 1 |
| | 9 | Structure and function of hemoglobin, types of hemoglobin, formation and destruction of hemoglobin | 2 |
| | 10 | Functions of CVS, circulation of blood. | 2 |
| | 11 | Blood pressure, clinical methods of measuring Blood pressure. | 1 |
| | 12 | Vasoconstrictors and vasodilators | 1 |
| **III** | **Biochemistry of respiration and renal function** | | |
| | 13 | Pulmonary volumes, pulmonary capacity, Blood flow through lungs and its distribution. | 3 |
| | 14 | Transport of oxygen and carbon dioxide in the blood, The role of haemoglobin and Carbonic anhydrase. | 3 |
| | 15 | Chloride shift, Oxygen dissociation curve and Bohr effect, The role of 2,3-bisphosphoglycerate, Respiratory exchange ratio. | 3 |
| | 16 | Renal excretory mechanism, Glomerular filtration, Tubular reabsorption of glucose, water and electrolytes, Tubular secretion.<br>Regulation of water and electrolyte balance.<br>Respiratory and renal regulation of pH. | 3 |
| **IV** | **Biochemistry of Specialized tissues & endocrinology** | | |
| | 17 | Muscle: Muscle proteins, Organization of contractile unit and mechanism of muscle contraction (Sliding filament theory). | 2 |

| | | | |
|---|---|---|---|
| | 18 | Maintenance of ATP availability in active muscle, the role of creatine and creatine kinase, , fuel metabolism in muscle | 2 |
| | 19 | Neurons- ultra structure, Mechanism of nerve impulse transmission, neurotransmitters, acetylcholine, GABA, serotonin, dopamine | 2 |
| | 20 | Bone-Role of calcium, phosphorus, vitamin D in bone metabolism. Collagen in bone formation, Bone disorders | 2 |
| | 21 | Organization of the endocrine system. Hormone secretion, transport, and clearance from blood,General mechanism of hormone action- | 2 |
| | 22 | Classification of hormones and hormone action- type I and type II hormones. Concept of second messengers- cAMP, DAG, IP3, G protein. A brief study of chemistry and major physiological functions of hormones of Hypothalamus (vasopressin, oxytocin), Pituitary (growth hormone, corticotropic hormone, thyroid-stimulating hormone, gonadotropic hormone), Adrenal (epinephrine, glucocorticoids, mineralocorticoids), Thyroid (thyroxine, calcitonin), Parathyroid, Pancreas (insulin, glucagon) and Gonads (androgen, estrogen | 3 |
| **V(open module)** | **Practicals** | | **30Hrs** |
| | 1 | Basics of Hemocytometer | |
| | 2 | Blood count, TC & DC | |
| | 3 | Blood grouping | |
| | 4 | Clotting and bleeding time. | |
| | 5 | Determination of hemoglobin levels | |
| | 6 | Packed cell volume | |
| | 7 | Erythrocyte sedimentation rate | |
| | 8 | Total urine volume -Collection of urine 24 hrs basis | |

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**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | 2 | - | 3 | - | 2 | - | 2 | - |
| CO2 | 3 | 2 | 1 | - | 2 | - | 3 | - | 2 | - | 2 | - |
| CO3 | 3 | 3 | 1 | - | 2 | 1 | 3 | - | 2 | - | 3 | - |
| CO4 | 3 | 2 | 1 | - | 2 | - | 3 | - | 2 | - | 3 | - |
| CO5 | 3 | 2 | 1 | - | 2 | - | 3 | - | 2 | - | 3 | - |
| CO6 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 2 | 3 | - |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Intermediary Metabolism III | | | | |
| Type of Course | Major | | | | |
| Semester | VI | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | Good base on intermediary metabolism | | | | |
| Course Summary | This course offers an extensive exploration of biochemical pathways, covering the biosynthesis of cholesterol, complex lipids, amino acids, nucleotides, and the metabolic disorders associated with these pathways. From understanding the synthesis of steroid hormones and neurotransmitters to the regulation of photosynthesis and photophosphorylation in plants, students will delve into the molecular intricacies of metabolic processes through both theoretical and practical components, enhancing their understanding of cellular metabolism and its physiological implications. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Evaluate biosynthesis of cholesterol & cholesterol derivatives. | U | C | Instructor-created exams / Quiz |
| CO2 | Understand the synthesis of amino acid and their derivatives. | U | C | Practical Assignment / Observation of Practical Skills |

| | | | | |
|---|---|---|---|---|
| CO3 | Evaluate the biosynthesis of purines and pyrimidines, degradation of nucleotides | U | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Explain the structure and functions of plant pigments. | U | P | Instructor-created exams / Home Assignments |
| CO5 | Compare the mechanisms of photosynthesis and photophosphorylation in plants. | U | C | One Minute Reflection Writing assignments |
| CO6 | Obtain detailed knowledge about metabolic disorders. | U | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Biosynthesis of cholesterol and complex lipids** | | |
| | 1 | Cholesterol biosynthesis (structure not needed), Regulation | 2 |
| | 2 | Derivatives from cholesterol and its significance. | 2 |
| | 3 | A brief account of the committed steps in the cholesterol biosynthesis pathway. Synthesis of steroid hormones from cholesterol (structure not needed) | 2 |
| | 4 | Synthesis and degradation of Phospholipids, glycolipids (Brief study). | 2 |
| | 5 | Functions and synthesis of lipoproteins - HDL, LDL, VLDL & Chylomicron | 2 |
| **II** | **Biosynthesis of amino acids** | | |
| | 6 | A brief outline of the synthesis of aromatic amino acids, Biosynthesis of glycine, valine and methionine | 2 |
| | 7 | Derivatives from amino acids | 2 |
| | 8 | Biosynthesis of creatine and creatinine, catecholamine (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA. Biological importance | 2 |
| | 9 | Heme - Porphyrin biosynthesis ( structure not required) | 2 |
| | 10 | One carbon metabolism | 2 |
| | 11 | Disorders of amino acid synthesis | 2 |
| **III** | **Metabolism of Purine and pyrimidine nucleotides & metabolic disorders** | | |

| | | | |
|---|---|---|---|
| | 12 | De novo synthesis of purine and pyrimidine nucleotides, regulation, salvage pathways (structure not required). | 2 |
| | 13 | Biosynthesis of deoxyribonucleotides and its regulation. | 2 |
| | 14 | Conversion to triphosphates | 1 |
| | 15 | Biosynthesis of coenzyme nucleotides (structure not required). | 1 |
| | 16 | Degradation of purine and pyrimidine nucleotides (structure not required | 2 |
| | 17 | Metabolic Disorders<br>Disorders of AminoAcid and Carbohydrate metabolism: Hyper phenylalaninemia , Alkaptonuria , Disorders of lysine metabolism , Disorders of tyrosine metabolism , Disorders of glycogen storage ,Disorders of fructose metabolism ,Disorders of Galactose metabolism Pentosuria, | 3 |
| | 18 | Disorders of Lipids and Nucleic Acids : Lipid storage diseases, Down's syndrome and Turner's syndrome , Hyperuricemia and Gout , Xanthinuria and Lesch-Nyhan syndrome. | 2 |
| IV | **Photosynthesis and Photophosphorylation** | | |
| | 19 | Ultrastructure and organization of chloroplast membranes. | 2 |
| | 20 | Structure, and functions of chlorophylls, xanthophylls, carotenoids and other plant pigments Light reactions, | 3 |
| | 21 | Functions and mechanisms of action of photoreceptor proteins in plants. | 2 |
| | 22 | Photosynthesis and pathway of carbon dioxide fixation: Cyclic and noncyclic phosphorylation, Calvin cycle, regulation of photosynthesis, photorespiration and the glycolate pathway, C4 pathway, Crassulacean acid metabolism | 3 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | Estimation of serum free fatty acids | |
| | 2 | Estimation of total cholesterol | |
| | 3 | Estimation of serum creatinine | |
| | 4 | Estimation of catecholamines | |

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2. D.L. Nelson and M. M. Cox. Lehninger Principles of Biochemistry: Worth Publishers, 41 Madisons Avenue New York, USA

3. Thomas M. Devlin.

Textbook of Biochemistry with clinical correlations. Wiley Publishers

4. Lubert Stryer, Biochemistry, 4th edition, W.H. Freeman & Co, 1995

5. J. L. Jain, Sunjay Jain, and Nitin Jain. Fundamentals of Biochemistry,Publishers: S.Chand & Co Ltd. New Delhi. 2008

6. U. Satyanarayana, U. Chakrapani. Biochemistry. books and Allied (P) Ltd

7. Debajyoti Das. Biochemistry, Academic Publishers, 1978

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO2 | 3 | 2 | - | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO3 | 3 | 2 | - | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO4 | 3 | 2 | 1 | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO5 | 3 | 2 | 1 | 1 | 2 | - | 3 | - | 2 | 1 | 3 | - |
| CO6 | 3 | 2 | 1 | 2 | 2 | 1 | 3 | - | 2 | 1 | 3 | - |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Clinical Biochemistry | | | | |
| Type of Course | Major | | | | |
| Semester | VI | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | A good base in intermediary metabolism, skill in biochemistry lab instrumentation. | | | | |
| Course Summary | The course provides a comprehensive understanding of clinical practices and laboratory techniques essential for medical diagnostics and healthcare management. From the principles of good clinical practices and quality control in laboratory settings to the analysis of various body fluids and organ function tests, students will develop practical skills in sample collection, preservation, and analysis, ensuring accurate diagnosis and patient care. Additionally, it covers topics such as health, hygiene, and nutrition, emphasizing the importance of public health interventions, hygiene practices, and community nutrition programs in promoting overall well-being. Through theoretical knowledge and hands-on practical sessions, students will be equipped to contribute effectively to healthcare delivery and public health initiatives. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Aware of the fundamental biochemistry knowledge related to health. and hygiene | A | C | Instructor-created exams / Quiz |
| CO2 | Explain the clinical significance of the laboratory tests. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Diagnosis of clinical disorders by estimating biomarkers. | A | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Evaluate the abnormalities which commonly occur in the human body. | E | P | Instructor-created exams / Home Assignments |
| CO5 | List the types of biological samples and their pre-analytical variables. | A | P | One Minute Reflection Writing assignments |
| CO6 | Explain the principle of estimating some common biomolecules and organ functions tests. | A | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Good clinical practices** | | |
| | 1 | Basics and principles, Requirements for setting up of a clinical laboratory, SI units in the clinical laboratory | 2 |
| | 2 | Collection, preparation, preservation, and handling of clinical samples, . | 2 |
| | 3 | Quality control, Automation in the clinical laboratory | 2 |
| | 4 | Sample identification by bar coding-automation in the analysis. | 2 |
| | 5 | Safety measures in the clinical laboratory, Familiarization of biochemical charts from clinical labs | 2 |

| | | | |
|---|---|---|---|
| **II** | **Analysis of body fluids** | | |
| | 6 | Blood: Routine examinations –TC, DC, ESR, PCV, blood groups and Rh factor incompatibility, prothrombin time, Bleeding & clotting time. | 3 |
| | 7 | Lipid profile: determination & significance of HDL-LDL ratio. | 2 |
| | 8 | Clinical significance of blood glucose, GTT. | 2 |
| | 9 | Serum cholesterol, albumin, creatinine, Na+, K+, Cl- and phosphate, Total protein, albumin, globulin, albumin-globulin ratio, etc. | 2 |
| | 10 | Urine: Normal and abnormal constituents, procedures of qualitative analysis, interpretation and clinical significance. | 2 |
| | 11 | Chemistry, composition, and functions of CSF, Lymph and Synovial Fluid. Semen, Feces | 2 |
| | 12 | Precautions during human body fluid collection and preservation, Ethical issues with human samples for analysis | 2 |
| **III** | **Organ function tests** | | |
| | 13 | Normal functions of the liver, liver function tests, hepatitis types, cirrhosis, alcoholic liver disease, and disorders of bilirubin metabolism. | 3 |
| | 14 | Normal functions of the kidney, Renal function tests, Glomerular filtration rate, Renal threshold and clearance values for urea and creatinine, renal failure and proteinuria. | 3 |
| | 15 | Normal functions of thyroid, Thyroid function test, thyroid disorders | 2 |
| | 16 | Cardiac function tests, Tests associate with brain function, Biochemical tests associate with cancer | 2 |
| **IV** | **Health, hygiene & Nutrition** | | |
| | 17 | Concepts of public health, its components interventions. | 1 |
| | 18 | Hygiene its relevance, personal and public places. | 1 |
| | 19 | Precautions during health emergencies. | 1 |
| | 20 | Laws and regulations on health and hygiene. | 2 |
| | 21 | Community nutrition program, Role of diet in health, Concepts of nutrition, nutrients, balanced diet, Caloric values of foods,<br>basal metabolic rate (BMR), factors affecting BMR, determination of BMR, respiratory quotient. | 2 |
| | 22 | Social aspects of nutrition - problems, social action, Nutritional significance of proteins, fats, carbohydrates, fiber, vitamins.<br>Energy requirements, recommended Dietary Allowances. | 3 |

| | | | |
|---|---|---|---|
| | | Nitrogen balance, protein-energy malnutrition, glycemic index. | |
| **V (open module)** | **Health, hygiene & Nutrition** | | **30** |
| | 1 | Collection of body fluids and preservation | |
| | 2 | Blood analysis | |
| | 3 | Urine analysis ( abnormal constituents) | |
| | 4 | Blood glucose estimation | |
| | 5 | GTT | |
| | 6 | Liver function tests | |
| | 7 | Renal function tests | |
| | 8 | Cardiac function tests | |

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1. Ramnik Sood. Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers, 2006.

2. Harper's Biochemistry Ed. R.K. Murray, D.K. Granner, P.A. Mayes& V.W. Rodwell.

3. Human Nutrition and Dietetics. Davidson and Passmore. Churchill Livingstone; 8th edition (1986)

4. Shivaraja Shankara YM. Laboratory Manual for Practical Biochemistry, Jaypee Brothers Medical Publishers 2013.

5. M Swaminathan. Advanced textbook on food & nutrition, Bapcco Publisher, 2015

6. B. Srilakshmi. Nutritional science B. Srilakshmi, New Age International, 2006

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9. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Publishers.

10. Burtis & Ashwood W.B. Tietz Textbook of Clinical Chemistry. Saunders Company


**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 2 | 1 | 3 | - | 2 | 1 | 3 | - |
| CO2 | 3 | 2 | 1 | 1 | 2 | 1 | 3 | - | 2 | 1 | 3 | - |
| CO3 | 3 | 2 | 1 | 2 | 2 | 1 | 3 | - | 2 | 1 | 3 | - |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 2 | 1 | 2 | 2 | 1 | 3 | - | 2 | 1 | 3 | - |
| CO5 | 3 | 2 | 1 | 1 | 2 | 1 | 3 | - | 2 | 1 | 3 | - |
| CO6 | 3 | 2 | 1 | 2 | 2 | 1 | 3 | - | 2 | 1 | 3 | - |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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**SEMESTER VII**

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Genetic engineering | | | | |
| Type of Course | Major | | | | |
| Semester | VII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | In this course, students dive into the realm of recombinant DNA technology, starting with fundamental principles and progressing to advanced techniques like cloning vectors, expression systems, and gene transfer methods. They explore gene manipulation techniques, transgenic animal creation, genome editing using CRISPR-Cas, and gene silencing mechanisms such as RNA interference. The course also covers biosafety guidelines and regulatory aspects of genetic engineering research and the release of genetically modified organisms. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Evaluate the principles, and enzymes employed in the genetic engineering process. | E | C | Instructor-created exams / Quiz |
| CO2 | Analyse the vectors used in Recombinant DNA technology | An | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Describe different gene transfer methods | A | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Describe and apply the screening and selection of recombinants and methods employed for DNA amplification and separation. | A | P | Instructor-created exams / Home Assignments |
| CO5 | Explain the application of genetic engineering. | A | P | One Minute Reflection Writing assignments |

| | | | | |
|---|---|---|---|---|
| CO6 | Discuss about the pros and cons of transgenic plants and animals. | | | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Unit I** | | |
| | 1 | Recombinant DNA Technology: basic principles | 3 |
| | 2 | Restriction endonucleases | 1 |
| | 3 | Cloning vectors: plasmid vectors, phage vectors, cosmid vectors | 2 |
| | 4 | High capacity cloning vectors- BACs, PACs, YACs and human artificial chromosomes | 3 |
| **II** | **Unit II** | | |
| | 5 | Cloning strategies: Directional Cloning, Blunt ended cloning; Cloning of fusion proteins; Introducing of tags to cloned proteins. | 3 |
| | 6 | Library Construction: cDNA and genomic DNA libraries | 2 |
| | 7 | cDNA cloning and cloning from genomic DNA. | 2 |
| | 8 | Expression systems: Expression vectors for optimum protein synthesis, solubilization of expressed proteins. | 2 |
| | 9 | Prokaryotic expression systems; Eukaryotic expression systems; Insect cell expression systems- baculovirus transfer vector. | 2 |
| | 10 | Gene transfer methods: Physical, Chemical and Biological. | 1 |
| | 11 | Screening of recombinants: Marker inactivation, nucleic acid hybridization and immunological screening for expressed genes. | 1 |
| **III** | **Unit III** | | |
| | 12 | Techniques in gene manipulation: Site directed mutagenesis; Random mutagenesis using PCR; | 2 |
| | 13 | Protein engineering to improve enzymes | 3 |
| | 14 | DNA shuffling. | 3 |
| | 15 | Transgenic Animals/ Cells: Transgenic animal, Retroviral DNA microinjection and engineered stem cells methods for producing transgenic mice. | 3 |
| | 16 | Whole body Knock outs and conditional knock outs. | 2 |
| | 17 | Use of CRISPR-CAS in generation of gene knock outs. | 2 |
| | 18 | Genome editing: Genome editing strategies based on Homologous recombination, ZFN, TALENS, CRISPR/Cas9 | 3 |

| | | | |
|---|---|---|---|
| **IV** | **Unit IV** | | |
| | 19 | Gene silencing: Transcriptional gene silencing –Genomic imprinting, effect of paramutation, position effect, | 2 |
| | 20 | RNA directed DNA methylation, role of transposon silencing in gene expression. | 2 |
| | 21 | Post-translational gene silencing – RNA interference, siRNA and miRNA mediated gene silencing, | 2 |
| | 22 | Anti-sense RNA technology. | 2 |
| **V (Open Module)** | **Unit V** | | |
| | 23 | Biosafety guidelines in rDNA technology- Role of IBSC, RCGM and GEAC in genetic engineering research and release of GMOs/LMOs. | 8 |

**REFERENCES**

1. Gene cloning and DNA analysis – An introduction. 7th Edition Wiley Blackwell 2016

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3. Lewins Gene XII. J.E Krebs, E.S Goldstein, S.T Kilpatrick. 2018

4. Molecular Cloning- a Laboratory Manual- Joseph Sambrook and Russell (2002) 3rd edn., CSHL Press

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO6 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | |
|---|---|
| Programme | B. Sc. Biochemistry |
| Course Code | |
| Course Title | Enzymes: Kinetics, Mechanisms and Regulation |
| Type of Course | Major |
| Semester | III |
| Academic Level | 400 |

| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
|---|---|---|---|---|---|
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | In this comprehensive course on enzyme kinetics, mechanisms and regulatory aspects students explore the fundamental principles of enzyme action, including substrate specificity, Michaelis-Menten kinetics, and multi-substrate reactions. They delve into the mechanisms of various enzymes and their regulation, including allosteric enzymes and feedback inhibition, and learn about the practical applications of enzymes in various industries, from pharmaceuticals to molecular biology research. The course includes hands-on practical sessions for students to gain experience in enzyme purification and analysis techniques. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Recognize enzymes as important molecules that act as catalysts in biological systems, understand the basics of enzyme kinetics, to generate in-depth knowledge in different aspect of enzyme kinetics | A | C | Instructor-created exams / Quiz |
| CO2 | Identify and evaluate the type and mode of action of an enzyme from E.C. number of that enzyme, Explain mechanisms enzyme catalysis, thermodynamics, kinetics, molecular interactions and regulatory aspects. And problem solving | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Interpret and explain significant mechanisms of regulation of enzymatic action and specify importance of enzymes in regulation of metabolism and to develop collaborative learning and presentation skills | A | P | Seminar Presentation / Group Tutorial Work |

| | | | | |
|---|---|---|---|---|
| CO4 | To analyze the levels up to global standards in the area of enzyme mechanism | An | P | Instructor-created exams / Home Assignments |
| CO5 | Draw kinetic plots and calculate kinetic parameters from experimental data. Analyze enzyme inhibition and regulation. | A | P | One Minute Reflection Writing assignments |
| CO6 | Design step wise protocols for the extraction, purification and characterization of enzymes from different sources, and to develop scientific curiosity. | C | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Enzyme kinetics** | | |
| | 1 | Importance of enzymes in biological systems, active site, substrate specificity, mechanism of action of different coenzymes in specific reaction types, | 1 |
| | 2 | Derivation of Michaelis-Menten equation for uni- substrate reactions. | 1 |
| | 3 | Different plots for the determination of Km & Vmax and their physiological significance | 2 |
| | 4 | Importance of Kcat/Km. Kinetics of zero & first order reactions. | 1 |
| | 5 | Significance and evaluation of energy of activation. Collision & transition state theories. | 1 |
| | 6 | Michaels – pH functions & their significance | 2 |
| | 7 | Classification of multi substrate reactions with examples of each class. Derivation of the rate of expression for Ping Pong, random & ordered Bi-Bi mechanisms. | 1 |
| | 8 | Use of initial velocity, inhibition and exchange studies to differentiate between multi substrate reaction mechanisms | 1 |
| | 9 | Reversible and irreversible inhibition. Competitive, non-competitive, uncompetitive, Suicide inhibition, linear-mixed type inhibitions and their kinetics, determination of KI | 2 |

| | | | |
|---|---|---|---|
| **II** | **Mechanism of Enzyme Action** | | |
| | 10 | Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. | 3 |
| | 11 | Chemical modification of active site groups | 2 |
| | 12 | Mechanism of action of chymotrypsin, carbonic anhydrases, lysozyme, glyceraldehyde 3-phosphate dehydrogenase, aldolase, carboxypeptidase, triose phosphate isomerase and alcohol dehydrogenase. | 2 |
| | 13 | Experimental approaches to the determination of enzyme mechanisms | 2 |
| **III** | **Enzyme Regulation** | | |
| | 14 | General mechanisms of enzyme regulation, product inhibition. Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modifications of enzymes, Mono cyclic and multicyclic cascade systems with specific examples | 3 |
| | 15 | Feedback inhibition and feed forward stimulation. Allosteric enzymes, qualitative description of "concerted" & "sequential" models for allosteric enzymes. | 2 |
| | 16 | Half site reactivity, Flip-flop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamoylase & phosphofructokinase. | 3 |
| | 17 | Protein-ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots | 2 |
| **IV** | **Multienzyme systems and application of enzymes** | | |
| | 18 | Multienzyme system – Occurrence, isolation & their properties. Mechanism of action and regulation of pyruvate dehydrogenase & fatty acid synthase complexes, Enzyme-enzyme interaction | 3 |
| | 19 | Multiple forms of enzymes with special reference to lactate dehydrogenase | 3 |
| | 20 | Applications of enzymes in Industry | 3 |
| | 21 | Applications in Pharmaceuticals, diagnostics & Applications in molecular biology research | 2 |
| | 22 | Enzyme purification<br>Extraction and purification of enzymes from different sources. Criteria of purity | 3 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | The theoretical aspects of an assay, activity, specific activity, Units of enzyme | |
| | 2 | Assay of Alpha amylase from saliva | |
| | 3 | Assay of Beta amylase from plants | |
| | 4 | Assay of Trypsin | |
| | 5 | Effect of Temperature, Ph, and Substrate concentration on velocity | |

| | | | |
|---|---|---|---|
| | 6 | Construction of progressive curve, double reciprocal plot using assay data. | |
| | 7 | Inhibition studies using trypsin inhibitors | |
| | 8 | Construction of kinetic curves using inhibition data. (Dixon curve) | |
| | 9 | Enzyme purification from animal & plant and microbial sources. | |

**REFERENCES**


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2. Enzyme Kinetics: Catalysis & Control A Reference of Theory and Best-Practice Methods, Daniel L. Purich , Academic press.

