# SRI SANKARA ARTS AND SCIENCE COLLEGE
# (AUTONOMOUS)
# ENATHUR, KANCHIPURAM – 631 561

## DEPARTMENT OF BIOCHEMISTRY

# M.Sc., BIOCHEMISTRY
# REGULATIONS AND SYLLABUS
## (Effective from the academic year 2023-2024)

## Choice Based Credit System

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**SRI SANKARA ARTS AND SCIENCE COLLEGE**

**(Autonomous)**

**DEPARTMENT OF BIOCHEMISTRY**

# MASTER DEGREE PROGRAMME IN BIOCHEMISTRY

## CHOICE BASED CREDIT SYSTEM (CBCS)

(With effect from the academic year 2023-2024)

## PREAMBLE

Biochemistry is the cross over scientific discipline that integrates the living world and chemistry. It involves the study of the structure of biomolecules and explores the biological processes at molecular level in the living organisms. It is the laboratory science that has several domains like cell biology, molecular biology, clinical biology, enzymology, immunology, physiology, pharmacology etc., It has enlightened many aspects of health and diseases and paved the way for many interdisciplinary technological innovations like metabolomics, genomics and proteomics. There is a continuous demand for biochemists in public and private health care sectors, agriculture, medical and forensic departments. Almost all food, pharmaceuticals, health and beauty care sectors etc required quality control and safety checks for which experts in the field of Biochemistry are always in need. The syllabi for the two years M.Sc., degree programme in Biochemistry was framed in such a way that at the end of the course they could apply the knowledge and expertise in industries, diagnostic laboratories and various research fields.

The programme endeavours to provide students a broad knowledge-based training in biochemistry with a solid background of basic concepts as well as exposing them to the exciting advancements in the field. In addition to theoretical knowledge, significant emphasis has been given to provide hands on experience to the students in the forefront areas of experimental biochemistry. A multidisciplinary approach has been employed to provide the best leverage to students to enable them to move into frontier areas of biological research in the future.

The course defines clearly the objectives and the learning outcomes, enabling students to choose the elective subjects for broadening their skills. The course also offers skills to pursue research in the field of Biological Chemistry and thus would produce best minds to meet the demands of society.

Biochemistry, today is considered as an application oriented integrated basic science. It's an interdisciplinary science that has emerged by the confluence of principles of Chemistry, Physics and Mathematics to Biology. Advances in Biochemistry have immense positive implications on the understanding of biochemical interactions, cellular communications, hormonal mechanisms and the cross talks between them. The research in Biochemistry has been translational and there is a shift from hypothesis driven research to data dependent research that promises translational, product-oriented research. Much of the advancement in Biochemistry is in the advancement of Biotechnology, as a basic science discipline Biochemistry lead to Biotechnological advancement.

## REGULATIONS

### 1. DURATION OF THE PROGRAME

1.1 Two years (four semesters)

1.2 Each academic year shall be divided into two semesters. The odd semesters shall consist of the period from June to November of each year and the even semesters from December to May of each year.

1.3 There shall be not less than 90 working days for each semester.

### 2. ELIGIBILITY FOR ADMISSION

2.1 **Pass in** B.Sc. degree program with Biochemistry/ Chemistry / Microbiology/ Life Science/ Nutrition and Dietetics as Main Subject.

### 3. CREDIT REQUIRMENTS AND ELIGIBILITY FOR AWARD OF DEGREE

3.1 A Candidate shall be eligible for the award of the Degree only if he/she has undergone the prescribed course of study in a College affiliated to the University for a period of not less than two academic years and passed the examinations of all the four Semesters prescribed earning a minimum of **91 credits as per the distribution given in Regulation** and also fulfilled such other conditions as have been prescribed thereof.

## *4. COURSE OF STUDY, CREDITS AND SCHEME OF EXAMINATION*

### 4.1 SCHEME OF EXAMINATIONS

**SEMESTER I**

| **Title of the Course** | **Credits** | **MARKS** | | |
|---|---|---|---|---|
| | | **CIA** | **EXT** | **TOTAL** |
| Basics of Biochemistry | 5 | 25 | 75 | 100 |
| Biochemical and Molecular Biology Techniques | 5 | 25 | 75 | 100 |
| Lab Course on Biomolecules and Biochemical Techniques-**Practical I** | 4 | 40 | 60 | 100 |
| Physiology and Cell Biology | 3 | 25 | 75 | 100 |
| Microbiology and Immunology | 3 | 25 | 75 | 100 |
| Biomedical Technology (SEC-I) | 2 | 25 | 75 | 100 |
| | **22** | | | |

**SEMESTER II**

| **Title of the Course** | **Credits** | **MARKS** | | |
|---|---|---|---|---|
| | | **CIA** | **EXT** | **TOTAL** |
| Enzymology | 5 | 25 | 75 | 100 |
| Cellular Metabolism | 5 | 25 | 75 | 100 |
| Lab Course on Enzymology, Microbiology and Cell Biology-**Practical II** | 4 | 40 | 60 | 100 |
| Energy and drug metabolism | 3 | 25 | 75 | 100 |
| Nutritional Biochemistry | 3 | 25 | 75 | 100 |
| Research Tools – (SEC-II) | 2 | 25 | 75 | 100 |
| | **22** | | | |

## SEMESTER III

| Title of the Course | Credits | MARKS | | |
|---|---|---|---|---|
| | | CIA | EXT | TOTAL |
| Gene Editing, Cell and Gene therapy | 5 | 25 | 75 | 100 |
| Biostatistics and Data Science | 5 | 25 | 75 | 100 |
| Laboratory Course on Clinical Biochemistry- **Practical III** | 4 | 40 | 60 | 100 |
| Pharmaceutical Biochemistry | 3 | 25 | 75 | 100 |
| Molecular basis of disease and therapeutic strategies | 3 | 25 | 75 | 100 |
| Term Paper and Seminar Presentation (SEC-III) | 2 | 25 | 75 | 100 |
| *Internship (Clinical Laboratory)/ Industrial Activity. | 2 | 20 | 80 | 100 |
| | **24** | | | |

***** Internship will be carried out during the summer vacation of the first year and marks will be included in the Third Semester Marks Statement.

## SEMESTER IV

| Title of the Course | Credits | MARKS | | |
|---|---|---|---|---|
| | | CIA | EXT | TOTAL |
| Clinical Biochemistry | 5 | 25 | 75 | 100 |
| Molecular Biology | 5 | 25 | 75 | 100 |
| Hormones | 4 | 25 | 75 | 100 |
| Core Project and viva voce | 3 | 20 | 80 | 100 |
| Bio-safety, Lab Safety and IPR | 3 | 25 | 75 | 100 |
| Professional Competency Skill (SEC – IV) | 2 | 25 | 75 | 100 |
| Extension Activity- Industrial Visit | 1 | | | |
| | **23** | | | |

**4.2 Inclusion of the Massive Open Online Courses (MOOCs) available on SWAYAM and NPTEL**

4.3.1 Students can choose the MOOC course available on SWAYAM and NPTEL under Core, Elective or Soft Skill category. He/she will be awarded degree only after producing valid certificate of the MOOC course for credit mobility.

## 5. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTER

**5.1 Eligibility:** Students shall be eligible to go to subsequent semester only if they earn sufficient attendance as prescribed by the academic council from time to time.

**5.2 Attendance:** All Students must earn 75% and above of attendance for appearing for the End Semester Examination. (Theory/Practical)

**5.3 Condonation of shortage of attendance**: If a Student fails to earn the minimum attendance (Percentage stipulated), the Principal shall condone the shortage of attendance up to a maximum limit of 10% (i.e. between 65% and above and less than 75%) after collecting the prescribed fee of Rs.250/-each for Theory/Practical examination separately, (Theory Rs.250/- per semester per Student: Practical Rs.250/- per semester per Student) towards the Condonation of shortage of attendance. Such fees collected and should be remitted to the college.

**5.4 Non-eligibility for Condonation of shortage of attendance:** Students who have secured less than 65% but more than 50% of attendance are NOT ELIGIBLE for Condonation of shortage of attendance and such Students will not be permitted to appear for the regular examination, but will be allowed to proceed to the next year/next semester of the program and they may be permitted to take next End Semester examination by paying the prescribed Condonation fee of Rs.250/- each for Theory/Practical separately. Such fees shall be remitted to the College. Name of such Students should be forwarded to the Principal along with their attendance details in the prescribed format mentioning the category (3 copies) Year wise/Branch wise/Semester wise together with the fees collected from them, so as to enable them to get permission from the College and to attend the Theory/Practical examination subsequently without any difficulty.

**5.5 Detained students for want of attendance:** Students who have earned less than 50% of attendance shall be permitted to proceed to the next semester and to complete the Program of study. Such Students shall have to repeat the semester, which they have missed by rejoining after completion of final semester of the course, by paying the fee for the break of study as prescribed by the College from time to time.

**5.6 Condonation of shortage of attendance for married women students**: In respect of married women students undergoing PG programs, the minimum attendance for Condonation (Theory/Practical) shall be relaxed and prescribed as 55% instead of 65% if they conceive during their academic career**.** Medical certificate from the Doctor (D.G.O) attached to the Government Hospital and the prescribed fee of Rs.250/- together with the attendance details shall be forwarded to the Principal to consider the Condonation of attendance mentioning the category.

**5.7 Zero Percent (0%) Attendance:** The Students, who have earned 0% of attendance, have to repeat the program (by rejoining) without proceeding to succeeding semester and they have to obtain prior permission from the College immediately to rejoin the program.

**5.8 Transfer of Students and Credits**: The strength of the credits system is that it permits inter Institutional transfer of students. By providing mobility, it enables individual students to develop their capabilities fully by permitting them to move from one Institution to another in accordance with their aptitude and abilities.

5.8.1 Transfer of Students is permitted from one Institution to another Institution for the same program with same nomenclature.

Provided, there is a vacancy in the respective program of Study in the Institution where the transfer is requested.

Provided the Student should have passed all the courses in the Institution from where the transfer is requested.

5.8.2 The marks obtained in the courses will be converted and grades will be assigned as per the College norms.

5.8.3 The transfer students are eligible for classification.

5.8.4 The transfer students are not eligible for Ranking, Prizes and Medals.

5.8.5 Students who want to go to foreign Universities upto two semesters or Project Work with the prior approval of the Departmental/College Committee are allowed to get transfer of credits and marks which will be converted into Grades as per the College norms and are eligible to get CGPA and Classification; they are not eligible for Ranking, Prizes and Medals.

5.9 Students are exempted from attendance requirements for online courses of the College and MOOCs.

## 6. EXAMINATION AND EVALUATION

**6.1** Students shall register their names for the First End Semester Examination after the admission in PG programs.

**6.2** Students shall be permitted to proceed from the First Semester up to Final Semester irrespective of their failure in any of the Semester Examination and they should **register for all the arrear courses of earlier semesters along with the current (subsequent) Semester courses.**

### 6. 3 Marks for Internal and End Semester Examinations

| Category | Theory | Practical |
|---|---|---|
| Internal Assessment | 25 | 40 |
| End semester (University) Examination | 75 | 60 |

### 6.4 Procedure for Awarding Internal Marks

| Course | Particulars | Marks |
|---|---|---|
| **Theory Papers** | Tests (2 out of 3) | 10 |
| | Attendance | 05 |
| | Seminars | 05 |
| | Assignments | 05 |
| | **Total** | **25** |

| | | |
|---|---|---|
| **Practical Papers** | Attendance | 05 |
| | Test (best 2 out of 3) | 30 |
| | Record | 05 |
| | **Total** | **40** |
| **Project** | Internal Marks<br>(Best 2 out of 3 presentations) | 20 |
| | Viva-Voce | 20 |
| | Project Report | 60 |
| | **Total** | 100 |

**6.5 (i) Awarding Marks for Attendance (out of 5**)

Below 60% = 0 marks,

60 % to 75% = 3 marks,

75 % to 90% = 4 marks

Above 90%= 5 marks

**(ii) Conducting Practical and Project Viva-voce Examination:**

By Internal and External Examiners

**6.5.1 Improvement of Internal Assessment Marks.**

(a) Should have cleared end-semester University examination with more than 50% Marks in PG.

(b) Should have obtained less than 30% marks in the Internal Assessment

(c) Should be permitted to improve internal assessment within N+2 years where N is denoted for number of years of the programme.

(d) Chances for reassessment will be open only for 25% of all core courses in Colleges and only one chance per course will be given.

(e) The reassessment may be based on a written test / assignment or any other for the entire internal assessment marks.

### 6.6 Question Paper Pattern for End Semester (University) Examination

**PART A**

(50 words): Answer 10 questions out of 12 Questions:

10 x 1 Marks = 10 marks

**PART B**

(200 words): Answer 5 questions out of 7 Questions:

5 x 5 Marks = 25 marks

**PART C**

(500 words): Answer 4 questions out of 6 Questions:

4 x 10 Marks = 40 marks

***Total =75 Marks***

### 6.7 PASSING MINIMUM

**6.7.1** There shall be no Passing Minimum for Internal.

**6.7.2** A Student who secures not less than 50 percent marks in the External Written Examination and the aggregate (i.e. Written Examination Marks and the Internal Assessment Marks put together) respectively of each paper shall be declared to have passed the examination in that subject.

**6.7.3** A Student shall be declared to have passed Project Work and Viva-Voce respectively, if he/she secures a minimum 50 percent marks in the Project Work Evaluation and the Viva Voce each.

**6.7.4** A Student failing in any subject will be permitted to appear for the examinations again on a subsequent occasion without putting in any additional attendance.

**6.7.5** A Student who fails in either Project Work or Viva-Voce shall be permitted to redo the Project Work for evaluation and reappear for the Viva-Voce on a subsequent occasion, if so recommended by the Examiners.

**6.7.6** A Student who successfully completes the Programme and passes the examinations of all the FOUR Semesters prescribed as per Scheme of Examinations earning **91 CREDITS** shall be declared to have qualified for the Degree.

**6.8 Instant Examination:** Instant Examinations is conducted for the students who appeared in the final semester examinations of the PG. Eligible criteria for appearing in the Instant Examinations are as follows:

**6.8.1. Eligibility**: A Student who is having arrear only in one theory paper in the final semester examination of the PG Degree program is eligible to appear for the Instant Examinations.

**6.8.2. Non eligibility for more than one Arrear Paper**: A Student who is having more than one arrear paper in the current appearance of Fourth Semester for PG Examinations is not eligible for appearing for the Instant Examinations.

**6.8.3. Non eligibility for Arrear in other semester:** Student having arrear in any other semester is not eligible and a candidate who is absent in the current appearance is also not eligible for appearing in the Instant Examinations and those Students who have arrear in Practical/Project are not eligible for the Instant Examinations.

**6.8.4. Non eligibility for those completed the programe:** Students who have completed their Program duration but having arrears are not eligible to appear for Instant Examinations.

**6.9 RETOTALLING, REVALUATION AND PHOTOCOPY OF THE ANSWER SCRIPTS:**

**6.9.1 Re-totaling:** PG Students not eligible for applying retotalling of their answer script.

**6.9.2 Revaluation**: All current batch Students who have appeared for their Semester Examinations are eligible for Revaluation of their answer scripts. Passed out candidates are not eligible for Revaluation.

**6.9.3 Photocopy of the answer scripts**: Students who have applied for revaluation can download their answer scripts from the College Website after fifteen days from the date of publication of the results.