3. The Enzymes edited by David S Sigman volume XX Mechanisms of catalysis third edition academic press, inc. 1992

4. The Enzymes kinetics and mechanism volume I1 Third Edition Edited by Paul D. Boyer academic press, New York and London 1970

5. Allosteric regulatory enzymes by Thomas Traut © 2008 Springer Science+Business Media, LL 2007

6. Lubert Stryer: Biochemistry, 5th edn. (Freeman)


**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO6 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | |
|---|---|
| Programme | B. Sc. Biochemistry |
| Course Code | |
| Course Title | Microbial Biochemistry |
| Type of Course | Major |

| | | | | | |
|---|---|---|---|---|---|
| Semester | VII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | | | | | |
| Course Summary | This course provides a comprehensive introduction to microbial biochemistry and basic microbiology, covering topics such as microbial diversity, growth, and metabolism. Students learn about the unique biochemical features of microorganisms, their classification, and applications in research and industry, including the production of antibiotics and fermented foods. Practical sessions enable hands-on experience in microbiological techniques, cultivation of bacteria, and the application of microbial enzymes in various industries. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Explain the significance of microbial diversity in various environments and their pivotal role in biogeochemical processes and classify microbes using molecular level approaches used in microbial taxonomy. | A | C | Instructor-created exams / Quiz |
| CO2 | Explain virus structure, viral replication and cultivation. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Illustrate staining techniques for visualization and identification of microbes, methods of sterilization, disinfection and safe handling of microorganisms and discuss the preparation and maintenance of | A | P | Seminar Presentation / Group Tutorial Work |

| | | | | |
|---|---|---|---|---|
| | microbial cultures, applications of microbes in research and industry and concepts of environmental microbiology. | | | |
| CO4 | Identify microbial enzymes and their applications in food processing, bioprocessing and pharmaceutical industries. | A | P | Instructor-created exams / Home Assignments |
| CO5 | Enumerate the types and applications of microbial secondary metabolites. | A | P | One Minute Reflection Writing assignments |
| CO6 | Illustrate microbial toxins and the xenobiotic metabolism in microbes and develop expertise in bacterial culture and staining techniques. | An | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Microbial Biochemistry** | | |
| | 1 | Overview of microbial diversity, | 2 |
| | 2 | Importance of microbes in biogeochemical cycles, | 2 |
| | 3 | Unique biochemical features of microorganisms, | 2 |
| | 4 | Biochemical basis of microbial motility and chemotaxis | 2 |
| **II** | **Basic microbiology** | | |
| | 5 | Brief History of microbiology. | 1 |
| | 6 | Classification of microorganisms. | 1 |
| | 7 | Viruses-structure, viral replication and cultivation | 2 |

| | | | |
|---|---|---|---|
| | 8 | Various staining techniques for visualization and identification of microbes | 2 |
| | 9 | Methods of sterilization and disinfection | 2 |
| | 10 | Instructions for safe handling of microorganisms | 2 |
| | 11 | Instrumentation of microbiology lab | 2 |
| **III** | **Microbial growth and application of microbes in research and industry** | | |
| | 14 | Cultivation and growth of bacteria, pure culture techniques. | 2 |
| | 15 | Different types of bacteriological media | 2 |
| | 16 | Bacterial growth curve, and measurement of growth, control of growth. | 2 |
| | 17 | Application of microbes in Biochemical research, industrial production of antibiotics and other organic substances. | 2 |
| | 18 | Microbiology of fermented foods, Food spoilage and preservation processes. | 2 |
| | 19 | Different types of microbial fermentation and Bioreactors | 3 |
| | 20 | Enzymes and their role in microbial metabolism | 2 |
| **IV** | **Applications of microbial enzymes in industry and research** | | |
| | 21 | Bacterial proteinases, Amylases, Amyloglucosidases, Glucose Oxidases, Glucose dehydrogenases,glucose isomerases, beta galactosidases, Invertases, Pectic enzymes, Cellulases. General Aspects of Secondary Metabolism, Bacterial antibiotics, types, Microbial Siderophores, Peptide Antibiotics, Lantibiotics, Glycopeptide Antibiotics, Aminoglycosides and Sugar Components in Other Secondary Metabolites, Cyclosporins | 5 |
| | 22 | Biochemistry of Bioluminescence; Bioluminescent bacteria, Bacterial toxins - Fungal toxins: - aflatoxins and ochratoxins, Biochemistry of methanogenesis, Microbial metabolism of Xenobiotics and steroid transformation. | 5 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | Familiarization of equipments used for bacterial culture | |
| | 2 | Sterilization techniques | |
| | 3 | Culture Media preparation | |
| | 4 | Streaking | |
| | 5 | Bacterial culture (broth culture, agar plate culture) | |

| | | | |
|---|---|---|---|
| | 6 | Staining (Gram's staining, Acid fast staining) | |

**REFERENCES**


1. Fundamentals of Microbiology, Aleamo Edward, Jones & Barret Publications, Massachusetts

2. Textbook of Microbiology, Anantha Narayanan & Jayaram Panicker, Orient Longmann.

3. Industrial Microbiology, Reed Gerald, Prescott and Dunn's, CBS Publications.

4. Microbology, Pelezar Michael J, Mc Graw Hill.

5. Biotechnology Second Edition Volume 7. Products of Secondary Metabolism Edited by H.-J. Rehm and G. Reeding cooperation with A. Piihler and P. Stadler

6. Enzyme and Microbial Technology 31 (2002) 804–826

7. Microbial/enzymatic synthesis of chiral intermediates for pharmaceuticals, Ramesh N. Patel Process Research & Development, Bristol-Myers Squibb Pharmaceutical Research Institute, New Brunswick, NJ 08903, USA.

8. Signposts to Chiral Drugs, Organic Synthesis in Action Vitomir S unjic l Michael J. Parnham , Springer Basel AG 2011.


**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |
| CO6 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | 2 | 1 | 3 | 2 |

**Correlation Levels:**

| Level | Correlation |
|---|---|

| | |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Research Methodology | | | | |
| Type of Course | Major | | | | |
| Semester | VII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | | | | | |

| | |
|---|---|
| Course Summary | This course equips students with essential research skills and methodologies necessary for conducting scientific investigations. They learn how to select topics, plan research projects, and prepare proposals effectively. Through hands-on training in literature collection, digital library search techniques, and data analysis using statistical software, students develop proficiency in gathering and analyzing research data. Practical sessions focus on thesis writing, including structuring, citing references, and manuscript preparation for publication in peer-reviewed journals, while also addressing ethical considerations like plagiarism and understanding the publication process. Finally, an open module explores avenues for publishing research findings in newspapers, newsletters, and peer-reviewed journals. |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Analyze the basics in research methodology and applying them in research/project work | An | C | Instructor-created exams / Quiz |
| CO2 | Apply an appropriate research design. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Take up and implement research project. | C | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Acquire skills to perform literature review, using internet | A | P | Instructor-created exams / Home Assignments |
| CO5 | Analyze the data, know the different types of data and know the different way to present the data scientifically and systematically. | An | P | One Minute Reflection Writing assignments |
| CO6 | Identify the components of a thesis, understand the purpose of thesis and practice writing and improving thesis statements. | A | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | | |
| | 1 | Topic selection - Planning research – defining objectives | 2 |
| | 2 | Preparation of work plans. Identification of suitable methodology - | 2 |
| | 3 | Preparation of project proposal – | 3 |
| | 4 | Summer Schools –Training in research institutes | 2 |
| **II** | | | |
| | 5 | Collection of literature- News articles – Newsletters – Magazines – Books - Journals. | 2 |
| | 6 | Bibliographic management software- end note, mendeley | 2 |
| | 7 | Digital library and search of articles - Keywords and search | 2 |
| | 8 | Internet :Google Scholar | 2 |
| | 9 | PubMed | 2 |
| | 10 | Inflibnet – Medline – Agricola | 3 |
| | 11 | Science direct -Open access Journals | 2 |
| | 12 | Virtual sources – other sources. Short communications | 2 |
| | 13 | Review articles | 2 |
| **III** | | | |
| | 14 | Collection of protocols and selection of suitable methods according to work plan. | 2 |
| | 15 | Observational and experimental research | 2 |
| | 16 | Data analysis, Construction of tables, headings - footer – Tabulation, Presentation of results - Use of statistical software to analyze the results: SPSS | 3 |
| **IV** | | | |
| | 17 | Thesis structure –Components - Writing Introduction – review of literature –Materials & Methods – Presentation of results –. | 3 |
| | 18 | Discussion of Results based on literature – Arriving at conclusions – Preparation of Summary/abstract – | 2 |
| | 19 | Arrangement of Bibliography and how to quote reference in thesis - Appendix | 2 |
| | 20 | Paper presentation in Conferences. | 2 |
| | 21 | Plagiarism – types, checking software | 2 |
| | 22 | Submission and Publication – reprints and pdf formats. Science citation index – impact factor and importance. Manuscripts preparation for Journals – components | 2 |

| | | | |
|---|---|---|---|
| **V (Open module)** | 23 | Publishing of Articles in newspapers /newsletters - | 6 |
| | 24 | Selection of journals – ISSN Number –Peer reviewed Journals | 6 |

References

. 1. Anderson, Durston & Polle 1970: Thesis and assignment, writing. Wiley Eastern Limited.

2. Booth W. C. et al. 2016. The Craft of Research. University of Chicago Press.

3. Rajendrakumar C. 2008. Research Methodology. APH Publishing Corporation.

4. Kothari C. R. 2004. Research Methodology. New Age International Publishers.

5. Gurumani, N. 2006. Research Methodology for Biological Sciences. MJP. Publishers.

6. Marczyk, G., DeMatteo, D., Festinger, D. 2005. Essentials of research design and methodology. John Wiley.

7. Katz, M. J. 2009. From Research to Manuscript: A Guide to Scientific Writing. Springer.

8. Michael Alley. The Craft of Scientific Writing (3rd Edition) Publisher: Springer.

9. Cargill, M., O. Connor, P. 2013. Writing Scientific Research Articles: Strategy and Steps. Wiley-Blackwell.

10. Blake, G. and Bly, R. W. 2000. The Elements of Technical Writing. Pearson.

11. Reep, D. C. 2014. Technical Writing: Principles, Strategies, and Readings. Longman.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | 2 | 2 | 1 | - | 3 | 2 | 2 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 | - | 3 | 2 | 2 | 2 | 1 |
| CO3 | 2 | 3 | 3 | 2 | 2 | 1 | - | 3 | 2 | 2 | 2 | 1 |
| CO4 | 2 | 3 | 3 | 2 | 2 | 1 | - | 3 | 2 | 2 | 2 | 1 |
| CO5 | 2 | 3 | 3 | 2 | 2 | 1 | - | 3 | 2 | 2 | 2 | 1 |
| CO6 | 2 | 3 | 3 | 2 | 2 | 1 | - | 3 | 2 | 2 | 2 | 1 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | |
|---|---|
| Programme | B. Sc. Biochemistry |
| Course Code | |
| Course Title | Biochemical Toxicology |
| Type of Course | Major |
| Semester | VII |
| Academic Level | 400 |

| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
|---|---|---|---|---|---|
| | 4 | 4 | - | - | 60 |
| Pre-requisites | | | | | |
| Course Summary | In this course, students delve into the fundamentals of toxicology, exploring topics such as biomarkers, acute and chronic exposures, and criteria of toxicity. They learn about factors influencing toxicity, dose-response relationships, and the principles and procedures of testing for acute toxic effects. Additionally, the course covers various types of metabolic changes, detoxification mechanisms, and the toxic responses to foreign compounds, including the role of diet in diseases and the toxicity of metals. The open module delves into advanced topics like chemical carcinogenesis, tissue lesions, developmental toxicology, and multiorgan toxicity, providing a comprehensive understanding of biochemical mechanisms of toxicity. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Evaluate the basics of toxicology | E | C | Instructor-created exams / Quiz |
| CO2 | Analyse factors affecting toxic response | An | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Apply test procedures related to toxic tests | A | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Evaluate toxic response to foreign compounds | E | P | Instructor-created exams / Home Assignments |
| CO5 | Analyse food toxicology | An | P | One Minute Reflection Writing assignments |
| CO6 | Describe how toxins affect organs | A | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Unit I** | | |
| | 1 | Fundamentals of toxicology | 2 |

| | | | |
|---|---|---|---|
| | 2 | Biomarkers of toxicity | 2 |
| | 3 | Acute and Chronic exposures | 2 |
| | 4 | Criteria of toxicity. Interactions | 2 |
| | 5 | Synergism and Antagonism | 2 |
| | 6 | Determination of ED50 & LD50, Dose response | 2 |
| | 7 | Hazard and risk assessments, factors influencing toxicity | 2 |
| | 8 | Pharmacodynamics & Chemo dynamics | 3 |
| **II** | **Unit II** | | |
| | 9 | Factors affecting toxic response | 2 |
| | 10 | Disposition; Absorption, distribution, excretion and metabolism. | 2 |
| | 11 | Types of Metabolic changes: Phase I reactions- Oxidation, Reduction, Hydrolysis and Hydration | 3 |
| | 12 | Phase II reactions/Conjugation- Methylation, Glutathione and amino acid conjugations. | 3 |
| | 13 | Detoxification mechanisms of Toxicity | 2 |
| **III** | **Unit III** | | |
| | 14 | Principles & Procedures of testing for acute toxic effects. | 2 |
| | 15 | Regulatory guidelines, Mammalian systems affected & the clinical signs of Systemic toxicity. Toxicity testing: Test Protocol, | 2 |
| | 16 | Genetic toxicity testing & Mutagenesis assays: Use of Drosophila in Toxicity testing. DNA repair assays | 3 |
| | 17 | *In vitro* Test systems– Bacterial Mutation Tests: Reversion Test, Fluctuation Tests and Eukaryotic Mutation Tests. Chromosome damage test. | 2 |
| | 18 | Toxicological evaluation of recombinant DNA derived proteins. | 2 |
| **IV** | **Unit IV** | | |
| | 19 | Toxic Responses to Foreign Compounds: Direct Toxic Action: Tissue Lesions. Mechanism and response in cellular toxicity.Pharmacological, physiological and Biochemical effects. | 2 |
| | 20 | Metabolism of Haloalkanes, Haloalkenes&Paracetamol with their toxic effects on tissues | 2 |
| | 21 | Food toxicology: Role of diet in cardio-vascular diseases and cancer. Toxicology of food additives | 2 |
| | 22 | Metal toxicity: Toxicology of Arsenic, mercury, lead and cadmium, Environmental factors affecting metal toxicity – effect of light, temperature & PH | 2 |

| | | | |
|---|---|---|---|
| **V (Open module)** | **Unit V** | | |
| | 23 | Chemical Carcinogenesis. Biochemical Mechanisms of Toxicity | 3 |
| | 24 | Tissue Lesions-organs and damage – Liver,kidney , Lung Heart, Neuron. | 3 |
| | 25 | Diagnosis of toxic changes in liver and kidneys | 3 |
| | 26 | Developmental Toxicology- Teratogenesis.Immunotoxicity, Genetic Toxicity. Multiorgan toxicity. | 3 |

**REFERENCES**


1 Principles of Biochemical Toxicology by John A. Timbrell, 4th edition, Informa Healthcare publications, 2009

2 Environmental Toxicology by Sigmund F. Zakrzewski, Oxford University Press, USA, 2002

3 Principles Of Toxicology by: Karen E Stine, Thomas M Brow, Crc press publications, 2006

4 A Textbook of Modern Toxicology, edited by Ernest hodgson , 4th Edition, wiley publications

5 General and Applied Toxicology by Marrs and Turner, Macmillan Press Ltd.

6 Basic Environmental Toxicology by Lorris G. Corkerthm and Barbara S S Shane CRP Press Inc.

7 Introduction to Food Technology by TakayurkiShibamato& Leonard F. Bzeldanes.

8 Molecular Biotechnology by Barnard R Glick & J JPastmak.


**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | - | 2 | 2 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | - | 2 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | - | 2 | 2 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | - | 2 | 2 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | - | 2 | 2 | 3 | 2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO6 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | - | 2 | 2 | 3 | 2 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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**SEMESTER VIII**

| | |
|---|---|
| Programme | B. Sc. Biochemistry |
| Course Code | |
| Course Title | Bioinformatics |

| | | | | | |
|---|---|---|---|---|---|
| Type of Course | Major | | | | |
| Semester | VIII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | | | | | |
| Course Summary | In this course on bioinformatics and computational biology, students are introduced to the fundamental concepts and tools used in analyzing biological data. They learn about data mining techniques and how they are applied in bioinformatics, as well as the organization and utilization of biological databases. Sequence alignment is covered in detail, including pairwise and multiple sequence alignment methods, and students delve into phylogenetics, protein structure analysis, and prediction methods. Practical sessions provide hands-on experience with bioinformatics tools and techniques, allowing students to apply their knowledge to real-world biological data analysis. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Demonstrate proficiency in utilizing data mining techniques and biological databases to retrieve, organize, and analyze biological data effectively. | U | C | Instructor-created exams / Quiz |
| CO2 | Perform sequence alignment using various algorithms and tools, interpret the results, and apply them to identify sequence similarities and evolutionary relationships. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Develop the skills to predict protein structures, including secondary and tertiary structures, and classify them into structural classes, motifs, folds, and domains. | A | P | Seminar Presentation / Group Tutorial Work |

| | | | | |
|---|---|---|---|---|
| CO4 | Gain competence in phylogenetic analysis, including constructing phylogenetic trees based on distance-based methods and understanding the evolutionary relationships among biological sequences. | An | P | Instructor-created exams / Home Assignments |
| CO5 | Demonstrate proficiency in protein structure analysis, including predicting structural classes, performing structural alignments, and utilizing molecular visualization tools for structural analysis and modeling. | Ap | P | One Minute Reflection Writing assignments |
| CO6 | Apply computational methods such as molecular docking and homology modeling to predict protein-ligand interactions and infer protein function based on structural information. | Ap | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Introduction** | | |
| | 1 | Introduction to bioinformatics and computational biology | 1 |
| | 2 | Data mining, application of data mining in Bioinformatics | 1 |
| | 3 | Biological databases and search tools, data organization, sequence databases, structural databases, derived and specialized databases, | 2 |
| | 4 | DNA and RNA sequence databases, protein sequence databases, genomic databases, mutation and polymorphism databases | 2 |
| | 5 | Data deposition | 2 |
| **II** | **Sequence Alignment** | | |
| | 6 | Basics of sequence alignment -pair wise alignment. | 3 |

| | | | |
|---|---|---|---|
| | 7 | Dynamic programming algorithms(brief study | 2 |
| | 8 | Shotgun DNA sequencing) | 2 |
| | 9 | End space free alignment.Multiple sequence alignment | 2 |
| | 10 | Generating motifs and profile, local and global alignment. | 3 |
| | 11 | Algorithms for multiple sequence alignment( Needle-wunsch, Smith Waterman, BLAST, PSI BLAST, PHI BLAST | 3 |
| **III** | **Phylogenetics** | | |
| | 12 | Introduction to phylogenetics study | 2 |
| | 13 | Distance based tree UPGMA trees | 2 |
| | 14 | Protein secondary and tertiary structure prediction methods. Ab-initio approaches | 3 |
| | 15 | Threading.structural genomics | 3 |
| **IV** | **Protein Structure Analysis** | | **12** |
| | 16 | Three dimensional structure of proteins | 1 |
| | 17 | Prediction of structural classes, motifs, folds and domains, | 2 |
| | 18 | Classification of three dimensional structures in Brookhaven protein data bank (HSSP, SCOP, FSSP, CATH); | 2 |
| | 19 | Protein structure prediction, structural alignment methods, molecular visualization tools-RasMol, RASWIN | 2 |
| | 20 | Basics of molecular docking | 1 |
| | 21 | Binding energy levels in different interactions | 2 |
| | 22 | Homology modelling | 2 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | Using Swiss-Prot, GenBank and PDB | |
| | 2 | Similarity search - BLAST | |
| | 3 | Multiple Sequence Alignment - CLUSTAL W | |
| | 4 | Secondary Structure Prediction of Protein | |
| | 5 | Protein/Nucleotide Sequence Analysis using EMBOSS | |
| | 6 | Molecular Visualisation of Protein- RASMOL | |

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3. David. W. Mount .Bioinformatics: Sequence and Genome Analysis.CBS publishers.

4. C.A. Orengo, D.T.Jones and J.M. Thornton. Bioinformatics: Genes, proteins and computers. Taylor & Francis,2002

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**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 1 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 1 |

**Correlation Levels:**

| Level | Correlation |
|---|---|

| | |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | |
|---|---|
| Programme | B. Sc. Biochemistry |
| Course Code | |
| Course Title | Nutritional Aspects of Biochemistry |
| Type of Course | Major / Minor |
| Semester | VIII |

| | | | | | |
|---|---|---|---|---|---|
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | | | | | |
| Course Summary | This course provides a comprehensive understanding of food and nutrition, covering topics such as basic food groups, calorific and nutritive values, and factors affecting basal metabolic rate and respiratory quotient. Students learn about the physiological roles and nutritional significance of macronutrients, vitamins, minerals, and nutraceuticals, along with the importance of dietary fiber, prebiotics, and probiotics. Additionally, the course explores the concept of a balanced diet, food-related disorders, the role of diet in health conditions like cardiovascular disease and cancer, and the use of food additives in food processing and preservation. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Evaluate the role of nutrients in maintaining proper health | E | C | Instructor-created exams / Quiz |
| CO2 | Analyse the nutritional significance of carbohydrates, lipids and proteins. | An | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Explain the nutritional significance of vitamins , minerals | A | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Describe the importance of a balanced diet. | A | P | Instructor-created exams / Home Assignments |
| CO5 | Explain the effect of additives, emulsifiers, flavour enhancing substances in food. | A | P | One Minute Reflection Writing assignments |
| CO6 | Evaluate the significance of nutraceuticals. | E | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Unit I** | | |
| | 1 | Basic food groups-energy yielding, body building and functional foods. | 2 |
| | 2 | Calorific and nutritive value of foods.Measurement of Calories by bomb calorimeter. | 2 |
| | 3 | Basal metabolic rate (BMR)- definition, determination of BMR and factors affecting BMR. | 2 |
| | 4 | Respiratory quotient (RQ) of nutrients and factors affecting the RQ | 2 |
| **II** | **Unit II** | | |
| | 5 | Physiological role and nutritional significance of carbohydrates, lipids and protein. | 3 |
| | 6 | Protein Energy Ratio and Net Protein Utilization. Protein energy malnutrition – Kwashiorkor and Marasmus | 3 |
| | 7 | Sources and functions of dietary fats, role of fats in health and diseases. | 3 |
| | 8 | Obesity-Types and preventive measures | 2 |
| | 9 | Role of dietary fiber in nutrition | 2 |
| | 10 | Prebiotics and probiotics | 2 |
| **III** | **Unit III** | | |
| | 11 | Vitamins-definition, classification, sources, properties, functions and deficiency symptoms. Recommended daily allowances. | 2 |
| | 12 | Minerals Role of minerals on human health, sources, biological functions, deficiency Disorders, Minerals in biological systems and their importance –Iron, Calcium, Phosphorus, Iodine, Copper, Zinc | 3 |
| | 13 | Nutraceuticals : Definition, properties and function of Nutraceuticals. | 2 |
| | 14 | Food Supplements and functional Foods. Food as medicine. | 2 |
| | 15 | Natural pigments from plants– carotenoids, anthocyanins and its benefits | 2 |
| **IV** | **Unit IV** | | |
| | 16 | Balanced diet, example of low and high cost balanced diet | 2 |
| | 17 | For infants, children, adolescents, adults and elderly people | 2 |
| | 18 | ICMR classification of five food groups and its significance food pyramid | 2 |
| | 19 | Junk foods- definition and its adverse effects | 2 |
| | 20 | Role of diet in cardiovascular disease | 2 |
| | 21 | Role of diet in cancer | 2 |
| | 22 | Food and Allergy | 2 |

| | | | |
|---|---|---|---|
| **V (Open module)** | **Unit V** | | |
| | | Food additives: Structure, chemistry, function and application of preservatives, emulsifying agents, buffering agents, stabilizing agents, natural and artificial sweeteners, antimicrobials, food emulsions, gelling agents, food colors, flavors, anti-caking agent and antioxidants. | 12 |

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3. Advances in food biochemistry, FatihYildiz (Editor), CRC Press, Boca Raton, USA, 2010

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5. Geoffrey Campbell-Platt. 2009. Food Science and Technology. Wiley-Blackwell, UK.


**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO6 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 2 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| Programme | B.Sc Biochemistry | | | | |
|---|---|---|---|---|---|
| Course Code | | | | | |
| Course Title | Cancer Biology | | | | |
| Type of Course | Major | | | | |
| Semester | VIII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | | | | | |
| Course Summary | This course offers a comprehensive study of cancer biology, covering topics such as the biology and genetics of cells, mechanisms of apoptosis, and the role of oncogenes and tumor suppressor genes in cancer induction. Students explore the mechanisms of tumor metastasis, including angiogenesis, invasion, and cell proliferation, as well as the immune response to cancer and mechanisms of tumor evasion. Additionally, the course delves into current topics in cancer research, including cancer | | | | |

| | |
|---|---|
| | vaccines, chemoprevention, and molecular targets for cancer therapy, providing students with a broad understanding of cancer biology and its therapeutic implications. |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Demonstrate a comprehensive understanding of the biology and genetics of cancer cells and organisms, including the mechanisms of apoptosis, oncogene activation, and tumor suppressor gene function. | A | C | Instructor-created exams / Quiz |
| CO2 | Analyze the molecular mechanisms underlying tumor initiation, progression, and metastasis, including the role of growth factors, tumor antigens, and immune evasion strategies employed by cancer cells. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Evaluate the impact of environmental factors, chemical carcinogens, and viral infections on the development and progression of cancer, integrating concepts from chemical and physical carcinogenesis theories. | A | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Assess the complex interactions between tumor cells and the immune system, including mechanisms of tumor evasion and the rational design of cancer immunotherapies. | A | P | Instructor-created exams / Home Assignments |
| CO5 | Demonstrate proficiency in analyzing current topics in cancer research, such as cancer vaccine | A | P | One Minute Reflection Writing assignments |

| | | | | |
|---|---|---|---|---|
| | development, chemoprevention strategies, and the molecular targets for novel anticancer therapies. | | | |
| CO6 | Develop understanding of cancer biology to critically evaluate and propose rational treatment approaches, including chemotherapy, radiotherapy, immunotherapy, and targeted therapy, towards the goal of improving cancer patient outcomes. | Ap | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Introduction** | | |
| | 1 | Biology and Genetics of Cells and Organisms | 2 |
| | 2 | The Nature of Cancer | 2 |
| | 3 | Origin and Terminology. apoptosis -Historical perspectives | 2 |
| | 4 | Biochemical mechanisms of apoptosis, caspases , bcl-2 family, Role of mitochondria in apoptosis, Resistance to apoptosis in cancer | 3 |
| **II** | **Oncogenes and cancer induction** | | |
| | 5 | Tumor suppressor genes, retroviral oncogenes, proto oncogenes. | 2 |
| | 6 | Tumorigenesis. Chemical and physical carcinogenesis. Theories of carcinogenesis | 2 |
| | 7 | Malignant Transformation of Cells, characteristics of transformed cells, Transformation of animal cells by tumor viruses | 2 |
| | 8 | Virus host interactions – morphological and biochemical studies. | 2 |
| | 9 | DNA Tumor Viruses, SV40 and Polyoma , Papilloma Viruses E6 and E7 , Adenoviruses E1A and E1B , Hepatitis B Virus , Herpes Viruses | 2 |
| **III** | **Mechanisms of tumor metastatses** | | |
| | 10 | Metastatic cascade – Angiogenesis, cell Attachment (Selectins & Integrins) | 3 |

| | | | |
|---|---|---|---|
| | | | |
| | 11 | Invasion and Cell Proliferation. Receptors, and Cancer. | 3 |
| | 12 | Role of growth factors in Carcinogenesis. Growth Factors | 3 |
| | 13 | Tumor Antigens - tumor-specific transplantation antigens (TSTAs) and tumor-associated transplantation antigens (TATAs) | 2 |
| | 14 | Chemically or physically induced Tumor antigens. Oncofetal tumor antigens, oncogene proteins as tumor antigens | 2 |
| | 15 | Diversity Of The T Cell Repertoire Against Tumor Antigens - Targets Of Tumor Reactive T Cells, TCR Diversity Among Tumor Reactive T Cells, Effect of TCR V Gene Usage on Tumor Antigen Recognition. | 2 |
| | 16 | Factors that influence T cell recognition of tumor cells. | 2 |
| IV | **Mechanisms of the Immune Response to Cancer** | | |
| | 17 | Danger Theory , Role of Gene Rearrangement in the Tumor Response | 2 |
| | 18 | Heat Shock Proteins as Regulators of the Immune Response , Inflammation and Cancer. | 2 |
| | 19 | Mechanism of Tumor Evasion - Escaping the Immune Response. | 2 |
| | 20 | Changes in tumor cells - Selection of Resistant Tumor Cells, Decreased HLA Antigen and Co-stimulatory Signal Expression. Changes in cell mediated immune response in cancer - | 2 |
| | 21 | Changes in Antigen Presenting Cells, Induction of Regulatory T Cells, Apoptosis of Effector T Cells, Changes in T Cell Signal Transduction, Mechanisms Leading to Alterations in T Cell Signal Transduction Rational Treatment of Cancer, | 2 |
| | 22 | Manipulation of Co-Stimulatory Signals, Enhancement of APC Activity, Cytokine Therapy, Monoclonal Antibodies, Drug therapy, Radiotherapy. Cancer Immunotherapy | 2 |
| **V (Open module)** | **Chemoprevention and treatment** | | |
| | 23 | Diet and cancer, Chemo prevention, Molecular targets for chemoprevention. Chemoprevention of cancer through dietary and nutritional agents. | 4 |
| | 24 | Antimutagens and carcinogen-blocking agents - isothiocyanates, oltipraz , other organosulfur compounds , Anti proliferative agents. Antitumor agents. Antibiotics, toxin immune conjugates and immune modulators. | 4 |
| | 25 | Current Topics in Cancer Research – Cancer Vaccine Development | 4 |

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2. Introduction to the cellular and molecular biology of cancer margaret a. Knowlespeter j. Selby. Oxford University Press

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7. Kuby Janis, Immunology, W H Freeman, New York

8. Roitt Ivan et al, Immunology, Mosby, London

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO6 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Endocrinology | | | | |
| Type of Course | **Discipline Specific Major** | | | | |
| Semester | VIII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course introduces the fundamentals of endocrinology, covering the organization of the endocrine system, hormone classification, and their effects on tissue response. It further explores the general mechanisms of | | | | |

| | |
|---|---|
| | hormone action, including hormone receptors, second messenger systems, and various hormones' biosynthesis, chemistry, and physiological functions. Additionally, it addresses hormonal effects, regulation, and disorders of endocrine glands, encompassing feedback mechanisms, hormonal disorders such as thyroid diseases, diabetes, adrenal disorders, and growth hormone-related conditions. |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Gain an in-depth understanding of basic principles, concepts, various classes and the chemistry of hormones. | U | C | Instructor-created exams / Quiz |
| CO2 | Understand the mechanisms of action and the concept of second messengers | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Familiarize with various endocrine glands with emphasis and focus on individual tissues and their respective hormones including the pituitary, pancreatic, adrenal, thyroid and reproductive systems | A | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Attain an idea of the site of biosynthesis of various hormones and acquire a thorough comprehension of the physiological functions of important hormones. | A | C | Instructor-created exams / Home Assignments |
| CO5 | Familiarization of hormonal effects and feedback mechanisms | A | C | One Minute Reflection Writing assignments |
| CO6 | Develop the ability to integrate across multiple endocrine systems to better understand the complexity of endocrine-related disorders. | An | C | Viva Voce |

| |
|---|
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Endocrinology** | | |
| | 1 | Organization of endocrine system- major glands of endocrine system | 3 |
| | 2 | Chemical Classification of Hormones-Peptide, amino acid derived and steroid hormones. | 2 |
| | 3 | Effects of Hormone Concentrations on Tissue Response | 2 |
| **II** | **General mechanism of hormone action** | | |
| | 4 | Mechanism of action of different hormones – Peptide hormones and steroid hormones | 3 |
| | 5 | Hormone receptors and target tissues | 2 |
| | 6 | Hormones that bind to nuclear receptor proteins | 2 |
| | 7 | Hormones that use second messengers- Adenylate Cyclase—Cyclic AMP Second Messenger System, Phospholipase C-$Ca^{2+}$ Second-Messenger System, Tyrosine Kinase Second-Messenger System | 3 |
| **III** | **Site of biosynthesis, chemistry and major physiological functions of various Hormones** | | |
| | 8 | Hypothalamic Control of the Anterior & Posterior Pituitary, Releasing and Inhibiting Hormones, Hormones of anterior and posterior pituitary gland | 2 |
| | 9 | Growth hormone (GH) | 2 |
| | 10 | Thyroid-stimulating hormone (TSH) | 2 |
| | 11 | Adrenocorticotropic hormone (ACTH) | 2 |
| | 12 | Follicle-stimulating hormone (FSH), Luteinizing hormone (LH), Prolactin (PRL) | 2 |
| | 13 | Feedback Control of the Anterior Pituitary | 2 |
| | 14 | Vasopressin & oxytocin | 2 |
| | 15 | Hormones of pancreas (glucagon, insulin), | 2 |

| | | | |
|---|---|---|---|
| | 16 | Hormones of adrenal gland- adrenal cortex (corticosteroids - mineralocorticoids, glucocorticoids, androgens) & medulla (epinephrine and norepinephrine), | 3 |
| | 17 | Hormones of the thyroid gland- tetraiodothyronine ($T_4$), or thyroxine triiodothyronine ($T_3$) | 2 |
| | 18 | Hormones of gastrointestinal tract (gastrin, secretin and cholecystokinin). | 2 |
| **IV** | **Hormonal effects and regulation** | | |
| | 19 | Feedback mechanisms, Signal transduction pathways for steroidal and non-steroidal hormones | 2 |
| | 20 | Permissive, additive, and synergistic actions of hormones- Permissive actions of steroid hormones | 2 |
| | 21 | Role of protein kinases and phosphoprotein phosphatases in hormone action | 2 |
| | 22 | Additive effects of hormones- epinephrine and glucagon, Synergism- FSH and LH, Receptor regulation | 2 |
| **V (open module)** | **Disorders of endocrine glands** | | |
| | 23 | Causes, risk factors, symptoms associated with endocrine disorders, prevention & treatment of endocrine disorders | 3 |
| | 24 | Diseases of the thyroid gland- iodine-deficiency goiter, Comparison of Hypothyroidism and Hyperthyroidism, myxedema, Graves' disease, cretinism, | 3 |
| | 25 | Diseases of the Pancreas- Diabetes | 2 |
| | 26 | Diseases of the adrenal gland- Addison's disease, Cushing's disease | 2 |
| | 27 | Growth hormone- Gigantism, acromegaly, dwarfism, Androgens - Polycystic ovary syndrome (PCOS) | 2 |

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**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | 2 | 2 | 3 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | 2 | 2 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | 2 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | 2 | 2 | 3 |
| CO6 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 2 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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**Multidisciplinary Courses (MDC)**

| Programme | B. Sc. Biochemistry | | | | |
|---|---|---|---|---|---|
| Course Code | | | | | |
| Course Title | Food Biochemistry and Quality control | | | | |
| Type of Course | MultidisciplinaryCourse (MDC) | | | | |
| Semester | I | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 3 | 2 | - | 2 | 30T+ 30P=60hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course provides a comprehensive overview of food chemistry, covering chemical reactions in food processing and storage, biochemical changes in food spoilage, fundamentals of carbohydrates, proteins, lipids, and vitamins, as well as microbiological aspects of food safety. It also explores food additives and contaminants, food technologies, quality control systems, and practical sessions focusing on chemical analysis of lipids and proteins, analysis of water, and chromatography demonstrations. Regulatory frameworks for food safety and quality assurance are also discussed, including FDA, USDA, and EU regulations. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the fundamental principles of food biochemistry | U | C | Instructor-created exams / Quiz |
| CO2 | Explore advanced concepts in protein, lipid, and carbohydrate chemistry. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Develop proficiency in advanced analytical techniques for food analysis. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Investigate microbiological aspects of food safety and quality. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Evaluate the role of food additives and contaminants in food quality and safety. | U | C | One Minute Reflection Writing assignments |
| CO6 | Understand quality control systems and regulatory compliance in the food industry. | U | C | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to food chemistry** | | |
| | 1 | Chemical reactions in food processing and storage: Maillard reaction, lipid oxidation, enzymatic browning. | 2 |
| | 2 | Biochemistry of food spoilage, Biochemical changes and changes in the quality characteristics of food structure, taste, color, aroma, nutritional value – Organoleptic control. | 2 |

| | | | |
|---|---|---|---|
| | 3 | Browning reaction in foods: Enzymatic and non-enzymatic browning in foods of vegetable and animal origin during storage and processing of foods. | 2 |
| | 4 | Basic principles for the preservation of food and its ingredients | 2 |
| **II** | **Fundamentals of Food Chemistry- Carbohydrates, Proteins, Lipids and Vitamins** | | |
| | 5 | The basic ingredients of food – their role in food industry. | 2 |
| | 6 | Sugar, starch, cellulose, glucans, hemicelluloses, gums, pectic substances, polysaccharides. | 2 |
| | 7 | Resistant Starches and Dietary Fibre – Definition, Sources and Functions. Modified starches. | 2 |
| | 8 | Concept of protein quality, dietary requirements, deficiency symptoms, Single cell proteins. Stress and Anti-freeze Proteins, Protein Isolates and Concentrates. | 3 |
| | 9 | Egg proteins, meat proteins, fish muscle proteins, Oil seed proteins and cereal proteins. | 2 |
| | 10 | Classification and physico-chemical properties of food lipids, Refining of crude oils, hydrogenation and winterization. Vegetable and animal fat, margarine, lard, butter. Frying and shortening. Flavor changes in fats and oils. | 2 |
| | 11 | Lipid oxidation, factors affecting lipid oxidation, auto oxidation, biological significance of auto-oxidation of lipids. | 2 |
| | 12 | Role of vitamins in food industry, effect of various processing treatments and fortification of foods. Food sources, effects of deficiency. | 2 |
| | 13 | Role of minerals in food industry, effects of various processing treatments. Effects of excess, if any, and deficiency. | 2 |
| | 14 | Emulsion: Definition, Theory, Emulsifiers: Properties, role & action in stabilizing an emulsion. | 2 |
| **III** | **Microbiological Aspects of Food Safety** | | |
| | 15 | Microbial hazards in food: bacteria, molds, yeasts, viruses. Fermentations: Exploitation of the action of micro-organisms and enzymes in food production. | 2 |

| | | | |
|---|---|---|---|
| | 16 | Microbiological testing methods: plate count methods, PCR-based techniques, immunological assays. | 2 |
| | 17 | Emerging issues in food microbiology: antimicrobial resistance, foodborne pathogens. | 2 |
| **IV** | **Food Additives and Contaminants & Quality Control Systems** | | |
| | 18 | Types and functions of food additives: preservatives, antioxidants, colorants, flavour enhancers. | 2 |
| | 19 | Food contaminants: pesticides, heavy metals, mycotoxins. | 2 |
| | 20 | Food technologies: pasteurization, sterilization, cooling, freezing, irradiation, canning, food dehydration. | 2 |
| | 21 | Principles of Total Quality Management (TQM) and Six Sigma in the food industry. Controlled Modified Atmosphere Packaging (MAP) and smart packaging. | 2 |
| | 22 | Implementation of Good Manufacturing Practices (GMP), ISO 9001 and Hazard Analysis and Critical Control Points (HACCP). Regulatory frameworks for food safety and quality assurance including FDA, USDA, and EU regulation. | 2 |
| **V (Open module)** | **Practicals** | | **30Hrs** |
| | 1 | Chemical Analysis of Lipids: Determination of Iodine value, saponification value, peroxide value and Free Fatty Acid. | |
| | 2 | Analysis of Protein: Estimation of protein by Kjeldahl's methods. | |
| | 3 | Analysis of Water: Estimation of Total solids, Acidity of water, Alkalinity of water, Determination of Chloride, and Hardness of water. | |
| | 4 | Demonstration of Paper chromatography. | |
| | 5 | Determination of ash content | |

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2. Frazier J & Westhoff DC, 1988. Food Microbiology. MC Graw Hill, New York.
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5. Jay J M, Loessner MJ & Golden D A, 2005. Modern Food Microbiology, Springer Verlag

6. Black J G. Microbiology, Principles and Explorations John Wiley.

7. Ananthanarayanan R Jayaram Paniker CK, 2009. Text book of Microbiology. University Press Pvt Ltd, Hyderabad

8. Meyer, L.H 1987 Food Chemistry CBS publishers.

9. Belitz, H.D 1999 Food Chemistry Springer Verlag.

10. Ranganna S 2001.Hand book of analysis and quality control of fruits and vegetable products Tata- McGraw- Hill.

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**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | 2 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 3 | 2 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 1 | 3 | 2 | 2 | 3 |
| CO6 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 1 | 3 | 2 | 2 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Biochemistry of Lifestyle Disorders | | | | |
| Type of Course | MultidisciplinaryCourse (MDC) | | | | |
| Semester | II | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 3 | 4 | - | - | 60hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course provides an overview of biochemistry principles and lifestyle disorders, including obesity, diabetes, and cardiovascular diseases, linking lifestyle choices with biochemical processes and emphasizing the role of diet, exercise, smoking, and alcohol consumption in preventing disorders. It explores metabolic pathways and diseases such as carbohydrate metabolism in diabetes, lipid metabolism in cardiovascular diseases, and protein metabolism in obesity, along with physiological responses like oxidative stress, inflammation, hormonal regulation, epigenetics, and gene expression in health impacts. Additionally, it covers disease mechanisms, interventions, lifestyle medicine, and advanced applications including recent research trends and future directions. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Demonstrate a comprehensive understanding of fundamental principles in biochemistry and their application to lifestyle disorders. | U | C | Instructor-created exams / Quiz |
| CO2 | Identify, describe, and differentiate between common lifestyle disorders, including obesity, diabetes, and cardiovascular diseases. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Propose and justify dietary and lifestyle interventions for the management and prevention of metabolic disorders, considering their biochemical underpinnings. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Explain the physiological responses to oxidative stress and inflammation in the context of lifestyle disorders and their impact on overall health. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Discuss the hormonal regulation of metabolism and its implications for the development and management of lifestyle diseases. | U | C | One Minute Reflection Writing assignments |
| CO6 | Understand the influence of epigenetics on gene expression and susceptibility to lifestyle diseases, and its relevance to disease prevention strategies. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **I** | **Fundamentals of Biochemistry and Lifestyle Disorders** | | |
| | 1 | Introduction to Biochemistry Principles | 2 |
| | 2 | Overview of Lifestyle Disorders | 2 |
| | 3 | Obesity | 2 |
| | 4 | Diabetes | 2 |
| | 5 | Cardiovascular Diseases | 2 |
| | 6 | Linking Lifestyle Choices with Biochemical Processes | 2 |
| | 7 | Importance of lifestyle factors in preventing disorders: Role of diet and exercise | 3 |
| | 8 | Role of smoking and alcohol consumption | 2 |
| **II** | **Metabolic Pathways and Diseases** | | |
| | 9 | Carbohydrate Metabolism and Diabetes | 3 |
| | 10 | Lipid Metabolism and Cardiovascular Diseases | 2 |
| | 11 | Protein Metabolism and Obesity | 2 |
| **III** | **Physiological Responses and Health Impacts** | | |
| | 12 | Oxidative Stress in Lifestyle Disorders | 3 |
| | 13 | Inflammation in Lifestyle Disorders | 2 |
| | 14 | Hormones and Metabolic Regulation | 3 |
| | 15 | Epigenetics and Lifestyle | 2 |
| | 16 | Gene Expression and Disease Development | 3 |
| **IV** | **Disease Mechanisms and Interventions** | | |
| | 17 | Understanding Cancer: Cell Cycle Regulation, Apoptosis, and Metastasis | 3 |
| | 18 | Nephritis: Inflammatory Pathways, Renal Function, Electrolyte Balance | 3 |
| | 19 | Dietary and Lifestyle Interventions for Managing Diseases | 3 |
| | 20 | Life style medicine | 2 |
| **V (open module)** | **Advanced Applications** | | |
| | 21 | Discussion of Recent Research and Trends | 6 |
| | 22 | Future Interventions and Research Directions | 6 |

**REFERENCES**

1. Textbooks:

1 Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox

2 Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer

3 Medical Biochemistry" by John W. Baynes and Marek H. Dominiczak

2 Journals and Review Articles:

The New England Journal of Medicine"

Annual Review of Biochemistry"

- "Trends in Biochemical Sciences"

- "Diabetes Care"

- "Journal of Lipid Research"

- "Cell Metabolism"

- "Nature Reviews Molecular Cell Biology"

- "Obesity Reviews"

- "Cardiovascular Research"

- "Journal of Clinical Investigation"

3. Online Resources:

- National Institutes of Health (NIH) - https://www.nih.gov/

- National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) - https://www.niddk.nih.gov/

- American Heart Association (AHA) - https://www.heart.org/

- American Diabetes Association (ADA) - https://www.diabetes.org/

- World Health Organization (WHO) - https://www.who.int/

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | - | 2 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 | 2 | 3 | 3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 | 2 | 3 | 3 |
| CO6 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 2 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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## Value Added Courses (VAC)