**6.10 Evaluation of MOOC courses**: The examination and evaluation for MOOCs will be as per the requirements of the Courses and will be specified at the beginning of the Semester in which such courses are offered and will be notified by the College

## 7. CLASSIFICATION OF SUCCESSFUL STUDENTS

**7.1** Students who secured not less than 60% of aggregate marks (Internal + External) in the whole examination shall be declared to have passed the examination in the **First Class.** All other successful Students shall be declared to have passed in **Second Class**. Candidates who obtain ≥75% of the marks in the aggregate (Internal + External) shall be deemed to have passed the examination in **First Class with Distinction**, obtain ≥90% of the marks in the aggregate (Internal + External) shall be deemed to have passed the examination in **First Class with Exemplary** provided they pass all the examinations (theory papers, practical, project and viva-voce) prescribed for the course in the First appearance.

## 8. GRADING SYSTEM

**8.1 Minimum Credits to be earned**: For TWO-year Program: **91 Credits**: 72 Credits (Core and Elective) and 19 Credits (Soft skills, Skill Enhancement Course, Internship, and Extension activities).

### 8.2 MARKS AND GRADES:

**8.2.1** The following table shows the marks, grade points, letter grades and classification to indicate the performance of the Student:

| RANGE OF MARKS | GRADE POINTS | LETTER GRADE | DESCRIPTION |
|---|---|---|---|
| 90-100 | 9.0-10.0 | O | Outstanding |
| 80-89 | 8.0-8.9 | D+ | Excellent |
| 75-79 | 7.5-7.9 | D | Distinction |
| 70-74 | 7.0-7.4 | A+ | Very Good |
| 60-69 | 6.0-6.9 | A | Good |
| 50-59 | 5.0-5.9 | B | Average |
| 00-49 | 4.0-4.9 | U | Re-appear |
| ABSENT | 0.0 | AAA | ABSENT |

**8.2.2 Computation of Grade Point Average (GPA) in a Semester, Cumulative Grade Point Average (CGPA) and Classification**

**GPA for a Semester:** = ∑iCiGi ÷ ∑iCi

That is, GPA is the sum of the multiplication of grade points by the credits of the courses divided by the **s**um of the credits of the courses in a semester.

**8.2.3 CGPA for the entire programme:** = ∑n∑iCniGni ÷∑n∑iCni That is, CGPA is the sum of the multiplication of grade points by the credits of the entire programme divided by the sum of the credits of the courses of the entire programme

Where,

Ci= Credits earned for course i in any semester,

Gi = Grade Points obtained for course i in any semester, n = Semester in which such courses were credited.

**8.3 Letter Grade and Class**

| CGPA | GRADE | CLASSIFICATION OF FINAL RESULT |
|---|---|---|
| 9.5-10.0 | O + | First Class with Exemplary * |
| 9.0 and above but below 9.5 | O | |
| 8.5 and above but below 9.0 | D + + | First Class with Distinction * |
| 8.0 and above but below 8.5 | D + | |
| 7.5 and above but below 8.0 | D | |
| 7.0 and above but below 7.5 | A + + | First Class |
| 6.5 and above but below 7.0 | A + | |
| 6.0 and above but below 6.5 | A | |
| 5.5 and above but below 6.0 | B + | Second Class |
| 5.0 and above but below 5.5 | B | |
| 0.0 and above but below 5.0 | C + | Re-appear |

*** The candidates who have passed in the first appearance and within the prescribed semester of the PG Programme (Major, Allied and Elective courses alone) are eligible.**

**9. RANKING**

Students who pass all the examinations prescribed for the Program in the **FIRST APPEARANCE ITSELF ALONE** are eligible for Ranking / Distinction, provided in the case of Students who pass all the examinations prescribed for the Program with a break in the First Appearance due to the reasons as furnished in the Regulations 5 are only eligible for Classification.

## 10. CONCESSIONS FOR DIFFERENTLY-ABLED STUDENTS

**10.1Dyslexia students:** For students who are mentally disabled, having disability and mental retardation, who are slow learners, who are mentally impaired having learning disorder and seizure disorder and students who are spastic and cerebral Palsy, the following concessions shall be granted, Provided the request is duly certified by the Medical Board of the Government Hospital/ General Hospital/ District headquarters Hospitals.:

a. One-third of the time of paper as extra time in the examination

b. Leniency in overlooking spelling

c. Amanuensis for all PG programme provided the request is duly certified by the Medical Board of the Government Hospital/ General Hospital/ District headquarters Hospitals and they shall be declared qualified for the degree if they pass the other examinations prescribed for the degree.

**10.2 Visually Challenged Students**

a. A scribe shall be arranged by the college and the scribe be paid as per the college decision.

## 11. MAXIMUM PERIOD FOR COMPLETION OF THE PROGRAMS TO QUALIFY FOR A DEGREE

11.1 A Student who for whatever reasons is not able to complete the program within the normal period (N) or the Minimum duration prescribed for the programme, may be allowed two years period beyond the normal period to clear the backlog to be qualified for the degree. (Time Span = N + 2 years for the completion of programme.)

11.2 In exceptional cases like major accidents and child birth an extension of one year be considered beyond maximum span of time (Time Span = N + 2 +1 years for the completion of programme).

11.3 Students qualifying during the extended period shall not be eligible for ranking**.**

**********

**Learning Outcomes-based Approach to Curricular Planning**

**Aims of M.Sc degree programme in Biochemistry:**

The overall aims of M.Sc degree programme in Biochemistry are to:

- Develop broad and balanced knowledge and understanding of biomolecules, key biochemical concepts, principles and theories related to Biochemistry

- Provide students with some work experience, for example a summer internship or a research project in a research laboratory to further boost the career prospects.

- Develop the ability of the students to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in Biochemistry.

- Expose the students to a wide range of careers that combine molecular biology, plants and medicine.

- Provide students with the knowledge and skill base that would enable them to undertake further studies in Biochemistry and related areas.

- Equip students with appropriate tools of analysis and with theoretical, technical and analytical skills to tackle issues and problems in the field of Biochemistry.

**Graduate attributes**

A Postgraduate student shall be able to develop skill and acquire knowledge in disciplinary theory and practical knowledge in the diversified areas of Biochemistry. The students are given fundamentals and advancements in each course and they are motivated to become unique by allowing them to perform experiments in the areas of their interest. This will enable the students to equip themselves with the basic practical training in different areas of Biochemistry ranging from Metabolism, Plant Biochemistry, Enzymology, Clinical Biochemistry, Molecular Biology, Biotechnology, Proteomics and Genomics etc. to pursue research or to undertake suitable assignments/jobs in Biochemical industries. The students shall enjoy the academic freedom which will bring to light the talent from each student. These attributes are elaborated as under:

**Disciplinary Knowledge**:

a) Ability to understand advancements of biochemistry.

b) Ability to apply basic principles of chemistry to biological systems and molecular biology.

c) Ability to relate various interrelated physiological and metabolic events.

d) A general awareness of current developments at the leading edge in biochemistry to apply for competitive examinations.

e) Ability to critically evaluate a problem and resolve to challenge indiscriminate concepts.

f) Acquire ability to work safely and effectively in a laboratory.

g) Obtain experimental and quantitative skills in preparation of laboratory reagents, conducting experiments, satisfactory analyses of data and interpretation of results.

h) Ability to think wisely in an integrating manner and develop interdisciplinary approach.

j) Overall knowledge in research field and higher academic achievements through competing examinations in the field of biochemistry and allied subjects.

**Communication Skills:**

a) Ability to communicate well in English

b) Ability to listen to and follow scientific aspects and engage with them.

C) Ability to present complex information in a clear and concise manner to different groups

**Critical Thinking**:

a) Ability to observe critical readings of scientific texts.

b) Ability to place scientific statements and themes in contexts and also evaluate them in terms of common conventions.

c) Capability to critically evaluate practices, policies and theories by following scientific approach to knowledge development.

**Problem Solving:**

a) Ability to analyse the situation and apply wise thinking and analytical skills.

b) Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge.