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Biochemical tests for Food Adulteration | | | | |
| Type of Course | Value Added Course (VAC) | | | | |
| Semester | III | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 3 | 3 | - | 2 | 75 hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course comprehensively covers the topic of food adulteration, starting with an introduction to its definition, types, and common adulterants. It then delves into biochemical techniques for detecting various types of adulterants in food products, including carbohydrates, fats, minerals, vitamins, and heavy metals. Advanced biochemical tests such as enzyme-based assays and immunoassays are also discussed, along with interpretation of test results, reporting, legal considerations, and public awareness initiatives. Practical sessions offer hands-on experience in detecting adulteration in different food products and conducting qualitative tests. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Identify various types of adulterants commonly found in food products. | U | C | Instructor-created exams / Quiz |
| CO2 | Perform a range of biochemical tests to detect adulteration in different food matrices. | U | C | Practical Assignment / Observation of Practical Skills |

| | | | | |
|---|---|---|---|---|
| CO3 | Interpret test results and assess the extent of adulteration in food samples. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Identify quality control measures to ensure the accuracy and reliability of test results. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Discuss the implications of food adulteration on public health. | U | C | One Minute Reflection Writing assignments |
| CO6 | Describe regulatory policies on food adulteration. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Food Adulteration** | | |
| | 1 | Definition and types of food adulteration. Examples of common adulterants and their effects on food quality. | 2 |
| | 2 | Motives behind food adulteration. Impact of food adulteration on health and society. | 2 |
| | 3 | Common Adulterants and detection methods**.** Detection of adulteration in milk and dairy products, oils and fats, spices and condiments, grains, cereals and beverages (e.g., juices, alcohol). | 2 |
| **II** | **Biochemical Techniques to evaluate adulteration** | | |
| | 4 | Overview of biochemical reactions involved in adulteration tests. Factors influencing test sensitivity and specificity. | 2 |
| | 5 | Selecting appropriate tests for different types of adulterants. Factors influencing test accuracy and reliability. | 2 |

| | | | |
|---|---|---|---|
| | 6 | Detection of Carbohydrate Adulterants: Tests for sugar adulteration: Benedict's test, Fehling's test, and Barfoed's test. | 2 |
| | 7 | Detection of starch adulteration: Iodine test, Molisch's test, and Reducing sugar test. | 2 |
| | 8 | Analysis of Fat Adulterants. | 2 |
| | 9 | Evaluation of mineral adulterants: Ash content determination. | 2 |
| | 10 | Examination of Vitamin Adulteration. Methods for detecting vitamin adulterants | 2 |
| | 11 | Detection of heavy metals: Chromatographic techniques, Spectrophotometry. | 2 |
| | 12 | Vitamin fortification and adulteration in fortified foods. Chromatographic techniques (e.g., HPLC, GC) for precise detection and quantification | 3 |
| | 13 | Case studies on food adulteration | 2 |
| **III** | **Advanced biochemical tests for food adulteration** | | |
| | 14 | Principles of enzyme-based assays for detecting adulterants (e.g., urease test for milk adulteration). Applications and limitations of enzyme assays. | 2 |
| | 15 | Introduction to immunoassays (e.g., ELISA) for detecting food adulterants. | 2 |
| | 16 | Advantages and challenges of immunological methods in food analysis. | 2 |
| **IV** | **Interpretation and Reporting** | | |
| | 17 | Interpreting test results. | 2 |
| | 18 | Calculation of adulterant levels. Reporting findings accurately and comprehensively. | 2 |
| | 19 | Understanding legal and regulatory requirements. | 2 |
| | 20 | Ethical issues related to food adulteration testing. | 2 |
| | 21 | Role of government agencies and regulatory bodies. | 2 |
| | 22 | Public awareness and consumer education initiatives. | 2 |
| **V (open module)** | **Practicals** | | **30Hrs** |
| | 1 | Determination of Adulteration in different food products | |
| | 2 | Qualitative test for carbohydrates in food | |
| | 3 | Determination of acidity and PH | |

| | | | |
|---|---|---|---|
| | 4 | Qualitative test for protein | |
| | 5 | Determination of moisture content | |
| | 6 | Determination of TSS. | |
| | 7 | Sensory evaluation | |

**REFERENCES**


1. A first course in Food Analysis, A.Y. Sathe, New Age International (P) Ltd., 1999.
2. Food Safety, case studies – R. V. Bhat, NIN, 1992.
3. Rapid detection of food adulterants and contaminants Theory and Practice, S. N. Jh, 2016, Kindle Edition.
4. Domestic Tests for Food Adulterations, H. G. Christian, Forgotten books.
5. A Laboratory Manual of Food Analysis, S. Sehgal, Wiley Publishers.
6. Food Safety and Standards Act, 2006. Bare ACT, November 2020, Commercial law publishers.
7. Fung, D.Y.C. and Matthews, R. (1991): Instrumental Methods for Quality Assurance in Foods, Marcel Dekker, Inc. New York.
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9. Gruenwedel, D.W.; Whitaker, J.R. (editors) (1984): Food Analysis Principles and techniques, Volumes 1 to 8, Marcel Dekker, Inc., New York.
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12. Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology (2010), Keith Wilson and John Walker, Cambridge University Press.

13. Chatwal, G.R.," Instrumental methods of chemical analysis"', Mumbai, Himalaya Pub. Pvt. Ltd, 2011.

14. S. Manany, N S. Swamy Food Facts and Principles. New Age International Publishers

15. B Sreelekshmi ; "Food science".

16. Potter N N, Hotchkiss JH. Food Science. CBS publishers and distributers

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 3 |
| CO4 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | - | 2 | 2 | 3 | 3 |
| CO6 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| Programme | B. Sc. Biochemistry | | | | |
|---|---|---|---|---|---|
| Course Code | | | | | |
| Course Title | Sports nutrition | | | | |
| Type of Course | Value Added Course (VAC) | | | | |
| Semester | IV | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 3 | 4 | - | - | 60 |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |

| | |
|---|---|
| Course Summary | This course covers the foundational principles of sports nutrition, including nutrient timing, macronutrient requirements, and micronutrient considerations for athletes. It delves into energy metabolism during exercise, outlining nutrition strategies to support aerobic and anaerobic activities and discussing pre- and post-exercise nutrition guidelines. The importance of hydration and electrolyte balance is emphasized, with practical strategies provided for maintaining optimal fluid and electrolyte levels. Applied sports nutrition topics include periodization, psychological aspects of nutrition, and the evaluation of research findings and sports supplements. Special considerations for different sports and populations, including endurance athletes, team sports, and special populations like youth and older athletes, are also addressed, along with the role of psychology in nutrition and performance. Practical applications and case studies round out the curriculum, providing students with a comprehensive understanding of sports nutrition principles and their real-world applications. |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the role of nutrition in optimizing athletic performance. | U | C | Instructor-created exams / Quiz |
| CO2 | Identify the specific nutrient needs of athletes based on their training intensity, duration, and sport. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Analyze various dietary strategies to support energy | U | C | Seminar Presentation / |

| | | | | |
|---|---|---|---|---|
| | metabolism and muscle recovery. | | | Group Tutorial Work |
| CO4 | Explore the importance of hydration for athletic performance. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Develop personalized nutrition plans for athletes to enhance performance, recovery, overall health and evaluate the effectiveness and safety of popular sports supplements. | U | C | One Minute Reflection Writing assignments |
| CO6 | Apply evidence-based nutrition principles to address common challenges faced by athletes, such as hydration, weight management, and travel. | Ap | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Sports Nutrition** | | |
| | 1 | Overview of sports nutrition principles | 2 |
| | 2 | Nutrient timing and meal planning for athletes | 2 |
| | 3 | Macronutrients for Athletic Performance: Carbohydrates: sources, timing, and utilization, | 2 |
| | 4 | Proteins: requirements, sources, and timing. | 2 |
| | 5 | Fats: Essential fatty acids and their role in inflammation and recovery. | 2 |

| | | | |
|---|---|---|---|
| | 6 | Micronutrients (vitamins and minerals) for performance and health. | 2 |
| **II** | **Energy Metabolism and Exercise** | | |
| | 7 | Overview of energy systems. | 2 |
| | 8 | Nutrition strategies to support aerobic and anaerobic metabolism. | 2 |
| | 9 | Pre- and post-exercise nutrition guidelines | 2 |
| | 10 | Sports supplements: benefits, risks, and ethical considerations. | 3 |
| | 11 | Specialized diets for specific sports or performance goals. | 2 |
| | 12 | Strategies for weight management and body composition optimization in athletes. | 2 |
| | 13 | Nutrition for Recovery and Injury Prevention: Importance of nutrition in post-exercise recovery. Nutritional strategies to reduce the risk of injury and promote tissue repair. | 3 |
| **III** | **Hydration and Electrolyte Balance** | | |
| | 14 | Importance of hydration for athletic performance. | 2 |
| | 15 | Electrolyte requirements and strategies for maintaining electrolyte balance. | 3 |
| | 16 | Fluid needs for different types of exercise and environments. | 2 |
| | 17 | Electrolyte balance and its impact on hydration status. | 2 |
| | 18 | Practical hydration strategies for athletes. | 2 |
| **IV** | **Applied Sports Nutrition** | | |
| | 19 | Nutrition periodization and planning for training cycles and competitions. | 2 |
| | 20 | Psychological aspects of nutrition and performance. | 3 |
| | 21 | Evaluating nutrition-related research and popular sports supplements' and applying findings to practice. | 2 |

| | | | |
|---|---|---|---|
| | 22 | Case studies and practical applications in sports nutrition. | 2 |
| **V (open module)** | **Special Considerations for Different Sports** | | |
| | 23 | Nutritional needs for endurance athletes. | 2 |
| | 24 | Nutrition strategies for team sports, strength sports, and individual sports. | 2 |
| | 25 | Sports Nutrition for Special Populations: Nutrition considerations for youth athletes. Nutrition for older athletes and masters athletes. | 3 |
| | 26 | Sports Nutrition and Performance Psychology: The role of mindset and psychology in nutrition and performance. | 3 |
| | 27 | Strategies to promote positive nutrition behaviours and adherence. | 2 |

**REFERENCES**


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2."Sports Nutrition: A Handbook for Professionals" by Nancy Clark and Nancy R. Clark

3."Essentials of Sports Nutrition and Supplements" by Jose Antonio, Douglas Kalman, Jeffrey R. Stout, Mike Greenwood, and Darryn S. Willoughby

4."Nutrition for Sport and Exercise" by Marie Dunford and J. Andrew Doyle

5."Advanced Sports Nutrition" by Dan Benardot

6."Advanced Nutrition and Human Metabolism" by Sareen S. Gropper, Jack L. Smith, and Timothy P. Carr

7."Sports Nutrition: From Lab to Kitchen" by Asker Jeukendrup and Michael Gleeson

8."Waterlogged: The Serious Problem of Overhydration in Endurance Sports" by Timothy Noakes

9."Exercise Physiology: Theory and Application to Fitness and Performance" by Scott Powers and Edward Howley

10."Nutrition for Health, Fitness & Sport" by Melvin H. Williams and Eric Rawson

11."Body Composition Assessment in Sports Medicine" by Vivian H. Heyward and Dale R. Wagner

12."Supplements for Endurance Athletes" by Suzanne Girard Eberle

13."Dietary Supplements in Health Promotion" by Taylor C. Wallace and Jeffrey B. Blumberg

14."Nutrition for Football: The FIFA/FMARC Consensus on Sports Nutrition" by Ron J. Maughan, Susan M. Shirreffs, and Mark D. Tarnopolsky

15."Nutrition for Elite Athletes" by Mary E. Henry and Nanna L. Meyer

16."Nutrition for Special Populations in Athletic Performance" by D. Enette Larson-Meyer

17."The Psychobiology of Human Motivation" by Edward T. Higgins and W. Andrew Collins

18."Nutritional Supplements in Sports and Exercise" by Mike Greenwood and Douglas Kalman

19."The Athlete's Guide to Recovery" by Sage Rountree

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 2 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 2 |
| CO4 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | 2 | 3 | 2 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| CO1 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 2 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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**Skill Enhancement Courses (SEC)**

| Programme | B. Sc. Biochemistry | | | | |
|---|---|---|---|---|---|
| Course Code | | | | | |
| Course Title | Phytochemical Analysis | | | | |
| Type of Course | Skill Enhancement Course (SEC) | | | | |
| Semester | V | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical | Total Hours |

| | | | | | |
|---|---|---|---|---|---|
| | | | | per week | |
| | 3 | 3 | - | 2 | 75 hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course offers an in-depth exploration of the diverse array of chemical compounds produced by plants, their classification, biosynthesis, functions, and applications. From understanding the role of secondary metabolites in plant defense and human health to mastering advanced techniques in phytochemical analysis, students will gain practical skills in extraction, separation, and identification of phytochemicals, paving the way for a deeper understanding of their significance in medicine, agriculture, and industry. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Demonstrate a comprehensive understanding of the principles, concepts, and theories related to phytochemistry. | U | C | Instructor-created exams / Quiz |
| CO2 | Classify and identify major classes of plant secondary metabolites | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Apply knowledge of extraction and isolation techniques to efficiently extract and isolate phytochemicals from plant sources. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Demonstrate proficiency in basic laboratory skills related to phytochemical analysis, including safety protocols. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Proficiently use chromatographic techniques, including thin-layer chromatography (TLC), column chromatography, and | Ap | P | One Minute Reflection Writing assignments |

| | | | | |
|---|---|---|---|---|
| | high-performance liquid chromatography (HPLC). | | | |
| CO6 | Conduct mass spectrometry experiments for the identification of plant compounds and interpret data obtained from various spectroscopic techniques such as UV-Visible spectroscopy, infrared spectroscopy, and NMR spectroscopy. | Ap | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Unit I. Introduction to Phytochemistry and Plant Secondary Metabolites** | | |
| | 1 | Definition of phytochemistry, Historical perspectives, Medicinal plants and natural products, scope of phytochemistry | 2 |
| | 2 | Overview of primary and secondary metabolites. | 2 |
| | 3 | Classification and functions of secondary metabolites, | 2 |
| | 4 | Biosynthesis of secondary metabolites-basic pathways, synthesis from primary metabolites, transport, storage, turnover and degradation. | 2 |
| | 5 | Structure, classification and distribution and pharmacological properties of alkaloids, betalains, cyanogenic glycosides, glucosinolates, polyphenols, flavonoids and related compounds, anthocyanins, coumarins, lignans, tannins, gallotannins, ellagitannins, suberins cutins, saponins, terpenoids, sterols and cardiac glycosides, phytohormones, carotenoids, brassinosteroids, phytoecdysteroids, steroid saponins and steroid alkaloids and essential oils. | 3 |
| **II** | **Functions of Secondary Metabolites** | | |
| | 6 | Role of secondary metabolites in plant defense, phytoalexins and microbial infection. | 2 |

| | | | |
|---|---|---|---|
| | 7 | Plant defense substances and risk for humans | 2 |
| | 8 | Role of secondary metabolites in attracting pollinators and protection against UV radiation | 2 |
| | 9 | Induced accumulation of secondary metabolites | 2 |
| | 10 | Antioxidant properties and Health benefits | 2 |
| | 11 | Role of secondary metabolites as pharmaceuticals. | 2 |
| | 12 | Importance of secondary metabolites in medicine, agriculture and industry. | 2 |
| **III** | **Techniques in Phytochemical Analysis** | | |
| | 13 | Principles of extraction, Solvent systems and their selection | 2 |
| | 14 | Qualitative methods for screening of phytochemicals, Chromatographic techniques (TLC, column chromatography, HPLC and GC) | 2 |
| | 15 | Spectroscopic Techniques (UV-Visible spectroscopy, Infrared spectroscopy, Nuclear Magnetic Resonance [NMR] spectroscopy), Mass spectrometry: Principles of mass spectrometry, Applications in phytochemical analysis, Interpretation of mass spectra, | 2 |
| | 16 | Analysis, Isolation and identification of Specific Phytochemical Classes like alkaloids and polyphenols, methods for quantitative analysis of alkaloids and Polyphenols **(**Flavonoids, phenolic acids, and tannins), chromatographic and spectrometric isolation | 2 |
| **IV** | **Advances in Phytochemical analysis** | | |
| | 17 | Bioinformatics in Phytochemical Analysis-overview | 2 |
| | 18 | Use of bioinformatics tools in the analysis of plant compounds | 2 |
| | 19 | Databases and resources | 2 |
| | 20 | Applications of phytochemical analysis in Metabolomics | 2 |
| | 21 | Nanotechnology in phytochemical research | 2 |
| **V** | **Practicals** | | **30 Hrs** |

| | | | |
|---|---|---|---|
| **(open module)** | 1 | Preparation of plant samples for analysis: Identification, collection, cleaning, drying (natural and artificial methods) and powdering. | |
| | 2 | Methods of extraction: Plant tissue homogenization, serial exhaustive extraction with solvents of increasing polarity, Soxhlet extraction, maceration, decoction, infusion, digestion, percolation and sonication. | |
| | 3 | Qualitative screening and estimation of phytochemicals in plant extracts: Test for alkaloids, amino acids, carbohydrates, fixed oils and fats, glycosides, phenolic compounds, tannins, phytosterols, proteins, saponins, gum, mucilages and volatile oils. | |
| | 4 | Separation and identification of phytochemicals using TLC, HPTLC, GC, HPLC, GCMS and LCMS. | |
| | 5 | Separation and identification of phytochemicals using UV, IR and NMR spectroscopy. | |

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2. Plant Biochemistry by P.M. Dey and J. B. Harborne (Ed.), Academic Press
3. Introduction to Plant Biochemistry by Mercer, T. W. and Goodwin, E. I., Oxford
4. Biochemistry of plant secondary metabolism by Michael Wink (Ed.) Wiley Blackwell Publishers
5. Plant Biochemistry by Hans-Walter Heldt, Birgit Piechulla, Fiona Heldt, Academic Press
6. Natural products from plants (Peter B. Kaufman, Leland J. Cseke, Cara Warber, James A. Duke, Harry L. Brielmann) CRC Press
7. Introduction to Phytochemical Analysis by Inge S. Fomsgaard, Derek McPhee, and Paul W. Needs
8. Phytochemical Techniques by M. M. Srivastava
9. The Biochemistry of plants A Comprehensive Treatise by P.K. Stumpf and E.E. Conn- (Ed.), Secondary Plant Products, Academic Press Inc.
10. Methods in Polyphenol Analysis edited by Richard L. Prior
11. Quantitative Analysis of Phytochemicals by Chandra Prakash Kala
12. Handbook of Phytochemical Constituents of GRAS Herbs and Other Economic Plants by James A. Duke

13. Natural Products Isolation by Satyajit D. Sarker and Zahid Latif

14. Bioactive Natural Products: Chemistry and Biology by Goutam Brahmachari

15. Chromatographic Fingerprint Analysis of Herbal Medicines by Hildebert Wagner and Rudolf Bauer

16. Modern Techniques in Applied Molecular Spectroscopy by Zaki Ahmad

17. High Resolution Mass Spectroscopy for Phytochemical Analysis: State- of- the- art Applications and Techniques by Sreeraj Gopi, Augustine Amalraj and Shintu Jude (Ed.)

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| Programme | B. Sc. Biochemistry | | | | |
|---|---|---|---|---|---|
| Course Code | | | | | |
| Course Title | Fish Biochemistry | | | | |
| Type of Course | **SEC** | | | | |
| Semester | V | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 3 | 4 | - | 0 | 60 |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course on Fish Biochemistry delves into the chemical composition of fish, covering major and minor components, proximate composition including water, protein, lipid, minerals, and vitamins. It explores fish muscle structure, proteins such as myoglobin and enzymes, lipid types and variations, and the role of minerals, vitamins, and carbohydrates in fish nutrition. Additionally, it investigates post-mortem changes in fish, including rigor mortis and flavor alterations. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| CO1 | Comprehend the major and minor components of fish, including proximate composition elements such as water, protein, lipid, and minerals. They will appreciate the significance of these components as quality and spoilage parameters in fish. | U | C | Instructor-created exams / Quiz |
| CO2 | Explore the molecular organization of fish muscle, focusing on key protein components like actin, myosin, and actomyosin. They will also study the changes that occur during muscle contraction, gaining insights into the functional aspects of fish muscle. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Gain proficiency in fractionating fish proteins, specifically sarcoplasmic, myofibrillar, and stroma proteins (connective tissue). They will understand the role of proteins such as heme proteins, enzymes, and their impact on post-mortem changes in fish. | U | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Learn about the thermal and freeze denaturation of proteins and comprehend the functional properties of seafood proteins. Emphasis will be placed on solubility, emulsification, viscosity, water holding capacity, gelation, and texture profile analysis. | U | P | Instructor-created exams / Home Assignments |

| | | | | |
|---|---|---|---|---|
| CO5 | Delve into various lipid types, fatty acids, and the biogenesis of polyunsaturated fatty acids. The physiological activities of polyunsaturated fatty acids and their benefits for human health will be highlighted. | U | P | One Minute Reflection Writing assignments |
| CO6 | Assess and analyze the quality of fish based on major and minor components, protein fractionation, lipid composition, and post-mortem changes. They will understand the key parameters influencing fish quality and the significance of these factors. | A | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Chemical composition of fish** | | |
| | 1 | Major and Minor components | 2 |
| | 2 | Proximate Composition of fish- Water, Protein, Lipid and Minerals and vitamins in Fish. Non-Protein Nitrogenous compounds in Fish. | 2 |
| | 3 | Significance as quality and spoilage parameters. | 2 |
| | 4 | Fish muscle structure- Molecular organization of muscle –protein components of muscle cell- actin, myosin &actomyosin. Changes during muscle contraction | 2 |
| **II** | **Fish Proteins** | | |
| | 5 | Fractionation of fish proteins –Sarcoplasmic, myofibrillar & Stroma (connective tissue) proteins. | 2 |
| | 6 | Heme proteins, Myoglobin, Haemocyanin, | 3 |

| | | | |
|---|---|---|---|
| | 7 | Parvalbumin, anti-freeze proteins, pigments | 2 |
| | 8 | . enzymes-hydrolases, oxydoreductases, lipases and phospholipases and other enzymes | 2 |
| | 9 | Role of fish enzymes in post mortem changes. | 2 |
| | 10 | Denaturation of proteins- Thermal and freeze denaturation of proteins | 2 |
| | 11 | Functional properties of seafood proteins: Solubility, emulsification, viscosity, water holding capacity, gelation and texture profile analysis. | 2 |
| **III** | **Fish Lipids** | | |
| | 12 | Composition and nutritive value of fish lipids | 3 |
| | 13 | Lipid types and variations, triglycerides, phospholipids. Fatty acids, biogenesis of polyunsaturated fatty acids, essential and non-essential fatty acids | 2 |
| | 14 | Fat constants, Hydrolytic and oxidative changes | 2 |
| | 15 | Mechanism of auto-oxidation. Factors affecting auto-oxidation | 2 |
| | 16 | Antioxidant synergists and pro-oxidants | 2 |
| | 17 | Fatty acid composition of fish liver oils and body oils. | 2 |
| | 18 | Physiological activities of PUFA | 2 |
| | 19 | Beneficial effects of Omega fatty acids on human health. | 2 |
| **IV** | **Minerals, vitamins and Carbohydrates in Fish** | | |
| | 20 | Macro and trace elements in fish and shellfish - Minerals of nutritional significance. | 2 |
| | 21 | Fat soluble and Water Soluble Vitamins in fish and deficiency diseases. Carbohydrate in fish- Glycogen composition in fish and shell fish. | 2 |
| | 22 | Nonprotein nitrogenous compounds in Fish: Free amino acids, Peptides, Nucleotides, Guanidins, Urea, Quarternary ammonium compounds, TMAO and its decomposition products, Nucleotides. | 3 |

| | | | |
|---|---|---|---|
| **V (open module)** | **Post mortem changes in Fish** | | |
| | 23 | Post mortem changes in Fish, Rigor mortis, significance in fish quality. Spoilage mechanisms in fish. | 6 |
| | 24 | Flavor changes in fish, Auto-oxidation of fatty acids and Rancidity. Biogenic amines. | 6 |

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3 Sea food: Effects of technology and nutrition. Marcel Dekker Inc., New York. J.J.Connel,1980.

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12 Roy, E. M., Geroge, J.F. and Donn, R. W., 1982. Chemistry and Biochemistry of marine food products. AVI publishing company, Westport, Connecticut.