**Analytical Reasoning**:

a) Ability to assess the strengths and weaknesses in scholarly texts identifying blemishes in their arguments.

b) Ability to use critics and theorists to create a framework and to corroborate one's argument in one's reading of scientific texts.

c) Capability to analyse and synthesise data from a variety of sources and draw valid conclusions and support them with evidence and examples.

**Research-Related Skills**:

a) Ability to develop hypothesis and research questions and to identify and consult appropriate sources to find answers.

b) Capability to analyse, interpret and draw conclusions from data

c) Ability to plan, execute and report the results of an experiment or investigation.

**Teamwork and Time Management:**

a) Ability to participate effectively in class room discussions.

b) Ability to contribute to group work and to complete the work within stipulated time.

c) Capability to work effectively and respectfully with diverse teams.

**Scientific Reasoning:**

a) Capability to analyze texts, evaluating ideas and scientific strategies.

b) Ability to formulate logical and convincing arguments.

c) Ability to analyze, interpret and draw conclusions from quantitative/qualitative data

**Reflective Thinking**:

Ability to locate and observe the influence of location, regional and national, global on critical thinking.

**Self-Directed Learning**:

a) Ability to work independently in terms of organizing laboratory and analyzing research literature.

b) Ability to postulate hypothesis, questions and search for answers.

c) Capability to manage a project effectively through to completion.

**Digital Literacy**:

Ability to handle digital sources and execute various platforms to convey and explain concepts of biochemistry.

**Moral and Ethical Values**:

a) Ability to interrogate one's own ethical values and to be aware of ethical and environmental issues and to avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights.

b) Ability to read values inherited in society and treats the environment, religion and spirituality as also structures of power.

**Leadership Readiness**:

a) Ability to conduct group discussions, to formulate questions related to scientific and social issues.

b) Setting direction, formulating an inspiring vision, building a team to achieve the vision, motivating and inspiring the team members to engage with that vision.

**Life-long Learning**:

a) Ability to retain and build clear thinking skills and execute them to update scientific knowledge

b) Ability to apply skills in day-to-day life.

c) Ability to acquire knowledge and skills that are necessary for participating in learning activities throughout life.

**Qualification descriptors for M.Sc degree programme in Biochemistry**

Each Postgraduate student in Biochemistry should be able to

- Demonstrate a coherent and systematic approach to the experimental and theoretical aspects of biochemistry. This would also include the student's ability to understand and engage with critical concepts, theories and dogmas.

- Demonstrate the ability to understand the role of scientific developments, particularly, biological sciences in a changing world from the disciplinary perspective as well as in relation to its professional and everyday use.

- Communicate ideas, opinions and values of both scientific themes and values of life in all shades and shapes in order to expand the knowledge of the subject as it moves from the classroom/laboratory to industry and society.

- Demonstrate the ability to share the results of academic and disciplinary learning through different forms of communication such as dissertations, reports, findings, notes, seminars etc, on different platforms of communication such as the classroom, the media and the internet.

- Recognize the scope of biochemistry in terms of career opportunities, employment and lifelong engagement in teaching, publishing, communication, media, soft skills and other allied fields.

- The programme will strengthen the student's competence, help to identify, analyze and evaluate keys issues of current science around in the world and think of ways to find logical and viable solutions.
- Students will have the ability to understand and articulate with clarity and critical thinking one's position in the world as a biochemistry graduate and as an Indian citizen of the world.
- Acquiring practical training as well as critical knowledge of the Biochemistry subject

## Programme Outcomes and Programme Specific Outcomes

| | |
|---|---|
| **Programme** | **M.Sc BIOCHEMISTRY** |
| **Programme Code** | **PBY** |
| **Duration** | **2 years** |
| **Programme Outcomes** | **PO1.** To make students understand the importance of biochemistry as a subject that deals with life processes, as well as the concepts, theories and experimental approaches followed in biochemistry, in order to pursue a research career, either in an industry or academic setting.<br>**PO2.** To develop analytical and problem-solving skills<br>**PO3**. To create an awareness among the students on the interconnection between the interdisciplinary areas of biochemistry.<br>**PO4**. To give the necessary practical skills required for biochemical techniques and analysis.<br>**PO5**. To develop ~~a~~ communication and writing skills in students.<br>**PO6**. To develop leadership and teamwork skills<br>**PO7**. To emphasiz**e** the importance of good academic and work ethics and their social implications.<br>**PO8**. To emphasize the importance of continuous learning and to promote lifelong learning and career development.<br>**PO9**. To teach students how to retrieve information from a variety of sources, including libraries, databases and the internet.<br>**PO10.** To teach students to identify, design and execute a research problem, analyze and interpret data and learn time and resource management. |

| | |
|---|---|
| **Programme Specific Outcomes** | **On successful completion of this course, students should be able to**:<br>**PSO-1:** Acquire detailed knowledge and understanding the principles and theories of Biochemistry.<br>**PSO-2**: Apply knowledge and understanding of Biochemistry to the solution of problems in life sciences and practical areas of the subject.<br>**PSO-3**: Induce research enthusiasm among student community and encouraging them to pursue higher studies in Biochemistry.<br>**PSO-4**: Compare and contrast the breadth and depth of scientific knowledge in the broad range of fields to enhance the ability of students to achieve clearance in competitive exams.<br>**PSO-5**: Develop the professional skills based on current trends in versatile fields through Job oriented certificate courses and Value-added courses. |

## Overall Template for P.G., Programme

| Semester–I | Credit | Hours | Semester-II | Credit | Hours | Semester-III | Credit | Hours | Semester–IV | Credit | Hours |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.1 Core-I | 5 | 6 | 2.1 Core-IV | 5 | 6 | 3.1 Core-VII | 5 | 6 | 4.1 Core-X | 5 | 6 |
| 1.2 Core-II | 5 | 6 | 2.2 Core-V | 5 | 6 | 3.2 Core-VIII | 5 | 6 | 4.2 Core-XI | 5 | 6 |
| 1.3 Core – III (Practical-I) | 4 | 6 | 2.3 Core – VI (Practical-II) | 4 | 6 | 3.3 Core – IX (Practical-III) | 4 | 6 | 4.3 Core-XII | 4 | 5 |
| 1.4 Discipline Centric Elective -I | 3 | 5 | 2.4 Discipline Centric Elective – III | 3 | 5 | 3.4 Core Industry Module | 3 | 5 | 4.4 Core Project with viva voce | 3 | 6 |
| 1.5 Generic Elective-II: | 3 | 5 | 2.5 Generic Elective -IV: | 3 | 5 | 3.5 Discipline Centric Elective - V | 3 | 5 | 4.5 Generic Elective - VI | 3 | 5 |
| 1.6 Skill Enhancement-I | 2 | 2 | 2.6 Skill Enhancement-II | 2 | 2 | 3.6 Skill Enhancement-III | 2 | 2 | 4.6 Skill Enhancement course -IV/ Professional Competency Skill | 2 | 2 |
| | | | | | | 3.7 Internship (Clinical Laboratory)/ Industrial Activity | 2 | - | 4.7 Extension Activity (Industrial Visit) | 1 | - |
| | | | | | | | | | | | |
| | **22** | **30** | | **22** | **30** | | **24** | **30** | | **23** | **30** |
| **Total Credit Points -91** | | | | | | | | | | | |

## Learning Outcomes Based Curriculum Framework (LOCF) Based Guidelines for Credits and Hours Distribution System

### First Year – Semester – I

| Part | List of Courses | Credits | No. of Hours |
|---|---|---|---|
| | Core Paper - I | 5 | 6 |
| | Core Paper - II | 5 | 6 |
| | Core - III **(Core Practical-I)** | 4 | 6 |
| | Core Elective Paper - I | 3 | 5 |
| | Core Elective Paper - II | 3 | 5 |
| | Skill Enhancement Course (SEC) - I | 2 | 2 |
| | | **22** | **30** |