**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 3 | 3 | 2 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | - | 2 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | - | 2 | 3 | 3 | 2 |
| CO6 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 2 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Biosafety and Biohazards | | | | |
| Type of Course | Skill Enhancement Course (SEC) | | | | |
| Semester | VI | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 3 | 4 | - | - | 60 Hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | The course covers essential principles, practices, and protocols necessary for ensuring safe handling of biological materials in laboratory settings. From laboratory techniques to risk assessment, biosafety level criteria, and emergency protocols, students will gain the knowledge and skills needed to mitigate risks and maintain a secure environment for both personnel and the surrounding community. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Able to understand the basics of biosafety | U | C | Instructor-created exams / Quiz |
| CO2 | To differentiate types of biosafety at laboratory level | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | To characterize risks associated with biohazards and biological agents. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | To apply apt skills for using safety safeguards. | U | C | Instructor-created exams / Home Assignments |

| | | | | |
|---|---|---|---|---|
| CO5 | To Understand the levels of Biosafety. | U | C | One Minute Reflection Writing assignments |
| CO6 | To acquire skills to handle bio hazardous materials. | Ap | P | |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Principles of Biosafety** | | |
| | 1 | Laboratory Practices and Technique | 2 |
| | 2 | Safety Equipment (Primary Barriers and Personal Protective Equipment) | 2 |
| | 3 | Facility Design and Construction (Secondary Barriers) | 2 |
| | 4 | Biosafety Levels | 3 |
| | 5 | Animal Facilities | 2 |
| | 6 | Clinical Laboratories | 3 |
| | 7 | Importation and Interstate Shipment of Certain Biomedical Materials | 2 |
| **II** | **Biological Risk Assessment** | | |
| | 8 | Hazardous Characteristics of an Agent. | 2 |
| | 9 | Hazardous Characteristics of Laboratory Procedures. | 3 |
| | 10 | Potential Hazards Associated with Work Practices. | 2 |
| | 11 | Safety Equipment and Facility Safeguards. | 3 |
| | 12 | An Approach to Assess Risks and Select Appropriate Safeguards. | 2 |
| **III** | **Laboratory Biosafety Level Criteria** | | |
| | 13 | Biosafety Level 1, 2, 3 & 4 | 3 |

| | | | |
|---|---|---|---|
| | 14 | Standard Microbiological Practices. | 3 |
| | 15 | Special Practices | 2 |
| | 16 | Safety Equipment (Primary Barriers and Personal Protective Equipment) | 2 |
| | 17 | Laboratory Facilities (Secondary Barriers) Laboratories | 2 |
| **IV** | **Storage and disposal of hazardous micoorganisms** | | |
| | 18 | Institutional biosafety committee compliance adherence. | 2 |
| | 19 | Containment and storage of hazardous microorganisms and genetically modified organisms. | 3 |
| | 20 | Decontamination and disposal. | 3 |
| **V (open module)** | **Safety aspects, Handling of hazardous materials and bio-waste** | | |
| | 22 | Handling hazardous chemicals, electrical and fire accidents. | 2 |
| | 24 | Laboratory decontamination, chemical disinfection, gaseous disinfection, heat sterilization, | 3 |
| | 25 | Biological indicators, chemical transport, storage and usage. | 2 |
| | 26 | Radiation safety, electrical safety, fire safety, biohazard spills. | 3 |
| | 27 | Bio-waste segregation | 2 |

**REFERENCES**

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3. Laboratory Biosafety Manual 4th edition and associated monographs- Personal Protective equipment (World Health Organization) 2020.

4. Laboratory Biosafety Manual 4th edition and associated monographs Biological Safety Cabinet and containment devices (World Health Organization) 2020.

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7. An Introduction to Ethical, Safety, and Intellectual Property Rights Issues in Biotechnology Padma Nambisan eBook ISBN: 9780128092514 Elsevier 2017

8 Biosafety in Microbiological and Biomedical Laboratories 5th Edition HHS Publication No. (CDC) 21-1112 Revised December 2009

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | 2 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | - | 2 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 2 | 3 | 2 | 3 |
| CO4 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | 2 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | 2 | 3 | 2 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 2 | 3 | 2 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| Programme | B. Sc. Biochemistry | | | | |
|---|---|---|---|---|---|
| Course Code | | | | | |
| Course Title | Sports Science & Lifestyle Disorders | | | | |
| Type of Course | **SEC** | | | | |
| Semester | VI | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 3 | 4 | - | 0 | 60 |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course on Health, Sports Nutrition, Ergogenic Aids, and Lifestyle Diseases covers a wide range of topics essential for understanding physical well-being. It explores the meaning and significance of health, the role of nutrients in sports performance, ergogenic aids and doping, and the science behind fitness including anatomy and muscle function. Additionally, it addresses lifestyle diseases such as diabetes, hypertension, and obesity, focusing on their characteristics, prevention, and management strategies. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Analyse the sports related medical issues from the perspective of biochemical and physiological sciences on various sports groups and deliver support to the coaches and athletes | U | C | Instructor-created exams / Quiz |
| CO2 | Be well conversant with the process of basic health issues and common injuries occurring as a result of continuous sports activities and unhealthy life style practices | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Analyze and handle complex situations in sporting activities arising during the long term athlete development program. | U | P | Seminar Presentation / Group Tutorial Work |
| CO4 | Create awareness regarding the effect of doping, doping control procedures and ergogenic aids | U | P | Instructor-created exams / Home Assignments |
| CO5 | Analyze and apply current development and research works in the field of sport science and welcome new ideas in sports and have capability in out of box thinking. | U | P | One Minute Reflection Writing assignments |
| CO6 | Prepare proper diet plan for specific nutritional requirements. | A | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Meaning and Importance of Health** | | |
| | 1 | Meaning of Health, Importance of Health, factors influencing Health Status, Characteristics of healthy individual. | 2 |
| | 2 | Physiological health, mental health, emotional health and social health. | 2 |
| | 3 | First Aid: Definition and importance of first aid in modern life, types of first aid. Reasons of sports injuries. Basic steps in safety measures safety measures for the following (i) bites of animals, burns, control of bleeding, cuts and wounds. Safety against drawning, artificial respiration. | 2 |
| | 4 | Metabolic Functions of key Organs during Exercise; Metabolic Factors in Fatigue, Metabolic Adaptations to Endurance. Metabolic Response to Exercises, Exercise and Lactate. | 2 |
| II | **Sports Nutrition** | | |
| | 5 | Nutrients and nutritional Role of macro and micro nutrients: Water Requirements and Fluid Balance | 2 |
| | 6 | Nutrition Supplements. Nutrients: Functions and Recommended Intakes, Healthy Eating and Balanced Diet, Fuel Sources for Muscle and Exercise. Food Energy and Expenditure. | 3 |
| | 7 | Nutrition and Immune Function in Athletes, Body Composition and Weight Management, Eating Disorders in Athletes | 2 |
| | 8 | Intake of Carbohydrates, proteins and fats affecting performance. Energy intake pattern of athletes: Nutritional intake concerns for athletes in sport and exercise | 2 |
| | 9 | Energy intake of athletes during training and for competition. | 2 |
| | 10 | Vitamins and Minerals in exercise performance Vitamins: Types; mode of action; primary functions; excess vs. deficiency; Requirements for athletes. | 2 |
| | 11 | Minerals: Types; mode of action; Primary functions; Excess vs. Deficiency; Role of increased intake of minerals in exercise performance. | 2 |
| III | **Ergogenic aids and Doping** | | |
| | 12 | The effects of ergogenic aids and nutritional supplements, effect of doping and doping control procedures. | 3 |
| | 13 | Ergogenic Aids: Mechanical Aids; Nutritional Aids- Carbo-Loading, Fluids; Creatine, Carnitine, Amino Acids, Dietary Supplements; Antioxidants; Physiological Aids- Bicarbonate, Loading, Altitude Training. | 2 |
| | 14 | History of Doping and Doping Control, the fundamental rights of athletes in doping trials the world anti-doping agency: transnational doping policy and globalisation; drug testing in amateur sports, the prohibited list of substances & methods. | 2 |

| | | | |
|---|---|---|---|
| | 15 | Human Growth Hormone, Anabolic Steroids, Hormones and Related Substances, Beta-2 Agonists, Agents with Anti-Oestrogenic Activity, Diuretics and Other Masking Agents, Stimulants, Narcotic Doping Control. | 2 |
| | 16 | Anti-Doping Rules, WADA and IADA, regulation, IOC regulation, Ethical issues. | 2 |
| | 17 | Testing and Sample Analysis. In-Competition Testing, Out-of-Competition Testing. | 2 |
| | 18 | Anti-doping rule violations. Guidelines | 2 |
| | 19 | Blood Sample Collection, Urine sample collections, Sample collection personel, Breath Alcohol Testing, Implementing an Effective Testing Program. Laboratory Test Reports | 2 |
| **IV** | **Science of Fitness** | | |
| | 20 | Anatomy of muscular system, structure of muscles and their kinds. Properties of muscles. Muscle work and, fatigue. | 2 |
| | 21 | Anatomy of respiratory organs, tissue and pulmonary respiration. | 2 |
| | 22 | Anatomy of heart, function of heart, heart beat, stroke volume, cardiac output. | 3 |
| **V (open module)** | **Lifestyle diseases** | | |
| | 23 | Characteristics, Causes, Diagnosis, Prevention, and Management of lifestyle diseases: Diabetes mellitus, Hypertension, Atherosclerosis, Liver diseases, Kidney diseases, Obesity. | 12 |

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**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | - | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | - | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | - | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 2 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |

| | |
|---|---|
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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## DSC Electives Semester V

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Physical Aspects of Biochemistry | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | V | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course provides a comprehensive foundation in the physical aspects of biochemistry. It covers safety protocols, handling of chemicals and biological samples, and management of laboratory accidents. Moving on, it explores water, acids, bases, and buffers, including pH calculations, electrolyte dissociation, and buffer action. Additionally, it delves into solutions, osmosis, osmotic pressure, colloidal systems, and principles of adsorption and partition. Chemical equilibrium, catalysis, thermodynamics, and nuclear chemistry are also discussed, providing a solid understanding of key principles and their applications in biological systems. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Follow good practices in a basic biochemistry laboratory. | U | C | Instructor-created exams / Quiz |
| CO2 | Safe handling & disposals of chemicals, biological & other samples. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Identify the types of molecular interactions, concepts on acids, bases and solutions, and the physical aspects of Biochemistry. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Prepare solutions of precise normality, molarity, molality, percentage and mole fractions. | Ap | P | Instructor-created exams / Home Assignments |

| | | | | |
|---|---|---|---|---|
| CO5 | Explain catalyst & equilibrium reactions. | An | C | One Minute Reflection Writing assignments |
| CO6 | Describe the role of thermodynamic principles in biochemical pathways. | An | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **General Introduction & Laboratory Practices** | | |
| | 1 | Laboratory safety requirements & precautions. | 2 |
| | 2 | Safe handling & disposals of chemicals, biological & other samples. | 2 |
| | 3 | Radioactive materials. | 2 |
| | 4 | Management of laboratory accidents & injuries. | 2 |
| **II** | **Water, Acids, Bases & Buffers** | | |
| | 5 | Dissociation of water, ionic product of water. | 2 |
| | 6 | Concepts of pH, pOH, simple numerical problems of pH, determination of pH using indicators, pH meter & theoretical calculations. Meaning of Ka and pKa values. | 3 |
| | 7 | Electrolytes and dissociation of electrolytes, weak acids. | 2 |
| | 8 | Concepts of acids and bases, shapes of titration curve of strong and weak acids and bases. | 2 |
| | 9 | Buffers and buffer action. Buffers in the biological system. | 2 |
| | 10 | Henderson-Hasselbalch equation with derivation. Simple numerical problems involving the application of this equation. | 2 |
| | 11 | Molecular interactions (Brief study): Noncovalent interactions: Hydrogen bonding, Vander Waal interactions, electrostatic interactions, hydrophobic interactions, Covalent interactions. | 2 |
| **III** | **Solutions** | | |

| | | | |
|---|---|---|---|
| | 12 | Meaning of normality, molarity, molality, percentage solution, mole fractions: simple numerical problems from the above. | 3 |
| | 13 | Principle of diffusion & osmosis. Biological importance of osmosis. | 2 |
| | 14 | Definition of osmotic pressure, isotonic, hypotonic & hypertonic solutions | 2 |
| | 15 | Relationship of osmotic pressure to gas laws. The general equation for dilute solutions, Influence of ionization & molecular size on osmotic pressure. | 2 |
| | 16 | Meaning of true solution, colloidal solution, and coarse suspension. The distinction between lyophilic and lyophobic sols. | 2 |
| | 17 | Elementary study of charge on colloids, Tyndall effect. | 2 |
| | 18 | Emulsion & emulsifying agents. | 2 |
| | 19 | Principles of adsorption & partition. | 2 |
| **IV** | **Chemical Equilibrium & Catalysis** | | |
| | 20 | Chemical equilibrium and equilibrium constant. Law of mass action. | 2 |
| | 21 | Donnan equilibrium & its application in the biological system. | 2 |
| | 22 | Catalysis - Catalyst - Autocatalyst - Enzyme catalyst - Promoters - Catalytic poisons – Active Centre - Differences between Homogeneous and Heterogeneous Catalysis - Industrial Applications of Catalysts. | 3 |
| **V (open module)** | **Thermodynamics And Nuclear Chemistry** | | |
| | 23 | Laws of thermodynamics- First, second, third and zero law. Enthalpy, entropy and free energy. | 6 |
| | 24 | Isotopes, isobars and isotones. Application of radioisotopes in biological system. | 6 |

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6. B.S. Bahl, G.D. Tuli, Arun Bahl. Essentials of Physical Chemistry. S.Chand and Company Ltd. New Delhi.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | - | 3 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | - | 3 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | - | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | - | 3 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Plant Secondary Metabolites | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | V | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course provides a comprehensive overview of plant cell structure, physiology, growth regulation, and secondary metabolites, highlighting the chemical composition and functional roles of cellular components. Students will explore the biochemical mechanisms underlying photosynthesis, nitrogen metabolism, plant growth regulation, and the biosynthesis of secondary metabolites, emphasizing their significance in plant growth, development, and interactions with the environment. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Equip the students with the basic knowledge of plant cell structure and functions | U | C | Instructor-created exams / Quiz |
| CO2 | Know about the photosynthetic activity of plants and nitrogen metabolism. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Provide knowledge about growth regulators ,The major plant hormones chemistry and functions. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Understand the different secondary metabolites produced by plants. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Analyze the protective functions of secondary metabolites in plants. | U | C | One Minute Reflection Writing assignments |
| CO6 | Acquire knowledge about the application of secondary metabolites in life. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | Structure, chemistry and function of plant cell | | |
| | 1 | An overview of plant cell and subcellular components of the plant cell. | 2 |
| | 2 | Structure and organization of the primary cell wall. | 1 |
| | 3 | Structural features, unique functional roles and chemical composition of membranes of plant cell organelles; nucleus, endoplasmic reticulum, | 2 |

| | | | |
|---|---|---|---|
| | | microtubules, plant microbodies, plasmalemma, plastid, vacuole, and Golgi body. | |
| | 4 | Importance of sucrose as the transport form of sugar in plants. | 2 |
| | 5 | A brief account of the separation of plant subcellular constituents. | 1 |
| **II** | **Plant physiology** | | |
| | 6 | Photosynthesis –structure, organization and composition of chloroplast membrane. Different photo systems; Light and dark reactions. Photosynthesis in C-4 plants. | 2 |
| | 7 | Photorespiration and compensation point. | 2 |
| | 8 | CAM plants | |
| | 9 | C-2 and C-3pathways. | |
| | 10 | Biochemistry of Rubisco and its activation. | |
| | 11 | Nitrate metabolism: Nitrate reduction- nitrate reductase- physiology and regulation; nitrite metabolism (nitrite reductase). | 2 |
| | 12 | Nitrogen fixation: Nitrogen cycle; symbiotic and non-symbiotic nitrogen fixation. Biochemistry of nitrogen fixation | 2 |
| **III** | **Plant growth regulators, senescence and seed dormancy** | | |
| | 13 | Plant growth regulators: Auxins, cytokinins, abscisic acid, and related compounds, gibberellins, and ethylene | 1 |
| | 14 | Chemical nature, physiological roles, distribution in plants, mode of action of different growth regulators. | |
| | 15 | Biochemical aspects associated with fruit ripening. | 2 |
| | 16 | Senescence | 2 |
| | 17 | Seed dormancy and germination | 2 |
| **IV** | **Secondary metabolites** | | |
| | 18 | Secondary plant products: major chemical classes of secondary metabolites. | 2 |

| | | | |
|---|---|---|---|
| | 19 | Role of secondary metabolites in plants. Biosynthesis, chemistry and functions; | 2 |
| | 20 | Nitrogen containing compounds: Alkaloids and its major classes with example -caffeine, theophylline , nicotine and caryophyllene, steroid alkaloids.Non protein amino acids, Amines and Cyanogenic glycosides. | 2 |
| | 21 | Terpenoids: isoprene rule, mono, di, sesqui, tri, tetraterpenes and poly terpenes with example, important members and their functions. | 2 |
| | 22 | Phenols: simple phenols, phenolic acids, phenyl propane, coumarins, phenolic glycosides, flavonoids, lignins and tannins. | |
| **V (open module)** | **Functions and applications of secondary metabolites** | | |
| | 23 | Importance of secondary metabolites: uses of secondary metabolites to the producer plants: protection of the plants from predators. | 1 |
| | 24 | Uses of plant secondary metabolites to man; as biologically active compounds in mammalian metabolism, as drugs, as precursors of drug in pharmaceuticals, as natural pesticides/ insecticides and other uses. | 1 |
| | 25 | Allelopathy | 1 |

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6. Noggle G R and Fritz G J , Introductory Plant Physiology, Prantice Hall of India Pvt Ltd, N. Delhi

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9. Taiz L and Zeiger E, Plant Physiology, 2 nd Ed., Sinauer Associates, IncPublishers, Massachussetts

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**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Neurobiochemistry | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | V | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course in Neurobiochemistry delves into the intricate organization of the nervous system, covering topics such as the structure and function of neurons, synaptic transmission, neurotransmitters, memory mechanisms, and neurological disorders. From the molecular basis of learning to the biochemical underpinnings of neurodegenerative diseases like Parkinson's and Alzheimer's, students explore the fascinating interplay between biochemistry and brain function in health and disease. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Demonstrate a deep understanding of the central and peripheral nervous systems. | U | C | Instructor-created exams / Quiz |
| CO2 | Acquire knowledge of neurotransmitter classification, | U | C | Practical Assignment / |

| | | | | |
|---|---|---|---|---|
| | synthesis, storage, release, and the chemistry behind key neurotransmitters. | | | Observation of Practical Skills |
| CO3 | Develop proficiency in explaining the structure of synapses, transmission events across synapses, membrane potential dynamics, action potential generation, and the neuromuscular junction. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Gain insight into the biochemical basis of memory, including short-term and long-term memory mechanisms, synaptic plasticity, and the role of neurotransmitters, receptors, and signaling molecules in learning and memory processes. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Develop a comprehensive understanding of the biochemical basis of neurodegenerative diseases and their implications for brain function. | U | C | One Minute Reflection Writing assignments |
| CO6 | Apply their understanding of neurobiochemistry to interpret brain imaging techniques such as EEG and understand the biochemical basis of pharmacological interventions for neurological disorders, including antidepressants and hallucinogenic agents. | Ap | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Organization of Nervous System** | | |
| | 1 | Central Nervous System -Brain -overview(forebrain, midbrain and hind brain)and Spinal cord | 2 |
| | 2 | Peripheral nervous system:somatic and autonomous nervous system | 2 |
| | 3 | Neuron-structure, classification and functions, | 2 |
| | 4 | Neuroglia-classification and functions ,Cerebrospinal fluid | 2 |

| | | | |
|---|---|---|---|
| | 5 | Formation, structure and biochemistry of myelin | 2 |
| | 6 | Chemistry of major brain lipids, developmental changes, lipid composition, biosynthesis and catabolism of major lipids, characteristics of brain lipids, regional variations. | 3 |
| | 7 | Blood-Brain barrier | 2 |
| | 8 | Blood-CSF barrier | 2 |
| **II** | **Synaptic transmission** | | |
| | 9 | Synapse-structure and types, correlation of structure and function at the synapse. | 2 |
| | 10 | Transmission across the synapse, pre and post synaptic events, | 2 |
| | 11 | Membrane potential in the steady state, action potential and propagation of nerve impulse. | 3 |
| | 12 | Neuromuscular junction. | 2 |
| **III** | **Neurotrasmitters** | | |
| | 13 | Neurotransmitters, Classification, synthesis, storage and release. | 2 |
| | 14 | Acetylcholine, Dopamine, Norepinephrine, Serotonin, Histamine, Epinephrine, Gamma-aminobutyric acid, Glycine, Glutamate, Aspartate, NO2, and CO– Chemistry of neurotransmitters. | 3 |
| | 15 | Neuropeptides: Classes of neuropeptides | 2 |
| | 16 | Structure of neurotransmitter receptors. | 2 |
| **IV** | **Basis of Memory** | | |
| | 17 | Learning and memory | 2 |
| | 18 | Mechanism of short term memory and Long Term Potentiation. | 3 |
| | 19 | NMDA and AMPA glutamate receptors. | 2 |
| | 20 | Retrograde messengers in synaptic transmission. | 2 |
| | 21 | Role of CAM kinase II, Calcium, protein kinases, cAMP, NO, Calpain and other proteins in memory and learning process. | 2 |
| | 22 | Synaptic plasticity | 2 |
| **V (open module)** | **Neurological disorders** | | |
| | 23 | Neurotoxic agents and diseases related to them | 3 |
| | 24 | Antidepressants and hallucionogenic agents. | 2 |
| | 25 | Biochemical theories of mental disorders and muscular dystrophy. | 2 |
| | 26 | Neurodegenerative Disorders: Parkinson's, Alzheimer's disease, amyotrophic lateral sclerosis, senile dementia. | 3 |
| | 27 | Brain imaging techniques, EEG. | 2 |

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5. Gerad J. Tortora and Bryan Derrickson, Essentials of anatomy and Physiology, 9th edition
6. Grossman &Neavy, Neuro anatomy.
7. John G. Nicholls, A. Robert Martin, Bruce G.Wallance& Paul A. Fuchs, From Neuron to Brain.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)

- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Oxidative stress and Antioxidants | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | V | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course on oxidative stress and antioxidants provides a comprehensive overview of the biochemical basis of oxidative damage, including the generation of reactive oxygen species, cellular defense mechanisms, and the consequences of lipid and protein oxidation. Students will delve into the classification and mechanisms of action of antioxidants, explore their role in mitigating oxidative stress-related diseases like neurodegenerative disorders and cancer, and examine emerging trends in oxidative stress research, including therapeutic targeting in precision medicine. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Demonstrate a thorough understanding of the biochemical basis of oxidative stress, including the sources and generation of reactive oxygen species (ROS), as well as the cellular defense mechanisms against oxidative stress. | U | C | Instructor-created exams / Quiz |
| CO2 | Identify and evaluate the impact of oxidative stress on human health and disease, particularly in neurodegenerative disorders, cardiovascular diseases, and cancer | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Demonstrate an ability to critically assess the literature and research findings in this area. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Analyze the mechanisms of action of various antioxidants, including enzymatic, non-enzymatic, and phytochemical antioxidants, and their potential therapeutic applications in mitigating oxidative damage and associated diseases. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Critically assess current research on oxidative stress and antioxidants. | U | C | One Minute Reflection Writing assignments |
| CO6 | Integrate interdisciplinary knowledge from biochemistry, physiology, pharmacology, and related fields to understand the implications for healthcare and aging. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Introduction to oxidative stress and biochemical basis of oxidative damage** | | |
| | 1 | Definition and historical perspective | 2 |
| | 2 | Sources and generation of reactive oxygen species (ROS) | 2 |
| | 3 | Cellular defense mechanisms against oxidative stress | 3 |
| | 4 | Reactive oxygen and nitrogen species: formation and reactivity | 2 |
| | 5 | Lipid peroxidation and its consequences | 3 |
| | 6 | Protein oxidation and carbonyl stress | 2 |
| II | **Antioxidants: classification and mechanisms of action** | | |
| | 7 | Enzymatic antioxidants (e.g., superoxide dismutase, catalase) | 2 |
| | 8 | Non-enzymatic antioxidants (e.g., vitamins C and E, glutathione) | 2 |
| | 9 | Phytochemical antioxidants and their sources | 3 |
| III | **Oxidative stress, human Diseases and role of antioxidants in health and disease** | | |
| | 10 | Role of oxidative stress in neurodegenerative diseases (e.g., Alzheimer's, Parkinson's) | 2 |
| | 11 | Cardiovascular diseases and oxidative damage | 2 |
| | 12 | Oxidative stress and cancer: mechanisms and therapeutic implications | 2 |
| | 13 | Dietary antioxidants and their impact on health | 2 |
| | 14 | Antioxidant supplementation: controversies and considerations | 2 |
| | 15 | Clinical trials evaluating antioxidant interventions | 2 |
| | 16 | Impact of environmental pollutants on oxidative stress and antioxidant defense mechanisms | 2 |
| | 17 | Role of lifestyle factors (e.g., diet, exercise, stress) in modulating oxidative stress levels | 2 |
| | 18 | Antioxidant strategies for mitigating environmental oxidative stress | 3 |
| IV | **Regulation of oxidative stress signaling** | | |
| | 19 | Redox signaling pathways in health and disease | 2 |
| | 20 | Antioxidant-responsive transcription factors (e.g., Nrf2) | 2 |
| | 21 | Cross-talk between oxidative stress and inflammation | 2 |
| | 22 | Role of oxidative stress in aging and longevity | 2 |
| V (open module) | **Experimental approaches to studying oxidative stress and emerging trends in oxidative stress research** | | |
| | 23 | Techniques for measuring ROS/RNS levels | 3 |
| | 24 | Assessment of oxidative damage markers | 2 |
| | 25 | Screening assays for antioxidant activity | 3 |

| | | | |
|---|---|---|---|
| | 26 | Mitochondrial dysfunction and oxidative stress | 2 |
| | 27 | Therapeutic targeting of oxidative stress in precision medicine | 2 |

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18 Nathan, C., & Cunningham-Bussel, A. (2013). Beyond oxidative stress: an immunologist's guide to reactive oxygen species. Nature reviews immunology, 13(5), 349-361.

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22 Stadtman, E. R. (2006). Protein oxidation and aging. Science, 312(5782), 530-531.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 6 | | | ✓ | |

**DSC Electives Semester VI**

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Nanobiology | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | VI | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course on Nanobiology offers a comprehensive exploration of the principles, techniques, and applications of nanotechnology in biological systems. From understanding the synthesis and characterization of nanoparticles to exploring their interactions with biomolecules and their applications in drug delivery, cancer therapy, tissue engineering, and environmental monitoring, students will gain insight into cutting-edge research at the intersection of nanotechnology and biology. Additionally, the course addresses ethical, safety, and societal considerations, promoting responsible research practices and public awareness of the potential impacts of nanobiology technologies. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Demonstrate an understanding of the fundamental principles of nanobiology, including the unique properties of nanomaterials and their applications in biological systems. | U | C | Instructor-created exams / Quiz |

| | | | | |
|---|---|---|---|---|
| CO2 | Explain the synthesize nanoparticles using appropriate techniques and characterize them using various methods, such as spectroscopy and microscopy. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Acquire practical skills in using advanced experimental techniques commonly employed in nanobiology research, enabling them to design and conduct experiments effectively. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Analyze and interpret the interactions between nanomaterials and biomolecules, evaluating their implications for biomedical applications and environmental impact. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Apply students' knowledge and skills to solve practical problems in areas such as drug delivery, diagnostics, and environmental monitoring, | U | C | One Minute Reflection Writing assignments |
| CO6 | Demonstrate the relevance and significance of nanobiology in addressing societal challenges. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Nanobiology** | | |
| | 1 | Overview of nanotechnology | 2 |
| | 2 | Principles and their applications in biology, | 2 |
| | 3 | Highlighting the significance of studying biological systems at the Nano scale | 3 |
| **II** | **Nanoparticle Synthesis and Characterization:** | | |
| | 4 | Basic techniques for synthesizing nanoparticles | 2 |
| | 5 | Methods for characterizing their size | 2 |
| | 6 | Methods for characterizing their shape | 2 |
| | 7 | Methods for characterizing their surface properties | 2 |

| | | | |
|---|---|---|---|
| | 8 | Methods for characterizing their stability | 2 |
| | 9 | Importance in biological applications of nano particles | 3 |
| **III** | **Nanobiology Techniques** | | |
| | 10 | Introduction to various experimental techniques used in nanobiology | 2 |
| | 11 | Microscopy (e.g., atomic force microscopy, scanning electron microscopy | 2 |
| | 12 | Spectroscopy (e.g., UV-Vis spectroscopy, fluorescence spectroscopy | 2 |
| | 13 | Molecular biology techniques adapted for nanoscale studies | 3 |
| **IV** | **Nanomaterial-Biomolecule Interactions & applications** | | |
| | 14 | Understanding the interactions between nanomaterials and biological molecules, such as proteins. | 2 |
| | 15 | Interactions with nucleic acids, and cell membranes. | 2 |
| | 16 | Nano drug delivery. | 3 |
| | 17 | Nano materials bio sensing, and toxicity | 2 |
| | 18 | Cancer therapy | 2 |
| | 19 | Tissue engineering, | 2 |
| | 20 | Environmental monitoring, with case studies and examples | 2 |
| | 21 | Ethical and Safety Issues in Nanobiology | 2 |
| | 22 | Societal Issues in Nanobiology | 2 |
| **V (Open module)** | | **Applications of Nanobiology** | |
| | 23 | Exploration of real-world applications of nanobiology in areas such as targeted drug delivery | 4 |
| | 24 | Discussion of ethical considerations, safety guidelines, and societal implications associated with the development and implementation of nanobiology technologies | 4 |
| | 25 | Promoting responsible research practices and public awareness | 4 |

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**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| Programme | B. Sc. Biochemistry | | | | |
|---|---|---|---|---|---|
| Course Code | | | | | |
| Course Title | Animal Developmental Biology | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | VI | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course on animal developmental biology explores the intersection of evolution and development, delving into concepts like genetic variation, body plan diversity, and reproductive adaptations across different animal species. It also examines model organisms such as Drosophila, *C. elegans*, zebrafish, and mice, and covers key stages of embryonic development, cellular mechanisms, and regeneration, including the potential applications of regenerative medicine in human health. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Relate evolutionary principles to developmental biology concepts, emphasizing the adaptive significance of developmental mechanisms. | U | C | Instructor-created exams / Quiz |
| CO2 | **E**xplain the fundamental principles of embryonic development, including fertilization, cleavage, gastrulation, and organogenesis. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Compare and contrast the developmental processes in various animal species, highlighting both similarities and differences and analyze and discuss the importance of various signaling pathways in regulating developmental processes. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Explain the molecular and cellular processes underlying embryonic development including cell differentiation and cell signalling. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Relate developmental biology concepts to human health, including the understanding of birth defects, regeneration, and the implications for regenerative medicine. | U | C | One Minute Reflection Writing assignments |

| | | | | |
|---|---|---|---|---|
| CO6 | Develop critical thinking skills by applying theoretical knowledge to solve problems related to animal developmental biology. | Ap | C | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Evolutionary aspects of Development** | | |
| | 1 | Concept and definition of Development, Importance of studying the evolution of developmental processes, Historical perspective on the integration of evolution and development | 2 |
| | 2 | Genetic Basis of Evolutionary Change: Role of mutations in generating genetic variation, Evolutionary conservation and divergence of key developmental genes | 3 |
| | 3 | Comparison of body plan diversity in animals, Evolutionary transformations in body symmetry, Emergence of novel body plans and their adaptive significance. | 2 |
| | 4 | Variations in reproductive modes (e.g., oviparity, viviparity), Evolutionary adaptations in reproductive structures and behaviours. | 2 |
| | 5 | Comparative analysis of embryonic development in different animal groups | 2 |
| | 6 | Evolutionary trends in embryogenesis, Homology and analogy in embryonic structures. | 2 |
| **II** | **Model Organisms for studying Developmental Biology** | | |
| | 7 | Definition and characteristics of model organisms. | 2 |
| | 8 | Importance of using model organisms in developmental biology research, Criteria for selecting suitable model organisms. | 2 |
| | 9 | Advantages, key features, applications and limitations of *Drosophila*, *C. elegans*, zebrafish and mice as model organisms for studying various aspects of animal development. | 3 |
| **III** | **Embryonic Development** | | |
| | 10 | Overview of male and female reproductive system and germ cells | 2 |

| | | | |
|---|---|---|---|
| | 11 | Events in fertilization, formation of zygote. | 2 |
| | 12 | Early embryonic development: Cleavage-types and mechanism. | 2 |
| | 13 | Formation of blastula, positional labels | 2 |
| | 14 | Gastrulation, formation of germ layers | 2 |
| | 15 | Neurulation | 2 |
| | 16 | Cell migration and tissue morphogenesis, organogenesis and growth. | 2 |
| **IV** | **Cellular mechanisms in Development** | | |
| | 17 | Totipotent, unipotent and pleuripotent cells, Fate of embryonic cells and fate map. | 2 |
| | 18 | Events in Cell differentiation: Cellular commitment, Cell specification (autonomous, conditional and syncitial), | 3 |
| | 19 | Progressive determination and its mechanisms, | 2 |
| | 20 | Pattern formation and its mechanisms, | 2 |
| | 21 | Pattern formation in Drosophila, maternal effect genes (Bicoid, Hunchback, Nanos and Caudal) and their functions. | 3 |
| | 22 | Role of various signaling pathways (e.g., Wnt, Hedgehog, Notch) in regulating developmental processes. | 2 |
| **V (open module)** | **Regeneration** | | |
| | 23 | Definition of regeneration, differentiating regeneration from repair and healing processes, regeneration in simple organisms like hydra and planarian worms. | 3 |
| | 24 | Types and mechanisms of regeneration (epimorphosis, morphallaxis and compensatory), Tetrapod limb regeneration. | 2 |
| | 25 | Environmental factors affecting regeneration, Hormonal regulation and its role in regeneration. | 2 |
| | 26 | Genetic and epigenetic factors influencing regenerative capacities. | 2 |
| | 27 | Regenerative medicine, Applications of regenerative medicine in human health, Stem cell therapies and tissue engineering, Challenges and prospects in regenerative medicine. | 3 |

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2. Essentials of Developmental Biology by JMW Slack

3. Principles of Development by Lewis Wolpert, Cheryll Tickle, and Alfonso Martinez Arias

4. Ecological developmental Biology integrating epigenetics, medicine and evolution by Scott F. Gilbert and Epel

5. Developmental Biology by Carlisle and Plopper

6. Life Unfolding: How the Human Body Creates Itself by Jamie A. Davies

7. Laboratory Manual for Developmental Biology by Michael G. Barresi and Scott F. Gilbert

8. Experimental Embryology: A Manual of Techniques and Procedures" by Mary L. Gardiner

9. Developmental Biology: A Guide for Experimental Study" by Mary S. Tyler, Ronald N. Kozlowski, and R. Tucker Gilman

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam

- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Analytical Biochemistry | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | VI | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course covers various methods of tissue homogenization and hydrodynamic techniques such as chromatography, electrophoresis, and centrifugation, as well as UV and visible absorption spectroscopy, colorimetry, and the use of radioisotopes in biochemical research, including measurement methods and safety precautions. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| CO1 | To familiarize different extraction methods. | U | C | Instructor-created exams / Quiz |
| CO2 | Obtaining analytical skills to separate samples (amino acids) using paper chromatography. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Demonstrate the methodology involved in separation of proteins, Nucleic acid by various electrophoretic techniques. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Separate biological sample by centrifugation, separation of subcellular organelles by differential centrifugation, density gradient centrifugation, ultra centrifugation. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Advanced knowledge about the interactions of electromagnetic radiation and matter and their applications in spectroscopy and colorimetry. | U | C | One Minute Reflection Writing assignments |
| CO6 | Acquire knowledge on Radiation, types of radioactive decay, Detection and measurement of radioactivity using GM counter and Scintillation counter, Biological hazards of radiation and safety measures in handling radio isotopes. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **I** | **Methods of tissue homogenization** | | |
| | 1 | Tissue homogenizer | 2 |
| | 2 | Salt and organic solvent extraction and Fractionation | 2 |
| | 3 | Dialysis, Reverse dialysis | 2 |
| | 4 | Lyophilization | 2 |
| | 5 | Ultra filtration | 2 |
| **II** | **Hydrodynamic techniques** | | |
| | 6 | Adsorption and partition chromatography | 2 |
| | 7 | Paper chromatography | 2 |
| | 8 | Thin layer chromatography, HPTLC.. | 3 |
| | 9 | Gel filtration chromatography | 3 |
| | 10 | Affinity chromatography | 3 |
| | 11 | Ion–exchange chromatography | 3 |
| | 12 | HPLC | 2 |
| **III** | **Electrophoresis** | | |
| | 13 | Free electrophoresis – Micro electrophoresis and Moving boundary electrophoresis | 2 |
| | 14 | Zone electrophoresis - Paper electrophoresis, Agarose gel electrophoresis, | |
| | 15 | SDS-PAGE | 2 |
| | 16 | Immuno electrophoresis | 2 |
| | 17 | Isoelectric focussing | 2 |
| **IV** | **Centrifugation** | | |
| | 18 | Principle of sedimentation techniques | 2 |
| | 19 | Sedimentation equation and Svedberg Units | 2 |
| | 20 | Principle, procedure and application of differential centrifugation | 2 |
| | 21 | density gradient centrifugation | 2 |

| | | | |
|---|---|---|---|
| | 22 | Ultracentrifugation. | 2 |
| **V (open module)** | **Spectroscopy and techniques based on radioactivity** | | |
| | 23 | UV and visible absorption spectra | 2 |
| | 24 | Laws of light absorption- Beer - Lambert's law. | 1 |
| | 25 | Principle and instrumentation of colorimetry and spectrophotometry. | 2 |
| | 26 | Important stable radioisotopes used in biochemical research. P32, I125, I 131, Co 60, C14 etc. | 2 |
| | 27 | Radiation hazards and precautions taken while handling radioisotopes. | 2 |
| | 28 | Measurement of radioactivity by GM counter and Scintillation counter. | 1 |
| | 29 | RIA and autoradiography | 2 |

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7. Cark Jr J. M. and Switzer R.L, Experimental Biochemistry. W.H. Freeman and Company.

8. Separation chemistry by R.p Budhiraja, New age international (P) Ltd, New Delhi.


**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Food Analysis | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | VI | | | | |
| Academic Level | 300 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course provides an overview of food chemistry, covering the composition of food, including carbohydrates, lipids, proteins, vitamins, and minerals, as well as the role of enzymes and various processing treatments. It also delves into the nutritive value of different food groups such as pulses, legumes, nuts, meats, fruits, vegetables, and spices, and teaches principles and methods of proximate analysis and quantitative analysis of nutrients. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Familiarize with the chemistry and composition of food. | U | C | Instructor-created exams / Quiz. |
| CO2 | Understand food enzymes. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Evaluate the composition and nutritive value of different food groups. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Learn about the principle of proximate analysis. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Understand proximate analysis of food. | U | C | One Minute Reflection Writing assignments |

| | | | | |
|---|---|---|---|---|
| CO6 | Perform quantitative analysis of nutrients. | Ap | P | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Food Chemistry** | | |
| | 1 | Definition and composition of food. | 2 |
| | 2 | Carbohydrates: Classification, Structure of important polysaccharides, Chemical reactions of carbohydrates – oxidation, reduction, acid and alkali. | 3 |
| | 3 | Lipids: Classification and Physico-chemical properties of lipids. Lipid oxidation, Factors affecting lipid oxidation. | 2 |
| | 4 | Proteins: Classification, Properties and functional properties of protein | 3 |
| | 5 | Vitamins and Minerals: Role of vitamins and minerals in food industry, | 2 |
| | 6 | Effect of various processing treatments and fortification of foods. | 3 |
| **II** | **Food enzymes** | | |
| | 7 | Nature, Classification, Properties of Food enzymes | 2 |
| | 8 | Enzyme activity in different food systems | 2 |
| | 9 | Hydrolyses and Lipases | 2 |
| | 10 | Utilization in Food Chemistry. | 2 |
| | 11 | Browning reaction in foods. | 2 |
| **III** | **Composition and nutritive value** | | |
| | 12 | Pulses& legumes | 2 |
| | 13 | Nuts & oil seeds | 2 |
| | 14 | Meat, fish, egg and milk | 2 |
| | 15 | Classification and composition of fruits& vegetables | 2 |

| | | | |
|---|---|---|---|
| | 16 | Classification and composition of spices | 2 |
| **IV** | **Principles of Proximate Analysis** | | |
| | 17 | Principles and methods of Food Analysis | 2 |
| | 18 | Moisture & Ash content | 2 |
| | 19 | Crude Fat, Crude Protein, Crude Fibre and Carbohydrates | 3 |
| | 20 | Determination of Starch. | 2 |
| | 21 | Test for unsaturation of fats. | 2 |
| | 22 | Rancidity of fats | 2 |
| **V (open module)** | **Quantitative analysis of nutrients** | | |
| | 23 | Quantitative analysis of Protein by Biuret method, Ninhydrin method, Lowry's method. | 4 |
| | 24 | Colorimetric methods of analysis of fat soluble and water soluble vitamins | 4 |
| | 25 | Principles and methods for estimation of minerals | 4 |

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1. Damodaran, S., Parkin, K.L. and Fennema, O. R. (2007). Fennema's Food Chemistry, fourth edition,published by CRC Press.
2. Meyer L.H. (2003). Food Chemistry, Reinhold Pub. Corp.
3. Nielsen, S.S.(2003). Food Analysis, Third Ed., Kluwer Academic/Plenum Publishers, New York.
4. S. Manny , N.S Swamy Food facts and principles . New age International publishers


**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

## DSC Electives Semester VIII

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Genetics | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | VIII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course provides a comprehensive exploration of fundamental genetic principles, including Mendelian inheritance, chromosome theory, gene interactions, and chromosomal variations. Students will delve into topics such as sex determination, sex-linked characteristics, and the application of genetic knowledge in medical science through pedigree analysis and human cytogenetics. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Demonstrate a comprehensive understanding of classical genetics, molecular genetics, and evolutionary genetics, including the molecular basis of heredity and the historical context of genetic studies. | U | C | Instructor-created exams / Quiz |
| CO2 | Gain proficiency in applying Mendel's principles of heredity, including understanding monohybrid and dihybrid crosses, inheritance patterns in humans, and the chromosome theory of heredity. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Acquire knowledge of gene interactions such as allelic interactions, epistasis, and degrees of gene expression, as well as the | U | C | Seminar Presentation / Group Tutorial Work |

| | | | | |
|---|---|---|---|---|
| | inheritance of traits influenced by cytoplasmic factors and maternal effects. | | | |
| CO4 | Analyze the types of chromosomal mutations, aneuploidy, and polyploidy, and be able to analyze pedigrees to infer patterns of inheritance, including autosomal dominance, autosomal recessive, and X-linked recessive traits. | An | C | Instructor-created exams / Home Assignments |
| CO5 | Become familiar with the mechanisms of sex determination in various organisms, the inheritance patterns of sex-linked characteristics, and the concept of dosage compensation for X-linked genes. | U | C | One Minute Reflection Writing assignments |
| CO6 | Apply genetic principles to analyze human karyotypes, understand the significance of chromosomal variations in medical science, and interpret pedigree data for clinical diagnosis and genetic counseling. | Ap | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Genetics** | | |
| | 1 | The molecular basis of Heredity– an overview of the early studies of DNA. | 2 |
| | 2 | Definition and overview of Classical Genetics | 2 |
| | 3 | Definition and overview of Molecular Genetics | 2 |
| | 4 | Definition and overview of Evolutionary Genetics | 2 |
| | 5 | Model genetic organisms (brief outline with examples). | 2 |
| **II** | **Mendelian Genetics & Chromosome Theory** | | |

| | | | |
|---|---|---|---|
| | 6 | Basic principles of heredity- Mendel's principles | 2 |
| | 7 | monohybrid, dihybrid and test cross (pea plant), | 2 |
| | 8 | Applications of Mendel's principles | 2 |
| | 9 | Chromosome Theory of Heredity (Sutton-Boveri) | 2 |
| | 10 | Inheritance patterns, the phenomenon of Dominance | 2 |
| | 11 | Inheritance patterns in Human (Autosomal Dominant, Autosomal Recessive, X-linked Dominant, X-linked Recessive, Mitochondrial- one example for each single-gene disorders). | 3 |
| **III** | **Extension of Mendelian Genetics** | | |
| | 12 | Gene interaction: Allelic gene interaction (complete dominance, co-dominance and incomplete dominance- brief outline with example). | 2 |
| | 13 | Multiple alleles- ABO blood groups in humans | 3 |
| | 14 | Epistasis- dominant & recessive epistasis (brief outline with example). | 2 |
| | 15 | Degrees of gene expression: Penetrance, expressivity, genetic anticipation and genomic imprinting (definition with examples). | 2 |
| | 16 | Cytoplasmic inheritance, extra nuclear inheritance (mitochondrial, chloroplast). | 2 |
| | 17 | Maternal inheritance (kappa particles in paramecium, male sterility in maize) and maternal effect (shell coiling in snail). | 3 |
| **IV** | **Chromosomal variation in number & structure** | | |
| | 18 | Types of chromosome mutation: chromosome rearrangements (duplication, deletion, inversion and translocation | 3 |
| | 19 | Aneuploidy, polyploidy (Brief outline | 2 |
| | 20 | Pedigree analysis and applications -autosomal dominance, autosomal recessive, X-linked recessive (brief outline). | 2 |
| | 21 | Human karyotype | 2 |
| | 22 | Use of Human cytogenetics in Medical science | 2 |
| **V (open module)** | **Sex determination & Sex linked characteristics** | | |
| | 23 | Sex determination in *Drosophila melanogaster* and human | 4 |
| | 24 | Sex linked characteristics (eye colour of drosophila). | 4 |

| | | | |
|---|---|---|---|
| | 25 | Dosage compensation of X-linked genes | 4 |

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2. Concepts of Genetics Gobal edition, William S. Klug, Michael R. Cummings, Charlotte Spencer, Michael Palladino, Darrell Killian, Edition 12, illustrated Pearson, 2019, ISBN 1292265329, 9781292265322

3. Genetics: Analysis of Genes and Genomes, Hartle DL and Jones EW – Jones and Bartlett (2005)

4.Principles of Genetics, 6th Edition D. Peter Snustad, Michael J. Simmons, John Wiley & Sons, 2011, ISBN 1118208706, 9781118208700

5. An Introduction to Genetic Analysis, Griffith AF et al., - Freeman

6. Lewin's Genes Twelve By Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick · 2017; ISBN:9781284104493, 1284104494.