### Semester-II

| Part | List of Courses | Credits | No. of Hours |
|---|---|---|---|
| | Core Paper - IV | 5 | 6 |
| | Core Paper - V | 5 | 6 |
| | Core Paper - VI **(Core Practical-II)** | 4 | 6 |
| | Core Elective Paper - III | 3 | 5 |
| | Core Elective Paper - IV | 3 | 5 |
| | Skill Enhancement Course (SEC) - II | 2 | 2 |
| | | **22** | **30** |

### Second Year – Semester – III

| Part | List of Courses | Credits | No. of Hours |
|---|---|---|---|
| | Core Paper - VII | 5 | 6 |
| | Core Paper - VIII | 5 | 6 |
| | Core Paper - IX **(Core Practical-III)** | 4 | 6 |
| | Core Industry Module | 3 | 5 |
| | Core Elective Paper - V | 3 | 5 |
| | Skill Enhancement Course (SEC) - III | 2 | 2 |
| | Internship / Industrial Activity [Credits] | 2 | - |
| | | **24** | **30** |

## Semester-IV

| Part | List of Courses | Credits | No. of Hours |
|---|---|---|---|
| | Core Paper - X | 5 | 6 |
| | Core Paper - XI | 5 | 6 |
| | Core Paper - XII | 4 | 5 |
| | Core Project with Viva Voce | 3 | 6 |
| | Core Elective Paper - VI (Industry Entrepreneurship) | 3 | 5 |
| | Skill Enhancement Course (SEC) - IV / Professional Competency Skill | 2 | 2 |
| | Extension Activity | 1 | - |
| | | **23** | **30** |

**Total 91 Credits for PG Courses**

**List of Courses:**

| Semester | Title of the Course | Core/Elective/ AECC | Credits | Tutorial Hours |
|---|---|---|---|---|
| I | Basics of Biochemistry | Core-I | 5 | 6 |
| | Biochemical and Molecular Biology Techniques | Core-II | 5 | 6 |
| | Laboratory Course on Biomolecules and Biochemical Techniques | Core-III (Practical-I) | 4 | 6 |
| | Physiology and Cell Biology | Discipline Centric Elective – I | 3 | 5 |
| | Microbiology and Immunology | Generic Elective – II | 3 | 5 |
| | Biomedical Technology | SEC-I | 2 | 2 |
| | | | **22** | **30** |

| Semester | Title of the Course | Core/Elective/ AECC | Credits | Tutorial Hours |
|---|---|---|---|---|
| II | Enzymology | Core-IV | 5 | 6 |
| | Cellular Metabolism | Core-V | 5 | 6 |
| | Lab Course on Enzymology, Microbiology and Cell Biology | Core-VI (Practical-II) | 4 | 6 |
| | Energy and drug metabolism | Discipline Centric Elective – III | 3 | 5 |
| | Nutritional Biochemistry | Generic Elective -IV | 3 | 5 |
| | Research Tools | SEC-II | 2 | 2 |
| | | | **22** | **30** |

| Semester | Title of the Course | Core/Elective/ AECC | Credits | Tutorial Hours |
|---|---|---|---|---|
| III | Gene Editing, Cell and Gene therapy | Core-VII | 5 | 6 |
| | Biostatistics and Data Science | Core – VIII | 5 | 6 |
| | Laboratory Course on Clinical Biochemistry | Core – IX (Practical-III) | 4 | 6 |
| | Pharmaceutical Biochemistry | Core Industry Module | 3 | 5 |
| | Molecular basis of disease and therapeutic strategies | Discipline Centric Elective - V | 3 | 5 |
| | Term Paper and Seminar Presentation | SEC-III | 2 | 2 |
| | *Internship [Clinical Laboratory]/Industrial Activity | Internship/ Industrial Activity | 2 | -- |
| | | | **24** | **30** |

***** Internship will be carried out during the summer vacation of the first year and marks will be included in the Third Semester Marks Statement.

| Semester | Title of the Course | Core/Elective/ AECC | Credits | Tutorial Hours |
|---|---|---|---|---|
| IV | Clinical Biochemistry | Core-X | 5 | 6 |
| | Molecular Biology | Core – XI | 5 | 6 |
| | Hormones | Core-XII | 4 | 5 |
| | Project and viva Voce | Core Project | 3 | 6 |
| | Bio-safety, Lab Safety and IPR | Generic Elective - VI | 3 | 5 |
| | Professional Competency Skill | SEC–IV | 2 | 2 |
| | Industrial Visit | Extension Activity | 1 | - |
| | | | **23** | **30** |

## SUGGESTIVE TOPICS IN CORE COMPONENT

1. Basics of Biochemistry
2. Biochemical and Molecular Biology Techniques
3. Laboratory Course on Biomolecules and Biochemical Techniques
4. Enzymology
5. Cellular Metabolism
6. Lab Course on Enzymology, Microbiology and Cell Biology
7. Gene Editing, Cell and Gene therapy
8. Biostatistics and Data Science
9. Laboratory Course on Clinical Biochemistry
10. Pharmaceutical Biochemistry
11. Clinical Biochemistry
12. Molecular Biology
13. Hormones
14. Industrial Microbiology
15. Biochemical toxicology

## SUGGESTIVE TOPICS IN ELECTIVE COURSES

1. Physiology and Cell Biology
2. Microbiology and Immunology
3. Energy and drug metabolism
4. Nutritional Biochemistry
5. Molecular basis of disease and therapeutic strategies
6. Bio-safety, Lab Safety and IPR
7. Developmental Biology

## SUGGESTIVE TOPICS IN ABILITY ENHANCEMENT COMPULSORY COURSES

1. Language and Communication
2. Spoken and Presentation Skill
3. Life and Managerial Skills
4. Computing Skill

## SUGGESTIVE TOPICS IN SKILL ENHANCEMENT COURSES

1. Biomedical Technology
2. Research Tools

## SUGGESTIVE TOPICS IN SKILL ENHANCEMENT COURSE – III

1. Structural characterisation of proteins by X-ray diffraction spectroscopy.
2. Nuclear Magnetic Resonance spectroscopy as an imaging tool of cancer.
3. Recent advances in technology for the production of Biopharmaceutical products from mammalian cells.
4. mRNA as a transformative technology for vaccine development.
5. Clinical applications of chemiluminescence assay.
6. Superparamagnetic nanoparticles for biomedical applications.
7. Gene expression profiling by DNA microarrays.
8. Computer Aided Drug Designing – Step wise listing of online tools with details.
9. Antibiotics and its resistance development.
10. Basic Techniques in Molecular Biology.
11. Nanotechnology and Biodiagnostics.
12. Wildlife DNA Forensics.
13. Organic Farming for Sustainable Agricultural Production
14. Role of stem cells in treatment of neurodegenerative diseases
15. Applications of 2-Dimensional electrophoresis in proteomic analysis
16. Applications of Flow cytometry in hematology
17. Metabolic profile of various organs and their interrelationship
18. Role of β-amyloid protein in Alzheimer's disease
19. Anti-diabetic phytochemicals from medicinal plants
20. Food adulteration: Sources, health risks, and detection methods
21. Automation in clinical biochemistry with special reference to the AutoAnalyzer
22. Benefits and risks of Human Genome Project
23. Clinical neurology of neurodegenerative disorders.
24. Membrane protein identification by shotgun proteomics
25. Genetic toxicology an Integration of in vivo Testing
26. Phytonanotechnology: Challenges and future perspectives.
27. Formulation and characterisation of silver nanoparticles and their biological adeptness.
28. Software tools for plagiarism, bibliography and reference.
29. Properties, Processing and Applications of biopolymers.
30. C - reactive protein (CRP) as a biomarker for assessing inflammation and heart failure risk in cardio vascular disease.
31. Applications of nanotechnology in medicinal diagnosis.
32. Hybrid intervention approach to coronary heart disease.