**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | - | 3 | 3 | 1 | 3 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | - | 3 | 3 | 3 | 3 |
| CO6 | 2 | 3 | 1 | 3 | 3 | 3 | 3 | - | 1 | 3 | 3 | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Environmental Biochemistry | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | VIII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course on Fundamentals of Ecology & Environmental Science covers various aspects crucial to understanding ecological systems and environmental issues. It explores the environment's physical and biotic components, pathways in ecosystems, and the concept of biomes. Additionally, it delves into environmental pollution, control, and | | | | |

| | |
|---|---|
| | remediation techniques, as well as environmental toxicology and hazard management, addressing topics such as pollutants, detoxification mechanisms, waste management, and disaster management. |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Get exposed to the basic knowledge of ecology and environmental science | U | C | Instructor-created exams / Quiz |
| CO2 | Get awareness and sense of responsibilities towards environment and apply knowledge to solve the issues related to Environmental pollution. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Understand about habitats, its pollution and their management | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Analyse the biochemical and toxicological processes in organisms those are influenced by the environment. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Understand basic concepts of Environmental Hazards, Risks & Disaster Management | U | C | One Minute Reflection Writing assignments |
| CO6 | Acquire basic knowledge on geological processes, environmental pollutions etc. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Fundamentals of Ecology & Environmental Science** | | |
| | 1 | The Environment: Physical environment; biotic environment; biotic and abiotic interactions. | 2 |
| | 2 | Physico-chemical and Biological factors in the Environment (Abiotic and Biotic components) | 2 |
| | 3 | Pathways in Ecosystems (food chain, food webs, ecological pyramids, Mass and energy flow) | 2 |
| | 4 | Concept of Biomes their classification and distribution; Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest, Chapparal, Savanna, Tropical rain forest, Highland Icy Alpine biome. | 3 |
| | 5 | Theories of biological evolution (basic outlines of Lamarkism, Darwinian theory, Mutation theory and Hardy-Weinberg principle). | 3 |
| II | **Environmental Pollution** | | |
| | 6 | Environmental pollutants, their classification, sources and impact on living beings. | 2 |
| | 7 | Effect of various pollutants on animal, plant and microbial metabolism; | 2 |
| | 8 | Pollutant detoxification mechanism in animals, plants and microbes. | 3 |
| | 9 | Biochemical basis of pollutant tolerance. | 2 |
| | 10 | Soil enzymes, their source and role in the environment. | 2 |
| III | **Control, Remediation and Management** | | |
| | 11 | Air pollution control technologies: Sampling of gases and vapours, Sampling of particulate pollutants. | 2 |
| | 12 | Prevention and control techniques of gaseous pollutants (Combustion, Absorption & Adsorption); | 2 |
| | 13 | Prevention and control methods of particulates matter (Settling Chambers, Cyclone Separators, Wet Collectors (Scrubbers), Bag Filters and Electrostatic Precipitators); | 3 |

| | | | |
|---|---|---|---|
| | 14 | Stack monitoring; Air quality standards, Indian National Ambient Air quality standards, Air pollution index. | 2 |
| | 15 | Waste water treatment process and Water Pollution and Resource Management: Waste water treatment processes (Characteristics of domestic, industrial and municipal wastewater, primary, secondary and tertiary treatment methods); Sludge digestion processes; | 2 |
| | 16 | Drinking water treatment processes (Ion exchange, Reverse Osmosis, Ozonisation, Carbon Adsorption, Membrane Processes, UV treatment and other advanced treatment methods) | 2 |
| | 17 | Water conservation methods | 2 |
| **IV** | **Environmental Toxicology** | | |
| | 18 | Definition and basic concept of toxicology; Definition of toxins, xenobiotics; | 2 |
| | 19 | LADME or ADME scheme of toxico kinetics (Liberation-routes of exposure, absorption, distribution, metabolism, and excretion). | 2 |
| | 20 | Duration and frequency of exposure (Acute, Sub-acute,Chronic); | 2 |
| | 21 | Statistical concept of LC50, LD50; Dose response relationships and curves; Therapeutic index, | 2 |
| | 22 | Factors that influence toxicity (biological, chemical, ecological); Biotransformation, Bio-accumulation, Bio-magnification. | 2 |
| **V (open module)** | **Environmental Hazard, Risk & Disaster Management** | | |
| | 23 | Disaster introduction; Disaster Management Capability: Vulnerability and risk, Hazard zonation and mapping- Risk Reduction Measures. | 3 |
| | 24 | Earthquake, Volcanic activity, Tsunami, Landslide, Tropical Cyclones, Flood and drought. | 3 |
| | 25 | Environmental and Occupational Health Hazards: Causes of disease outbreak; Specific causes, consequences and mitigation of occupational diseases (Asbestosis, Silicosis), vector borne and infectious diseases (Dengue, Chikungunya, Plague, Swine flu, Bird flu, AIDS, Ebola). | 4 |
| | 26 | Role of WHO in disease control. | 2 |

**REFERENCES**

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2. The Atmosphere: An Introduction to Meteorology by FK Lutgen and EJ. Tarbuk, Pearson

3. Oceanography-an introduction to marine science by Tom Garrison, Brooks/Cole-Thomson Learning

4. Understanding Earth by Grotzinger, Jordan, Press & Siever; WH Freeman and Company

5. Industrial safety and health, David L. Goetsch, Macmillan Publishing Company.

6. Handbook of environmental health and safety, Vol I & II, H Kooren & M Bisesi, Jaico Publ. House

7. Environmental Science by Cunningham and Cunningham

8. Ecology and Environmental Science by SVS Rana, PHI pvt. ltd.

9. Air Pollution by VP Kudesia, Pgagati Prakashan

10. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publishing House.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | - | - | 2 | 3 | - | - | - | - | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | - | - | - | 3 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | - | - | - | 3 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | - | - | - | 3 |
| CO5 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - | 3 |
| CO6 | 3 | 3 | 3 | - | - | 3 | 3 | 3 | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar

- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Environmental Studies | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | VIII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course covers a broad range of topics essential for understanding environmental issues and sustainability. It introduces the components of the environment, including the atmosphere, hydrosphere, lithosphere, and biosphere, and discusses natural resources, ecosystems, biodiversity, and environmental concerns such as pollution and climate change. Additionally, it explores environmental policies and laws at national and international levels, emphasizing the importance of conservation and sustainable practices. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the basic concepts, scope & importance of environmental science | U | C | Instructor-created exams / Quiz |
| CO2 | Familirize with various types of natural resources, its use and over exploitation by mankind and get awareness about the necessity to conserve natural resources. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Gain knowledge about structure, function & energy flow in the different ecosystems. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Recognize and explain various human-induced threats to biodiversity & familiar with different conservation strategies and techniques aimed at preserving biodiversity. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Gain a comprehensive understanding of various environmental issues facing the world , familiar with national and international environmental policies, regulations, and agreements aimed at addressing environmental challenges. | U | C | One Minute Reflection Writing assignments |
| CO6 | Communicate environmental concerns and advocate for sustainable solutions to various audiences. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **I** | **Introduction to Environmental Studies** | | |
| | 1 | Definition, structure and components of Environment | 2 |
| | 2 | Atmosphere, Hydrosphere, Lithosphere, Biosphere, | 2 |
| | 3 | Multidisciplinary nature of Environmental Studies | 2 |
| | 4 | Scope and importance of Environmental Studies | 2 |
| **II** | **Natural Resources** | | |
| | 5 | Types - Renewable resources and non-renewable sources. Natural resources and associated problems. | 2 |
| | 6 | Forest resources; Use and over exploitation, deforestation –conservation strategies. | 2 |
| | 7 | Water resources- use and over-utilization of surface and ground water, water conservation,rain water harvesting ,dams –benefits & problems. | 3 |
| | 8 | Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. | 3 |
| | 9 | Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. | 2 |
| | 10 | Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. | 2 |
| **III** | **Ecosystems** | | |
| | 11 | Concept of an ecosystem. | 2 |
| | 12 | Structure and function of an ecosystem. | 2 |
| | 13 | Energy flow in the ecosystem | 3 |
| | 14 | Characteristic features, structure and function of Forest ecosystem, | 2 |
| | 15 | Characteristic features, structure and function of Grassland ecosystem | 2 |
| | 16 | Characteristic features, structure and function of Desert ecosystem | 2 |
| | 17 | Characteristic features, structure and function of Aquatic ecosystems (ponds,lakes rivers, oceans). | 2 |

| | | | |
|---|---|---|---|
| **IV** | **Biodiversity and its conservation** | | |
| | 18 | Introduction- Definition: genetic, species and ecosystem diversity. | 2 |
| | 19 | Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. | 2 |
| | 20 | Biodiversity at global, national and local levels. | 2 |
| | 21 | Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts, Endangered and endemic species of India. | 3 |
| | 22 | Conservation of biodiversity; In-situ and ex-situ conservation of biodiversity. | 2 |
| **V (open module)** | **Environmental concerns and Environmental Policies** | | |
| | 23 | Pollution, Ozone layer depletion,global warming, greenhouse effect, climate change | 3 |
| | 24 | Environment Laws: Wildlife Protection Act; Forest Conservation Act. Water (Prevention and control of Pollution) Act; Air (Prevention & Control of Pollution) Act; Environment Protection Act; Biodiversity Act, | 3 |
| | 25 | National Green Tribunal: Structure, composition and functions. | 4 |
| | 26 | International agreements: Montreal Protocol, Kyoto protocol and climate negotiations; Convention on Biological Diversity (CBD) | 2 |

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1 Bharucha E.: The Biodiversity of India, Ahmedabad, Mapin

2· Bharucha E.: Textbook of Environmental Studies. Orient BlackSwan

3· Basu, M. and Xavier, S., Fundamentals of Environmental Studies, Cambridge University Press, 2016.

·4 Enger, E. and Smith, B., Environmental Science: A Study of Interrelationships, Publisher: McGraw-Hill Higher Education; 12th edition, 2010

5· Gadgil, M., &Guha, R. 1993. This Fissured Land: An Ecological History of IndiaUniv.of California Press.

·6 Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders

· 7 Agrawal, KM, Sikdar, PK and Deb, SC, A Text book of Environment, Macmillan Publication, 2002.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | - | - | - | - | 3 | 3 | - | - | - | - | 3 |
| CO2 | 3 | 2 | - | - | - | 3 | 3 | 2 | - | - | - | 3 |
| CO3 | 1 | - | 3 | - | - | 3 | 3 | - | - | - | - | 3 |
| CO4 | 3 | 3 | - | 3 | - | 3 | 3 | 2 | - | - | - | 3 |
| CO5 | 3 | - | - | - | 1 | 3 | 3 | - | - | - | 2 | 3 |
| CO6 | 3 | - | - | - | - | 3 | 3 | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Intellectual Property Rights | | | | |
| Type of Course | Discipline Specific Elective | | | | |
| Semester | VIII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | In this course, students explore various aspects of intellectual property (IP) law, with a focus on its relevance to biotechnology. They learn about different types of IP such as patents, trademarks, and copyrights, as well as agreements and treaties governing international IP rights, including the TRIPS Agreement. The course covers the role of organizations like WIPO and WTO, the Indian Patent Act, patent application procedures, patent databases, and patent licensing. Additionally, students examine issues related to access to biological resources, traditional knowledge, and equitable benefit sharing, with case studies illustrating real-world applications of IP law in biotechnology. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Evaluate the importance of exercising rights over ones own intellectual outputs the same way as any physical property | U | C | Instructor-created exams / Quiz |
| CO2 | Analyze the differences between Patent, Copyright, Trademark etc. | U | C | Practical Assignment / |

| | | | | |
|---|---|---|---|---|
| | | | | Observation of Practical Skills |
| CO3 | Evaluate the requirements and procedure to protect ones intellectual property | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Differentiate what cannot be patented in India and why. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Evaluate the international scenario of IPR with Indian situations. | U | C | One Minute Reflection Writing assignments |
| CO6 | Indulge in group discussions and case studies regarding IPR | Ap | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Unit I** | | |
| | 1 | Types of Intellectual property (IP): Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications | 3 |
| | 2 | Protection of GMOs IP as a factor in R&D | 2 |
| | 3 | IPs of relevance to Biotechnology | 3 |
| | 4 | Agreements and Treaties History of GATT & post GATT scenario | 3 |
| | 5 | TRIPS Agreement | 2 |
| | 6 | Important International agreements | 2 |
| **II** | **Unit II** | | |
| | 7 | Role of WIPO and WTO in the international scenario | 3 |
| | 8 | Geographical indications of Goods- Recent examples in Indian scenario | 3 |
| | 9 | Plant varieties and farmers right undisclosed information | 2 |
| | 10 | Plant varieties and farmers right | 2 |
| | 11 | Undisclosed information | 2 |
| **III** | **Unit III** | | |
| | 12 | Introduction to Patents | 1 |

| | | | |
|---|---|---|---|
| | 13 | Indian Patent Act – an overview and its major amendments. | 2 |
| | 14 | Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; | 2 |
| | 15 | Forms and fees Invention in context of "prior art"; | 2 |
| | 16 | Patent databases; Searching International Databases | 2 |
| | 17 | Country-wise patent searches (USPTO, esp@cenet (EPO), | 2 |
| | 18 | PATENT Scope (WIPO), IPO, etc.) | 2 |
| **IV** | **Unit IV** | | |
| | 19 | National & PCT filing procedure | 2 |
| | 20 | Precautions while patenting – disclosure/non-disclosure | 2 |
| | 21 | Patent licensing and agreement | 2 |
| | 22 | Patent infringement meaning, scope, litigation, case studies | 2 |
| **V (open module)** | **Unit V** | | |
| | 23 | Procedure for access to biological resources and associated traditional knowledge, restriction on access. | 3 |
| | 24 | Prior approval before seeking intellectual property protection, | 2 |
| | 25 | Approval for transferring of results from bioresources collected from India, | 2 |
| | 26 | Third party transfer of the approval granted | 2 |
| | 27 | criteria for equitable benefit sharing on development of product/processes from bioresources / TK, case studies. | 3 |

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1. Intellectual Property and Development; Theory and Practice. Olwan, Rami M. Springer-Verlag Berlin Heidelberg. 2013
2. Intellectual Property Rights in Agricultural Biotechnology- Erbisch FH and Maredia KM (2004) CABI Publishing
3. The Biological Diversity ACT 2002 and Rules 2004. National Biodiversity Authority, India. 2015


**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | 3 | - | - | 3 | 3 | - | - | - | - | - |
| CO2 | - | 3 | - | - | - | 3 | 3 | 3 | - | - | - | 3 |
| CO3 | - | - | 3 | - | - | 3 | 3 | - | - | - | - | - |
| CO4 | - | 3 | - | - | - | 3 | 3 | 3 | - | - | - | - |
| CO5 | - | 3 | - | - | - | 3 | 3 | 3 | - | - | - | 3 |
| CO6 | - | - | 3 | - | - | 3 | 3 | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Biostatistics | | | | |
| Type of Course | Elective | | | | |
| Semester | VIII | | | | |
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | | | | | |
| Course Summary | In this biostatistics course, students gain a solid foundation in statistical methods essential for biochemistry research. They start with descriptive statistics, exploring measures of central tendency and dispersion, and then move on to probability theory and its applications in biochemistry. Probability distributions, sampling distributions, and the Central Limit Theorem are covered in detail, along with statistical inference techniques like estimation and hypothesis testing. The course also delves into advanced topics such as analysis of variance (ANOVA), regression analysis, and logistic regression. Additionally, students learn to use various statistical software packages like Excel, Origin, MATLAB, Stata, and SPSS for data analysis, providing practical skills for their research endeavors. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Demonstrate Understanding of Basic Probability Concepts | A | C | Instructor-created exams / Quiz |
| CO2 | Define and explain basic probability concepts relevant to biological data, including random variables, probability distributions, and the Central Limit Theorem. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Apply Statistical Techniques to Analyze Experimental Data | E | P | Seminar Presentation / Group Tutorial Work |

| | | | | |
|---|---|---|---|---|
| CO4 | Critically evaluate statistical methods and results presented in biochemistry literature, assessing their validity and appropriateness for addressing research questions. | A | P | Instructor-created exams / Home Assignments |
| CO5 | Interpret ANOVA results and perform post-hoc tests to identify significant differences between experimental groups. repetitions | An | P | One Minute Reflection Writing assignments |
| CO6 | Conduct Regression Analysis for Biochemical Data: | Ap | P | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to Biostatistics** | | |
| | 1 | Overview of biostatistics and its importance in biochemistry research. | 2 |
| | 2 | Descriptive statistics: measures of central tendency and dispersion. | 2 |
| | 3 | Mean | 2 |
| | 4 | Mode | 2 |
| | 5 | Median | 2 |
| | 6 | Introduction to probability theory | 2 |
| | 7 | Applications of probability theory in biochemistry. | 2 |
| **II** | **Probability Distributions** | | |
| | 8 | Discrete and continuous probability distributions (e.g., binomial, normal, Poisson). | 3 |
| | 9 | Probability density functions and cumulative distribution functions. | 2 |
| | 10 | Sampling distributions and Central Limit Theorem | 2 |
| **III** | | | |

| | | | |
|---|---|---|---|
| | **Statistical Inference** | | |
| | 11 | Estimation: point estimation and confidence intervals. | 2 |
| | 12 | Hypothesis testing: principles, types of errors, significance levels | 2 |
| | 13 | Parametric tests | 3 |
| | 14 | Non-parametric tests | 3 |
| **IV** | **Analysis of Variance (ANOVA) & Regression analysis** | | |
| | 15 | One-way ANOVA and multiple comparisons. | 2 |
| | 16 | Two-way and higher ANOVA designs. | 2 |
| | 17 | Assumptions and diagnostics for ANOVA | 2 |
| | 18 | Two-way and higher ANOVA designs. | 2 |
| | 19 | Regression Analysis | 2 |
| | 20 | Simple linear regression and correlation. | 3 |
| | 21 | Multiple linear regression and model selection. | 2 |
| | 22 | Logistic regression for categorical outcomes | 2 |
| **V (Open module)** | **Software used for statistical analysis** | | |
| | 23 | Excel | 2 |
| | 24 | Origin | 2 |
| | 25 | Matlab | 2 |
| | 26 | Stata | 3 |
| | 27 | SPSS | 3 |

**REFERENCES**

1 Introduction to Biostatistics◦ Bland, J. Martin, and Douglas G. Altman. "Statistics notes: the odds ratio." BMJ: British Medical Journal 320.7247 (2000): 1468.

2 ◦ Altman, Douglas G., and J. Martin Bland. "Statistics notes: measurement in medicine: the analysis of method comparison studies." The Statistician (1983): 307-317.

3 ◦ Rosner, Bernard. Fundamentals of Biostatistics. Nelson Education, 2015.

Probability Distributions

4 ◦ Rice, John A. Mathematical statistics and data analysis. Cengage Learning, 2007.

5 ◦ Larsen, Richard J., and Morris L. Marx. An introduction to mathematical statistics and its applications. Pearson, 2019.

6 ◦ Wackerly, Dennis, William Mendenhall, and Richard L. Scheaffer. Mathematical statistics with applications. Cengage Learning, 2014.

Statistical Inference

7 ◦ Casella, George, and Roger L. Berger. Statistical inference. Cengage Learning, 2002.

8 ◦ Lehmann, Erich L., and Joseph P. Romano. Testing statistical hypotheses. Springer Science & Business Media, 2006.

9 ◦ Gelman, Andrew, et al. Bayesian data analysis. CRC press, 2013.

10 Analysis of Variance (ANOVA)

11 ◦ Kutner, Michael H., et al. Applied linear statistical models. McGraw-Hill Irwin, 2004.

12 ◦ Hinkelmann, Klaus, and Oscar Kempthorne. Design and analysis of experiments: Introduction to experimental design. John Wiley & Sons, 2008.

13 ◦ Montgomery, Douglas C. Design and analysis of experiments. John Wiley & Sons, 2017.

Regression Analysis

14 ◦ Kutner, Michael H., et al. Applied linear statistical models. McGraw-Hill Irwin, 2004.

◦ Draper, Norman R., and Harry Smith. Applied regression analysis. John Wiley & Sons, 2014.

15 ◦ Hosmer, David W., et al. Applied logistic regression. John Wiley & Sons, 2013

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| CO2 | 2 | - | - | - | - | - | 3 | - | - | - | - | - |
| CO3 | - | - | 3 | - | - | - | - | - | 1 | - | - | - |
| CO4 | - | - | - | 2 | - | - | - | - | - | 3 | - | - |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | - | - | - | - | 3 | - | - | - | - | - | 3 | - |
| CO6 | - | - | - | - | - | 3 | - | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

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| | |
|---|---|
| Programme | B. Sc. Biochemistry |
| Course Code | |
| Course Title | Metabolic and Non-Communicable disorders |
| Type of Course | Discipline Specific Elective |
| Semester | VIII |

| | | | | | |
|---|---|---|---|---|---|
| Academic Level | 400 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | Good background of intermediary metabolism | | | | |
| Course Summary | This course provides a comprehensive overview of nutritional and metabolic disorders, exploring topics such as nutrient deficiencies, metabolic syndromes, and multifactorial complex disorders. Students learn about the biochemical basis for symptoms associated with various disorders, including obesity, diabetes mellitus, cardiovascular diseases, and cancer. The course also covers mood disorders, neurodegenerative diseases, and diseases due to misfolded proteins. Practical sessions provide hands-on experience in diagnosing and managing these disorders, enabling students to apply their knowledge in real-world scenarios. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | To generate in-depth knowledge in different aspects of metabolic and non-communicable disorders. | A | C | Instructor-created exams / Quiz |
| CO2 | Skills to interpret the metabolism of various Biomolecules with associated disorders. | A | C | Practical Assignment / Observation of Practical Skills |
| CO3 | To explain and to develop collaborative learning and presentation skills in the topics of metabolic and non- communicable disorders. | An | P | Seminar Presentation / Group Tutorial Work |
| CO4 | To develop the understanding levels up to global standards in the area of metabolic and non - communicable disorders. | C | P | Instructor-created exams / Home Assignments |
| CO5 | To Analyse the reasons behind each of the disorders | An | P | One Minute Reflection Writing assignments |
| CO6 | To develop scientific curiosity by creating in | C | C | Viva Voce |

| | | | | |
|---|---|---|---|---|
| | depth knowledge in the area of study. | | | |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Nutritional disorders** | | |
| | 1 | Overview of major and minor nutrient components in the diet. | 2 |
| | 2 | Balanced diet and the concept of RDA. | 2 |
| | 3 | Nutrient deficiencies; Kwashiorkor and Marasmus, Scurvy, beri beri, pellagra and B12 deficiency, Xerophthalmia and Night blindness, Vitamin D deficiency, Vitamin K deficiency. Discuss with relation to biochemical basis for symptoms | 2 |
| | 4 | Mineral deficiencies related disorders | 2 |
| **II** | **Metabolic and Lifestyle disorders** | | |
| | 5 | Obesity and eating disorders like Anorexia nervosa and Bullemia. | 2 |
| | 6 | Diabetes mellitus A metabolic syndrome and the relationship with hypertension, obesity, hypothyroidism and stress | 3 |
| | 7 | Cardiovascular disorders | 2 |
| | 8 | Atherosclerosis-defining the broad spectrum of ailments that fall in this category, understanding the factors that contribute to the syndrome, stages of disorder and the management of the condition. | 3 |
| | 9 | Irritable bowel syndrome- biochemistry behind the disorder and the influence of diet, stress and environment on the condition | 3 |
| **III** | **Multifactorial complex disorders and Cancer** | | |
| | 10 | Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of diseases | 2 |
| | 11 | Cancer: characteristics of a transformed cell, causes and stages of Cancer | 2 |
| | 12 | Molecular basis for neoplastic growth and metastasis, Proto-oncogenes and tumor suppressor genes; Cancer causing mutations; Tumor viruses | 2 |
| | 13 | Biochemical analysis of cancer; Molecular approaches to cancer treatment | 2 |
| | 14 | Disorders of mood: Schizophrenia, dementia and anxiety disorders. | 2 |

| | | | |
|---|---|---|---|
| | 15 | Polycystic ovarian syndrome, Parkinson's disease, ALS | 2 |
| **IV** | **Diseases due to misfolded proteins** | | |
| | 16 | Introduction to protein folding and proteosome removal of misfolded proteins; | 2 |
| | 17 | Etiology and molecular basis for Alzheimer's | 2 |
| | 18 | Prion diseases | 2 |
| | 19 | Huntington's | 1 |
| | 20 | Chorea | 1 |
| | 21 | Sickle cell anaemia | 2 |
| | 22 | Thalassemia | 2 |
| **V (open module)** | **Practicals** | | **30** |
| | 1 | Anthropometric measurements for normal and high risk individuals and identifications for Kwashiorkor, Marasmus and Obesity | |
| | 2 | Estimation of homocysteine levels in serum | |
| | 3 | Estimation of glycosylated hemoglobin | |
| | 4 | Permanent slides for different types of cancer | |
| | 5 | Diagnostic profile for assessment of CVS and Diabetes mellitus using case studies | |
| | 6 | Bone densitometry test demonstration (visit to a nearby clinic) | |

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2. Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.

3. The World of the cell, 7th edition (2009)

4. Genetics (2012) Snustad and Simmons,

5. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

6 Harper's Illustrated Biochemistry 32nd edition

7 METABOLIC SYNDROME AND NEUROLOGICAL DISORDERS Edited by Tahira Farooqui and Akhlaq A. Farooqui, published 2013 C 2013 by John Wiley & Sons, Inc References

**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | 3 | 3 | 2 | 3 | 3 | - | - | 3 | 2 | 3 |
| CO2 | 3 | - | 2 | 3 | 3 | 3 | 1 | - | - | 3 | 3 | 2 |
| CO3 | - | 3 | 3 | - | - | - | - | 3 | 3 | - | - | - |
| CO4 | - | - | - | 3 | - | - | - | - | - | 2 | - | - |
| CO5 | - | - | - | - | 1 | - | - | - | - | - | 1 | - |
| CO6 | - | - | - | - | - | 3 | - | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 6 | | | ✓ | |

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**MINOR COURSES IN BIOCHEMISTRY ( For Aquaculture and Microbiology Students)**

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | BIOCHEMISTRY | | | | |
| Type of Course | Minor | | | | |
| Semester | I | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 45 T +30 P=75hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | The course focus on the basics of cell, cellular organelles, biological molecules and membrane transport and physical principles. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | To understand the structure and functioning of eukaryotic cell. | U | C | Instructor-created exams / Quiz |
| CO2 | To understand the classification, structure, function and applications of biomolecules | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | To understand the biochemistry of life and living organisms | U | C | Seminar Presentation / Group Tutorial Work |

| | | | | |
|---|---|---|---|---|
| CO4 | To understand the physical biochemistry of phenomina observed in living world | U | C | Instructor-created exams / Home Assignments |
| CO5 | To understand the type of membrane transportation. | U | C | One Minute Reflection Writing assignments |
| CO6 | Understand the functions and different types of biological solutions. | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Unit I** | | |
| | 1 | Cell theory, Cell types, Cell- structure and function of different cell organelles-. | 1 |
| | 2 | Cell wall, mitochondria, extracellular matrix, nucleus, cytoplasm, ribosome, golgi apparatus etc | 2 |
| | 3 | Digestion and absorption of macromolecules, | 2 |
| | 4 | Biochemical aspects of diet and nutrition (energy level) | 1 |
| **II** | **Unit II** | | |
| | 5 | Biological Macromolecules, Functions | 3 |
| | 6 | Definition and classification of biomolecules of life, types, source. | 3 |
| | 7 | Importance of biomolecules in living organisms, | 2 |
| | 8 | Chemical elements essential for life, trace elements | 2 |
| **III** | **Unit III** | | |
| | 9 | Chemical bonds and interactions- Van der Waals forces | 2 |
| | 10 | Dipole-dipole interactions, , Ion-dipole interactions, covalent bonds, ionic bonds | 1 |
| | 11 | Chemical equilibrium | 1 |
| | 12 | Hydrogen bonding- importance in Biology | 1 |
| | 13 | Water the universal biological solvent, Dissociation of water, Ionic product of water | 4 |
| | 14 | Concepts of Acids, bases | 1 |
| | 15 | Dissociation of weak acids, Titration curve | 1 |
| | 16 | Concept of pH, POH buffers - physiological buffers, calculations | 2 |
| | 17 | Henderson Hassel Balch equation, calculations | 2 |
| **IV** | **Unit IV** | | |
| | 18 | Biomembrane and transport, osmosis, diffusion, dialysis | 2 |

| | | | |
|---|---|---|---|
| | 19 | Colloids: True solution, colloidal solution and suspension. Preparation of colloidal system, Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples. Properties of colloids: | 3 |
| | 20 | Brownian movement – Tyndall effect – Electrophoresis. Emulsions. Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps | 3 |
| | 21 | Basic reactions of organic functional groups, OH, CO, CHO, COOH, NH2,Amide SH, | 3 |
| | 22 | Redox reactions, decarboxylation, elimination, addition, substitution, condensation, isomerisation | 3 |
| **V (open module)** | **Practicals** | | **30 hrs** |
| | 1 | Scientific weighing using weighing bottle and electronic balance | |
| | 2 | Preparation of standard solutions | |
| | 3 | Percentage solutions W/V, V/V, W/W etc preparation | |
| | 4 | Molar and mole fraction - solutions- preparation | |
| | 5 | Normal solutions | |
| | 6 | Quantitative transfer of materials, accuracy in transfer (to find out percentage error.) | |
| | 7 | To learn the functions of light microscope | |

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1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46 th Edn., Vishal

Publishing Company, New Delhi, 2013.

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**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| CO2 | - | 3 | - | - | - | - | - | 3 | - | - | - | - |
| CO3 | - | - | 3 | - | - | - | - | - | 3 | - | - | - |
| CO4 | - | - | - | 3 | - | - | - | - | - | 3 | - | - |
| CO5 | - | - | - | - | 3 | - | - | - | - | - | 3 | - |
| CO6 | - | - | - | - | - | 3 | - | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Life Molecules | | | | |
| Type of Course | Minor | | | | |
| Semester | II | | | | |
| Academic Level | 100 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 45 T +30 P=75hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | It provides the learner an overall knowledge of biomolecule, its chemistry in detail. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Identify and differentiate between D and L isomers, epimers, and anomers in carbohydrates, xplain the concept of mutarotation and its significance. | U | C | Instructor-created exams / Quiz |
| CO2 | Describe the structure of key monosaccharides, including glucose, fructose, galactose, and mannose, in both linear and cyclic forms. | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Understand glycosidic bonds in disaccharides. Explore the structures and importance of maltose, sucrose, lactose, and trehalose. | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Examine the structure and significance of homopolysaccharides such as cellulose, glycogen/starch, and chitin. | U | C | Instructor-created exams / Home Assignments |
| CO5 | Identify and describe the structure of the 20 amino acids found in proteins. | U | C | One Minute Reflection Writing assignments |

| | | | | |
|---|---|---|---|---|
| CO6 | Analyze the levels of organization in proteins, including primary, secondary, and tertiary structures. Describe the structure of purines, pyrimidines, nucleosides, and nucleotides. | U | C | Viva Voce |

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | **Carbohydrates** | | |
| | 1 | Carbohydrates- isomerism of carbohydrates - D and L isomerism, epimerism, anomerism - mutarotation. Optical isomerism - d and l isomerism. Monosaccharides -Structure of following monomers (linear and cyclic) - glucose, fructose, galactose, mannose. | 3 |
| | 2 | Sugar derivatives - 2- deoxy β D ribofuranose. Reducing action of sugars, Reactions of monosaccharides | 2 |
| | 3 | . Disaccharides - glycosidic bonds, structure and importance of the following disaccharides - maltose, sucrose, lactose, trehalose | 2 |
| | 4 | Polysaccharides- structure and importance of following - Homopolysaccharides - cellulose, glycogen/starch, cellulose, chitin. Heteropolysaccharides - heparin, sialic acids, hyaluronic acid. | 2 |
| II | **Amino acids and proteins** | | |
| | 5 | Structure of 20 amino acids occurring in proteins | 2 |
| | 6 | Color reactions of amino acids. zwitter ions and isoelectric pH; peptide bond; structure of proteins | 2 |
| | 7 | Levels of organization- Primary, secondary and tertiary structures. Proteins sequencing - Sanger's method and Edman's reaction. | 2 |
| | 8 | Reactions of proteins - Biuret, Lowry; Precipitation reactions (organic solvent precipitation - acetone, ethanol, salt precipitation - ammonium sulphate, heavy metal ions). Denaturation and renaturation of proteins. | 3 |
| | 9 | Nucleic acids - structure of purines, pyrimidines,Nucleosides, Nucleotides ATP and cAMP | 2 |
| | 10 | RNA - structure and types. DNA - structure, and types, Watson and Crick Model. | 2 |
| III | **Techniques in Biochemistry** | | |
| | 11 | Chromatographic techniques - principles and applications of paper, thin layer, gas, HPLC, gel filtration, ion exchange. | 2 |
| | 12 | Colorimetry & Spectrophotometry | 2 |
| | 13 | Electrophoretic techniques - SDS - PAGE, native PAGE | 2 |
| | 14 | Dialysis and Ultracentrifugation | 2 |

| | | | |
|---|---|---|---|
| | 15 | ELISA , RIA & Radio isotopic techniques | 2 |
| | 16 | AAS | 1 |
| | 17 | Mass spectrophotometry, MALDI, MS/MS | 2 |
| **IV** | | | |
| | 18 | (Lipids - Structure and Classification of lipids - simple lipids (fats and oils), compound lipids<br>(Phospholipids, Sphingo lipids). | 2 |
| | 19 | Derived lipids (steroids - cholesterol, ergosterol). | 2 |
| | 20 | Physiological functions of lipids | 2 |
| | 21 | Fatty acids -Classification, saturated and unsaturated, essential and nonessential - structures | 2 |
| | 22 | Reactions of lipids - saponification and saponification number, rancidity, acid number and iodine number | 2 |
| **V** | **Practicals** | | **30 hrs** |
| | 1 | General reactions of carbohydrates (mono, di, and polysaccharides) Molisch test, anthrone reaction, phenol -sulphuric acid reaction | |
| | 2 | Specific reactions of reducing sugars. Benedict's test, Fehling's test, picric acid test, ferricyanide test. Seliwanoff's test and osazone reaction of sugars. | |
| | 3 | Schematic analysis of biochemical solution containing a single component; Carbohydrate (Glucose, Fructose, Lactose, Maltose, Sucrose, and Starch. | |
| | 4 | Protein estimation (Biuret test, Lowry's test, solubility pattern, xanthoproteic test, Millon's test, glyoxylic acid test, nitroprusside test, precipitation by heavy metal ions and alkaloidal reagents). | |
| | 5 | Colorimetric estimations of Biomolecules | |

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**Mapping of COs with PSOs and POs:**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| CO2 | - | 3 | - | - | - | - | - | 3 | - | - | - | - |
| CO3 | - | - | 3 | - | - | - | - | - | 3 | - | - | - |
| CO4 | - | - | - | 3 | - | - | - | - | - | 3 | - | - |
| CO5 | - | - | - | - | 3 | - | - | - | - | - | 3 | - |
| CO6 | - | - | - | - | - | 3 | - | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

| | | | | | |
|---|---|---|---|---|---|
| Programme | B. Sc. Biochemistry | | | | |
| Course Code | | | | | |
| Course Title | Enzymology and Metabolism | | | | |
| Type of Course | Minor | | | | |
| Semester | III | | | | |
| Academic Level | 200 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 45 T +30 P=75hrs |
| Pre-requisites | +2 level Science with Biology and chemistry background | | | | |
| Course Summary | This course covers the fundamental principles of enzyme action and metabolic pathways. The practical component allows students to gain hands-on experience in enzyme assays and metabolic experiments. | | | | |

**Course Outcomes (CO):**

After the successful completion of the course, a student will be able to:

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand enzymes and enzyme action in metabolic reaction | U | C | Instructor-created exams / Quiz |

| | | | | |
|---|---|---|---|---|
| CO2 | Analyse the factors affecting enzyme action | U | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Understand commercial applications of enzymes | U | C | Seminar Presentation / Group Tutorial Work |
| CO4 | Understand carbohydrate metabolism | U | C | Instructor-created exams / Home Assignments |
| CO5 | Understand lipid metabolism | U | C | One Minute Reflection Writing assignments |
| CO6 | Understand protein metabolism | U | C | Viva Voce |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Unit I** | | |
| | 1 | Introduction to Enzymology - apoenzyme, holoenzyme, prosthetic group; lock and key hypothesis and induced fit hypothesis. Classification of enzymes; Seven major classes of enzymes with one example each. | 3 |
| | 2 | Factors affecting velocity of enzyme-catalyzed reactions, Michaelis Menten equation, Km and its significance The Lineweaver- Burk plot. Enzyme specificity – group specificity, optical specificity, geometrical specificity and cofactor specificity | 3 |
| | 3 | Enzyme inhibition: Reversible and irreversible, determination of competitive inhibition using double reciprocal plot. | 2 |
| | 4 | Allosteric regulation of enzyme action with example. Activation of zymogen. | 3 |
| | 5 | Applications of enzymes - Industrial and medical (outline study only), | 1 |
| **II** | **Unit II** | | |
| | 6 | Introduction to metabolism, Anaerobic Metabolism of Carbohydrates. | 3 |
| | 7 | Reactions of glycolytic sequences with the names of enzymes and intermediates (without structures). | 3 |
| | 8 | Fate of pyruvate in alcoholic fermentation. Outline study of glycogenesis and glycogenolysis. | 3 |
| | 9 | Role of cyclic AMP and hormones in glycogen metabolism. Gluconeogenesis and pentose phosphate pathway (only outline without structures of intermediate | 3 |

| | | | |
|---|---|---|---|
| **III** | **Unit III** | | |
| | 10 | Aerobic Oxidation of Carbohydrates, Decarboxylation of pyruvate – reactions of citric acid cycle (without structures of intermediates). Only outline expected. | 2 |
| | 11 | Calculation of energy yield (as ATP) of aerobic and anaerobic oxidation of carbohydrates. Redox reactions and inhibitors of electron transport chain. | 2 |
| | 12 | The mitochondria – arrangement of electron carriers in the electron transport chain. | 1 |
| | 13 | Substrate level phosphorylation, Oxidative phosphorylation | 1 |
| | 14 | Site of ATP formation in the chain. Chemiosmotic mechanism | 1 |
| | 15 | Phosphate potential, principle of reversible reaction | 1 |
| | 16 | Uncouplers & Inhibitors | 1 |
| | 17 | Regulation of TCA cycle and Oxidative phosphorylation. | 2 |
| | 18 | High energy compounds with an example. | 1 |
| **IV** | **Unit IV** | | |
| | 19 | Metabolism of Lipids<br>Outline study of β-oxidation scheme. ATP yield in β- Oxidation | 2 |
| | 20 | Outline study of the cytoplasmic systems of fatty acid biosynthesis. | 2 |
| | 21 | Metabolism of Amino acids and Proteins, Ketogenic and glucogenic amino acids. Metabolism of ammonia; Decarboxylation, deamination and transamination of aminoacids (without molecular mechanisms). Urea cycle& Regulation | 3 |
| | 22 | Hormones: Classification of hormones based on chemical nature and mechanism of action; site of biosynthesis and important physiological functions of thyroxine, insulin, glucagon, epinephrine, glucocorticoids and growth hormones | 2 |
| **V** | **Practicals**<br>**Quantitative analysis** | | **30 hrs** |
| | 1 | Glucose estimation by Benedict's method, anthrone or arsenomolybdate methods | |
| | 2 | Amino acid estimation by Ninhydrin method | |
| | 3 | Protein estimation by Biuret method. | |
| | 4 | Protein estimation by Lowry et al. method. | |
| | 5 | Cholesterol estimation by Zak's method. | |
| | 6 | DNA estimation by diphenylamine method | |
| | 7 | RNA estimation by orcinol method | |

| | | | |
|---|---|---|---|
| | 8 | Assay of enzymes, ( Trypsin or Amylase) | |

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**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| CO2 | - | 3 | - | - | - | - | - | 3 | - | - | - | - |
| CO3 | - | - | 3 | - | - | - | - | - | 3 | - | - | - |
| CO4 | - | - | - | 3 | - | - | - | - | - | 3 | - | - |
| CO5 | - | - | - | - | 3 | - | - | - | - | - | 3 | - |
| CO6 | - | - | - | - | - | 3 | - | - | - | - | - | 3 |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |

| | |
|---|---|
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

B.Sc Biochemistry Honors

First semester exam 2024

Model question paper

| BCH1CJ101/BCH1MN100 |
| --- |
| INTRODUCTION TO BIOCHEMISTRY |

Hrs- 2 marks -70

Part A

Answer Any 8, each question carries 3 marks

1 What you mean by Hypothesis?

2 Differentiate science and Pseudoscience?

3 Importance of Repeatability in science?

4 What you mean by accuracy?

5 What are the contribution of Emil Fischer to Biochemistry?

6 Differentiate Prokaryotes and Eukaryotes?

7 Name few complex molecules of cell?

8 Major carbon functional groups in organic molecules.

9 What you mean by gram molecular weight?

10 Role of ATP in cell? 8X3= 24

Part B

Answer any six, each question carries 6 marks

11 Differentiate Theory and Law?

12 Explain deductive model in science with example?

13 What are the components of an Experiment and explain?

14 The history and principle of colorimeter.

16 Major subcellular organelles of animal cell

17 What are major biomolecules?

18 Explain steady state of chemical reaction? 6x6=36

Part C

Answer any one, carries 10 marks.

19 Write an essay of molecular organization of animal cell?

20 Essay on various chemical bonds. 1x10=10

B.Sc Biochemistry Honors

Second semester exam 2024

Model question paper

| |
|---|
| BCH2CJ101/BCH2MN100 |
| Cell Biology |

Hrs- 2 marks -70

Part A

Answer Any 8, each question carries 3 marks

1 Meaning of cell theory?

2 Differentiate animal cell and Bacterial cell?

3 Functions of endoplasmic reticulum?

4 Name the transport systems in cell?

5 Differentiate active and passive transport?

6 What are ion channels?

7 Functions of desmosomes?

8 Role of integrins in cell.

9 Meaning of apoptosis?

10 Features o cell necrosis? 8X3= 24

Part B

Answer any six, each question carries 6 marks

11 Write note marker enzymes of animal cell?

12 Note on facilitated transport?

13 Explain cell –matrix interactions?

14 Explain the ultra-stricture of mitochondria.

16 Note on ionophores

17 Explain cell cycle analysis?

18 Details of mitosis? 6x6=36

Part C

Answer any one, carries 10 marks.

19 Write an essay on active transport?

20 Essay on cell cycle.. 1x10=10

**I Semester B.Sc. (CUFYUGP) Degree Examinations October 2024**

**BIOCHEMISTRY**

**BCH1MN 101**

**Maximum Time: 2 hours** **Maximum Marks: 70**

**Section A**

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Write the role of ribosomes in protein synthesis.
2. What is the importance of carbohydrates in living organisms
3. Define dialysis process
4. How do the biochemical aspects of diet and nutrition relate to energy levels in the body?
5. Define pH and explain its importance
6. What is the ionic product of water? Why is it significant?
7. Define Brownian movement
8. Define trace elements and provide examples of their biological significance.
9. What is delta formation?
10. Define acids and bases. Explain their dissociation in aqueous solutions

**Section B**

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks )

11. Explain the role of trace elements in human health.
12. What is the Henderson-Hasselbalch equation and how is it used in biochemistry?
13. Explain Sodium Potassium ATPase
14. Differentiate between true solution, colloidal solution, and suspension
15. Explain differences between osmosis and diffusion.
16. Discuss the significance of proteins in biological systems
17. Discuss the significance of the golgi apparatus in the cell.
18. Explain the different types of chemical bonds and interactions in the body?

**Section C**

[Answer any one. Each question carries 10 marks] (1x10=10marks )

19. Explain the classification of colloids with examples
20. Describe the functions and sources of biomolecules of life.

**II Semester B.Sc. (CUFYUGP) Degree Examinations October 2024**

**BCH2MN101: Life molecules**

**Maximum Time: 2 hours** **Maximum Marks: 70**

**Section A**

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. How is ELISA used in the detection of antigens?
2. Define isoelectric point and write down its significance
3. Comment on sphingolipids
4. Differentiate the structures of ribose and deoxyribose
5. What is denaturation of protein with respect to its structure
6. What is molar extinction coefficient? Write its significance.
7. Define mutarotation
8. Explain the principle of high-performance liquid chromatography.
9. Define saponification number
10. Differentiate between saturated and unsaturated fatty acids with examples.

**Section B**

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks )

11. Discuss the structure, types, and functions of RNA.
12. Discuss sequencing of proteins.
13. Explain the structure and functions of two homopolysaccharides.
14. Describe the principle and working of ion-exchange chromatography
15. Explain the methods to check the purity of fats or oil
16. Illustrate phosphodiester linkage.
17. Discuss thin layer chromatography.
18. Explain the different types of isomerism of carbohydrates

**Section C**

[Answer any one. Each question carries 10 marks] (1x10=10 marks )

19. Describe the different levels of structural organization of proteins.
20. Discuss the principles and applications of SDS-PAGE and native PAGE in protein analysis

**I Semester B.Sc. (CUFYUGP) Degree Examinations October 2024**

**BCH1FM105: Food Biochemistry and Quality control**

**Maximum Time: 1.5 hours** **Maximum Marks: 50**

**Section A**

[Answer All. Each question carries 2 marks] (Ceiling 16 marks)

1. What is the significance of single cell proteins in the food industry?
2. What is meant by food spoilage?
3. Define resistant starches and dietary fiber.
4. What are the functions of antioxidants as food additives?
5. Identify two common food contaminants and their effects on food safety.
6. What is the principle of the plate count method?
7. Name two common bacteria cause food infection.
8. What are the symptoms of protein deficiency?
9. What is mean by antimicrobial resistance?
10. What are the basic principles for the preservation of food?

**Section B**

[Answer All. Each question carries 6 marks] (Ceiling 24 marks)

11. Discuss the role of carbohydrates in the food industry
12. Explain the Maillard reaction and its significance in food processing and storage?
13. Describe the microbiological testing methods used to ensure food safety.
14. Explain the principles of TQM and Six Sigma in the food industry.
15. Discuss the role of different microorganisms in food fermentation.

**Section C**

[Answer any one. Each question carries 10 marks] (1x10=10 marks)

16. Discuss the role of food additives and contaminants in the food industry
17. Discuss the roles of vitamins, minerals, and emulsions in the food industry.

**II Semester B.Sc. (CUFYUGP) Degree Examinations October 2024**

**BCH2FM206: Biochemistry of Lifestyle Disorders**

**Maximum Time: 1.5 hours** **Maximum Marks: 50**

**Section A**

[Answer All. Each question carries 2 marks] (Ceiling 16 marks)

1. Define lifestyle diseases.
2. What is the primary characteristic of atherosclerosis?
3. How is the inflammation linked to lifestyle disorders?
4. What is the primary function of leptin in the context of obesity?
5. What is apoptosis?
6. What is the primary cause of lifestyle disorders such as atherosclerosis and hypertension?.
7. Name one hormone involved in metabolic regulation and describe its role in maintaining blood glucose levels.
8. Define myocardial infarction?
9. Explain the significance of the enzyme lipoprotein lipase in lipid metabolism.
10. What is significance of cell cycle regulation in cancer development?

Section B

[Answer All. Each question carries 6 marks] (Ceiling 24 marks)

11. Discuss the biochemical mechanisms underlying the development of obesity and its association with lifestyle choices.
12. Explain the importance of diet and exercise in lifestyle disorders?
13. Discuss the inflammatory pathways involved in nephritis.
14. Discuss the relationship between dyslipidaemia and cardiovascular diseases.
15. Describe the role of oxidative stress in lifestyle disorders..

**Section C**

[Answer any one. Each question carries 10 marks] (1x10=10 marks)

16. Discuss the role of epigenetics and gene expression in the development and progression of lifestyle disorders.
17. Explain the concept of lifestyle medicine and its approach to preventing and treating chronic diseases..