**SYLLABUS**

**SEMESTER I**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Basics of Biochemistry** | Core | 5 | 1 | 0 | 0 | 5 | 6 | 25 | 75 | 100 |

| | |
|---|---|
| **Course** | **CORE PAPER I** |
| **Title of the Course** | **BASICS OF BIOCHEMISTRY** |
| **Credits** | **5** |
| **Pre-requisites, if any** | Basic Knowledge of Biochemistry and Biomolecules. |
| **Course Objectives** | **The main objectives of this course are to:**<br>**1.** Students will be introduced to the structure of biomolecules.<br>**2.** The significance of carbohydrates in biological processes will be understood.<br>**3.** The structure, properties and biological significance of lipids in the biological system will be studied.<br>**4.** Students will learn about the concepts of protein structure and their significance in biological processes and creatively comprehend the role of membrane components with theirbiological significance.<br>**5.** Students will gain knowledge about the structures and functional roles of nucleic acids in thebiological system. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1:** Explain the chemical structure and functions of carbohydrates. (K1, K2)<br>**CO2:** Using the knowledge of lipid structure and function, explain how it plays a role in Signalling pathways. (K3, K4)<br>**CO3:** Describe the various levels of structural organisation of proteins and the role of proteins in biological system. (K4, K5)<br>**CO4:** Apply the knowledge of proteins in cell-cellinteractions. (K3, K4)<br>**CO5.** Applying the knowledge of nucleic acid sequencing in research and diagnosis. (K2, K3, K4). |
| | |

| Units | |
|---|---|
| **I**<br><br>**15 Hours** | **Carbohydrates:** Classification, structure (configurations and conformations, anomeric forms), function and properties of monosaccharides, mutarotation, Disaccharides and oligosaccharides with suitable examples. Polysaccharides - Homopolysaccharides (starch, glycogen, cellulose, inulin, dextrin, agar, pectin, dextran). Heteropolysaccharides - Glycosaminoglycans– source, structure, functions of hyaluronic acid, chondroitin sulphates, heparin, keratan sulphate. Glycoproteins - proteoglycans. O- Linked and N-linked glycoproteins. Biological significance of glycan. Blood group polysaccharides. Bacterial cell wall (peptidoglycans, teichoic acid) and plant cell wall carbohydrates. |
| **II**<br>**15 Hours** | **Lipids:** Classification of lipids, structure, properties and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, sphingolipids and steroids – Biological importance. Eicosanoids- classification, structure and functions of prostaglandins, thromboxanes, leukotrienes. Lipoproteins – Classification, structure, and their biological significance. |
| **III**<br>**15 Hours** | **Amino acids:** classification, structure and properties of amino acids, biological role. Non-Protein amino acids and their biological significance. Proteins – classification based on composition, structure and functions. Primary, secondary, super secondary (motifs) (Helix-turn –helix, helix-loop-helix, Beta-alpha-beta motif, Rosemann Rossmann fold, Greek key), tertiary and quaternary structure of proteins. Structural characteristics of collagen and hemoglobin. Determination of amino acid sequence. Chemical synthesis of a peptide, Forces involved in stabilization of protein structure. Ramachandran plot. |
| **IV**<br>**15 Hours** | **Membrane Proteins:** Types and their significance. Cytoskeleton proteins - actin, tubulin, intermediate filaments. Biological role of cytoskeletal proteins. Membrane structure-fluid mosaic model |
| **V**<br>**15 Hours** | **Nucleic acids:** types and forms (A, B, C and Z) of DNA. Watson-Crick Model-Primary, secondary and tertiary structures of DNA. Triple helix and quadruplex DNA. Mitochondrial and chloroplast DNA. DNA supercoiling (calculation of Writhe, linking and twist number). Determination of nucleic acid sequences by Maxam Gilbert and Sanger's methods. Forces stabilizing nucleic acid structure. Properties of DNA and RNA. C-value, C-value paradox, Cot curve. Structure and role of nucleotides in cellular communications. Major and minor classes of RNA, their structure and biological functions. |
| **Reading List (Print and Online)** | 1. https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Online_(Jakubowski)<br>2. https://www.thermofisher.com/in/en/home/life-science/protein-biology/protein-biology-learning-center/protein-biology-resource- |

| | |
|---|---|
| | library/pierce-protein-methods/protein-glycosylation.html<br>3. https://ocw.mit.edu/courses/biology/7-88j-protein-folding-and- human-disease-spring-2015/study-materials/<br>4. https://www.open.edu/openlearn/science-maths-technology/science/biology/nucleic-acids-and-chromatin/content-section- 3.4.2<br>5. https://www.genome.gov/genetics-glossary/Cell-Membrane<br>https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod3.pdf |
| **Self-Study** | 1. Classification of Sugars.<br>2. Nutritional classification of fatty acids. |
| **Recommended Texts** | 1. David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed) W.H. Freeman.<br>2. Voet.D & Voet. J.G (2010) Biochemistry, (4th ed), JohnWiley & Sons, Inc.<br>3. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.<br>4. Zubay G.L (1999) Biochemistry, (4th ed), Mc Grew-Hill.<br>5. Lubert Stryer (2010) Biochemistry, (7th ed), W.H.Freeman.<br>6. Satyanarayan,U (2014) Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata. |

**Method of Assessment**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, solve problems, Observe, Explain.
**Analyse (K4) –** Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | L | M | S | M | M | M | S | M | M | S | L | S | S | L |
| **CO 2** | S | M | L | S | M | M | M | S | M | M | S | S | S | S | L |
| **CO 3** | S | M | M | S | S | M | L | S | M | M | S | L | M | S | L |
| **CO 4** | S | M | M | S | M | M | M | S | M | M | S | L | M | S | L |
| **CO 5** | S | S | M | S | S | M | M | S | M | M | S | L | M | M | L |

**S**

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Biochemical and Molecular Biology Techniques** | Core | 5 | 1 | 0 | 0 | 5 | 6 | 25 | 75 | 100 |

| **Course** | **CORE PAPER II** |
|---|---|
| **Title of the Course** | **BIOCHEMICAL AND MOLECULAR BIOLOGY TECHNIQUES** |
| **Credits** | **5** |
| **Pre-requisites, if any** | Comprehensive Knowledge of Tools of Biochemistry/Molecular Biology. |
| **Course Objectives** | **Biochemical techniques combine various inter-disciplinary methods in biological research and the course aims to provide students with the following objectives:**<br>1. To understand the various techniques used in biochemical investigation and microscopy.<br>2. To explain chromatographic techniques.\ and their applications.<br>3. To explain electrophoretic techniques.<br>4. To comprehend the spectroscopic techniques and demonstrate their applications in biochemical investigations.<br>5. To acquire knowledge of radio labelling techniques and centrifugation. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.** Attain good knowledge in modern used in biochemical investigation and microscopy and apply the experimental protocols to plan and carry out simple investigations in biological research. (K1, K5)<br>**CO2.** Demonstrate knowledge to implement the theoretical basis of chromatography in upcoming practical course work. (K3, K5)<br>**CO3.** Demonstrate knowledge to implement the theoretical basis of electrophoretic techniques in research work. (K3, K5)<br>**CO4.** Tackle more advanced and specialized spectroscopic techniques that are pertinent to research. (K1, K2 & K5)<br>**CO5.** Tackle more advanced and specialized radioisotope and centrifugation techniques that are pertinent to research work. (K1, K2 & K5) |
| **Units** | |
| **I**<br>**15 Hours** | **General approaches to biochemical investigation:** Organ and tissue slice technique, cell disruption and homogenization techniques, cell sorting, and cell counting, tissue Culture techniques, Cryopreservation. Biosensors-principle and applications. Principle, working and applications of light |

| | |
|---|---|
| | microscope, dark field, phase contrast and fluorescent microscope. Electron microscope- Principle, instrumentation of TEM and SEM, Specimen preparation and applications. Shadow casting, negative staining and freeze fracturing. |
| **II**<br>**15 Hours** | **Chromatographic Techniques:** Basic principles of chromatography-adsorption and partition techniques. Adsorption Chromatography – Hydroxy apatite chromatography, hydrophobic interaction Chromatography, Affinity chromatography and Ion exchange chromatography. Gas liquid chromatography- principle, instrumentation, column development, detectors and applications. High pressure liquid chromatography- principle, instrumentation, delivery pump, sample injection unit, column packing, development, detection and application. |
| **III**<br>**15 Hours** | **Electrophoretic Techniques:** General principles of electrophoresis, supporting medium, factors affecting electrophoresis, Isoelectric focusing-principle, ampholyte, development of pH gradient and application. PAGE-gel casting-horizontal, vertical, slab gels, sample application, detection-staining using CBB, silver, fluorescent stains and applications. SDS PAGE-principle and application in molecular weight determination. Principle of disc gel electrophoresis, 2D PAGE. Electrophoresis of nucleic acids - agarose gel electrophoresis of DNA and RNA, pulsed field gel electrophoresis - principle, apparatus, application. Capillary electrophoresis and immuno-electrophoresis. |
| **IV**<br>**15 Hours** | **Spectroscopic techniques:** Basic laws of light absorption. Principle, instrumentation and applications of UV-Visible, IR, ESR, NMR, Mass spectroscopy, Turbidimetry and Nephelometry. Luminometry (Luciferase system, chemiluminescence). X - ray diffraction. Atomic absorption spectroscopy - principle, instrumentation and applications, determination of trace elements. |
| **V**<br>**15 Hours** | **Radiolabeling Techniques and Centrifugation:** Nature of radioactivity. Detection and measurement of radioactivity- methods based upon ionisation (GM counter) and excitation (scintillation counter). Autoradiography and applications of radioactive isotopes. Biological hazards of radiation and safety measures in handling radioactive isotopes.<br>Basic principles of Centrifugation. Preparative ultracentrifugation, Differential centrifugation, Density gradient centrifugation. Analytical ultracentrifugation - Molecular weight determination. |
| **Reading List (Print and Online)** | Principles and techniques of biochemistry and molecular biology:<br>1. https://www.kau.edu.sa/Files/0017514/Subjects/principals%20and%20techiniques%20of%20biochemistry%20and%20molecular%20biology%207th%20ed% |
| **Self-Study** | 1. Types of rotors.<br>2. Colorimetry – principle and applications. |
| **Recommended Texts** | 1. Keith Wilson, John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th ed) Cambridge University |

| | |
|---|---|
| | Press.<br>2. Rangarajan. N and Sampath. V, 2003, Fundamentals of Analytical Biochemistry, 1st edition, MJP publishers.<br>3. David Sheehan (2009), Physical Biochemistry: Principles and Applications (2nd ed), Wiley-Blackwell.<br>4. David M. Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology,W.H.Freeman.<br>5. Rodney F.Boyer (2012), Biochemistry Laboratory: Modern Theory and techniques,(2nd ed),Prentice Hall.<br>6. Kaloch Rajan (2011), Analytical techniques in Biochemistry and Molecular Biology, Springer.<br>7. Robyt JF (2015) Biochemical techniques: Theory and Practice (1st ed), CBS Publishers & Distributors. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, solve problems, Observe, Explain.
**Analyse (K4) –** Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | L | M | S | S | L | L | S | S | M | M | **S** | **S** | **S** | **S** |
| **CO 2** | S | M | M | S | M | L | M | S | S | L | S | **S** | **S** | **S** | **S** |
| **CO 3** | S | M | L | S | M | M | M | S | M | L | S | **S** | **S** | **S** | **S** |
| **CO 4** | S | S | L | S | S | M | M | S | M | M | S | **S** | **S** | **S** | **S** |
| **CO 5** | S | S | M | S | M | M | M | S | M | M | M | **S** | **S** | **S** | **S** |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Laboratory Course on Biomolecules and Biochemical Techniques** | Core | 0 | 1 | 5 | 0 | 4 | 6 | 40 | 60 | 100 |

| **Course** | **CORE PAPER III** |
|---|---|
| **Title of the Course** | **LABORATORY COURSE ON BIOMOLECULES AND BIOCHEMICAL TECHNIQUES** |
| **Credits** | **4** |
| **Pre-requisites** | Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions. |
| **Course Objectives** | 1. To instill skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the biomolecules under investigation.<br>2. To inculcate the knowledge of various isolation and purification techniques of macromolecules like DNA, RNA, Glycogen and Starch.<br>3. To perform colorimetric estimations to quantify important metabolites like lactate and tryptophan and minerals like calcium and iron from various sources.<br>4. To achieve training in subcellular fractionation and to identify them by markers.<br>5. To achieve training in various chromatographic techniques.<br>6. To perform the isolation and identification of the organelles of a cell using differential centrifugation.<br>7. To perform phytochemical screening and quantification enabling them to give an insight on phytochemicals this will be useful for future research. |

| | |
|---|---|
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.**The student will be able to acquire knowledge and skill in the techniques used in the isolation, purification and estimation of different biomolecules that are widely employed in research. (K1, K2, K4)<br>**CO2.**The students will get acquainted with Principle, Instrumentation and method of Performing UV absorption studies of DNA, Protein and interpreting the alteration occurred during the process of denaturation. (K1, K2, K 3, K4).<br>**CO3.**The student will be fine-tune in handling the instruments like colorimeter, spectrophotometer and will be able to estimate the biomolecules and minerals from the given samples. (K1, K2, K4,)<br>**CO4.** The student, in addition to acquiring skill in performing various biochemical techniques can also learn to detect presence of phytochemicals and quantify them in the plant sample. (K1, K2, K3, K4 & K6)<br>**CO5.**The students will develop skill in analytical techniques like subcellular fractionation, Paper, Column and Thin layer Chromatography and the group experiments will enable them to build learning skills like team work, Problem solving, Communication ability. (K1, K2, K3, K4 & K6) |
| **Units** | |
| **I**<br>**18 Hours** | **Biochemical studies and estimation of macromolecules**<br>1. Isolation and estimation of glycogen from liver.<br>2. Isolation and estimation of DNA from animal tissue.<br>3. Isolation and estimation of RNA from yeast.<br>4. Purification of Polysaccharides –Starch and assessment of its purity. |
| **II**<br>**18 Hours** | **UV absorption**<br>1. Denaturation of DNA and absorption studies at 260nm.<br>2. Denaturation of Protein and absorption studies at 280nm. |
| **III**<br>**18 Hours** | **Colorimetric estimations**<br>1. Estimation of Pyruvate.<br>2. Estimation of tryptophan. |
| **IV**<br>**18 Hours** | **Estimation of minerals**<br>1. Estimation of calcium.<br>2. Estimation of iron. |
| **V**<br>**18 Hours** | **Plant Biochemistry**<br>1. Qualitative analysis Phytochemical screening.<br>2. Estimation of Flavonoids -Quantitative analysis.<br><br>**Group Experiments**<br>1.Fractionation of sub-cellular organelles by differential centrifugation-Mitochondria and nucleus. |

| | |
|---|---|
| | 2. Identification of the separated sub-cellular fractions using marker enzymes (any one).<br>3.Separation of identification of lipids by thin layer chromatography.<br>4.Separation of plant pigments from leaves by column chromatography.<br>5. Identification of Sugars by Paper Chromatography.<br>6.Identification of Amino acids by Paper Chromatography. |
| **Reading List (Print and Online)** | 1. https://www.researchgate.net/publication/313745155_Practical_Biochemistry_A_Student_Companion<br>2. https://doi.org/10.1186/s13020-018-0177-x<br>3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5368116/<br>4. https://www.life.illinois.edu/biochem/455/Lab%20exercises/2Photometry/spectrophotometry.pdf<br>5. https://ijpsr.com/bft-article/determination-of-total-flavonoid-and-phenol-content-in-mimusops-elengi-linn/?view=fulltext<br>6. https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf |
| **Self-Study** | 1. Laboratory Safety Rules, Requirements and Regulations.<br>2. Preparation of standard solutions and reagent |
| **Books Recommended** | 1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd<br>2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers<br>3. Varley H (2006) Practical Clinical Biochemistry (6th ed), CBS Publishers<br>4. O. Debiyi and F. A. Sofowora, (1978) "Phytochemical screening of medical plants," Iloyidia, vol. 3, pp. 234–246,<br>5. Prof. Sarin A. Chavhan, Prof. Sushilkumar A. Shinde (2019) A Guide to Chromatography Techniques Edition:1<br>6. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011) |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, solve problems, Observe, Explain.
**Analyse (K4)-** Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)-** Check knowledge in specific or offbeat situations, Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | S | M | S | L | S | M | S | L | **S** | L | M | M |
| **CO 2** | S | S | S | S | M | S | L | S | M | S | L | **S** | **S** | M | **S** |
| **CO 3** | S | S | S | S | M | S | M | S | M | S | L | **S** | **S** | **S** | M |
| **CO 4** | S | S | S | S | S | S | S | S | S | S | L | **S** | **S** | M | M |
| **CO 5** | S | S | S | S | S | S | S | S | S | S | L | **S** | L | **S** | **S** |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Physiology and Cell Biology** | Elective | 4 | 1 | 0 | 0 | 3 | 5 | 25 | 75 | 100 |

| | |
|---|---|
| **Course** | **DISCIPLINE CENTRIC ELECTIVE PAPER - I** |
| **Title of the Course** | **PHYSIOLOGY AND CELL BIOLOGY** |
| **Credits:** | **3** |
| **Pre-requisites, if any** | Anatomy, Cells and Biological Compounds. |
| **Course Objectives** | 1. To understand the functions and activities of organs, tissues or cells and of physical and chemical phenomena involved in the human body.<br>2. Aid in understanding the physiology of digestive and respiratory systems.<br>3. Explain the structure and physiology of the nervous system.<br>4. Impart knowledge about cell junctions and cell division.<br>5. Explicate the functions of reproductive system of the body.<br>6. Impart knowledge about the basic concepts of developmental biology. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.** specifically understand the biological and chemical processes within a human cell. (K1, K2, K5, K6)<br>**CO2.** identify and prevent diseases. (K2, K3, K4, k5, K6)<br>**CO3.** understand defects in digestion, nutritional deficiencies and intolerances, and gastrointestinal pathologies. (K1, K2, K3, K4, K5, K6)<br>**CO4.** identify general characteristics in individuals with imbalances of acid-base, fluid and electrolytes. (K1, K2, K3, K4, K5, K6)<br>**CO5.** process the mechanism: the transmission of biochemical information between cell membrane and nucleus. (K1, K2, K5) |
| **Units** | |
| **I**<br><br>**15 Hours** | **Digestive system:** structure and functions of different components of digestive system, digestion and absorption of carbohydrates, lipids and proteins, role of bile salts in digestion and absorption, mechanism of HCl formation in stomach.<br><br>**Respiratory system:** Gaseous transport and acid-base homeostasis. Mechanism of the movement of O2 and CO2 through lungs, arterial and venous circulation. Bohr effect, oxygen and carbon dioxide binding haemoglobin. |

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| **II**<br>**15 Hours** | **Nervous system:** Sensory transduction, Nerve impulse transmission - nerve cells, synapses, reflex arc structure, resting membrane potential, Nernst equation, action potential, voltage gated ion-channels, impulse transmission, neurotransmission, neuromuscular junction. Types and role of neurotransmitters in nerve impulse transmission, neurotransmitter receptors, synaptosomes, synaptotagmin. |
| **III**<br>**15 Hours** | **Reproductive system:** Male Reproductive system – Testes, spermatogenesis, factors affecting spermatogenesis, Functions of testosterone, Prostate gland. Female reproductive system – Ovary, ovulation, ovarian hormones, functions of estrogens, progesterone, Menstrual cycle, Fertilization process. |
| **IV**<br>**15 Hours** | **Major classes of cell junctions:** anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs)- cadherins, integrins. Types of tissues. Epithelium- organisation and types. The basement membrane. Cell cycle- mitosis and meiosis, Cell cycle-phases and regulation. Cell death mechanisms- an overview-apoptosis, necrosis. |
| **V**<br>**15 Hours** | **Developmental biology:** Basic concepts of development - Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants.; zygote formation, cleavage, blastula formation, embryo and embryonic membranes, gastrulation, formation of germ layers and outline to organogenesis. |
| **Reading List (Print and online)** | 1. https://www.genome.gov/genetics-glossary/Cell-Cycle<br>2. https://my.clevelandclinic.org/health/diseases/16083-infertility-causes<br>3. https://www.webmd.com/heartburn-gerd/reflux-disease<br>4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5760509/<br>5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3249628/ |
| **Self-Study** | 1. Variation in cell differentiation and progression.<br>2. Lesch Nyhan syndrome, orotic aciduria and GERD. |
| **Recommended Texts** | 1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6th ed). John Wiley & Sons. Inc.<br>2. Bruce Alberts and Dennis Bray (2013), Essential Cell Biology, ($4^{th}$ ed), Garland Science.<br>3. De Robertis, E.D.P. and De Robertis, E.M.F. (2010). Cell and Molecular Biology. ($8^{th}$ ed). Lippincott Williams and Wilkins, Philadelphia.<br>4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. ($5^{th}$ ed). Sunderland, Mass. Sinauer Associates, Inc.<br>5. Wayne M. Baker (2008) the World of the Cell. ($7^{th}$ ed). Pearson Benjamin Cummings Publishing, San Francisco. Cell Biology<br>6. John E. Hall (2010). Guyton and Hall Textbook of Medical Physiology ($12^{th}$ ed), Saunders<br>7. Harrison's Endocrinology by J. Larry Jameson Series: Harrison's Specialty, 19th Edition Publisher: McGraw-Hill, Year: 2016. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, solve problems, Observe, Explain.
**Analyse (K4)** -Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)**- Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | S | S | M | S | S | S | M | S | M | S | M | L |
| **CO 2** | S | S | S | S | S | L | S | S | S | M | S | M | S | S | L |
| **CO 3** | S | S | S | S | S | M | M | S | S | M | S | S | S | S | S |
| **CO 4** | S | S | S | S | S | M | M | S | S | M | S | S | S | S | S |
| **CO 5** | M | S | L | S | S | L | M | M | L | L | S | M | S | M | L |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Microbiology and Immunology** | Elective | 4 | 1 | 0 | 0 | 3 | 5 | 25 | 75 | 100 |

| **Course** | **GENERIC ELECTIVE PAPER - II** |
|---|---|
| **Title of the Course** | **MICROBIOLOGY AND IMMUNOLOGY** |
| **Credits** | **3** |
| **Pre-requisites, if any** | The student should possess basic knowledge about microorganisms, types and their general characteristics. The students are also expected to possess basic understanding about the process of infection, immunological defence and pathological outcomes, if any. |
| **Course Objectives** | 1. To appreciate the classification of microorganisms based on their structure, size and shape with an insight into the ancient scriptures about microbes.<br>2. To understand the role of microorganisms in environment and also to learn the culture conditions.<br>3. To recognize the possible contamination of foods by microorganisms, to learn about counteracting preservative measures and to know about probiotic nature of microorganisms.<br>4. To gain knowledge on pathogenic mediation by microorganisms and preventive measures as well.<br>5. To understand about the immune cells and organs.<br>6. To be able to exploit the basics of antigens and antibodies. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.** To classify (by both ancient and modern modes) different types of microorganisms and explain life cycle of the microbes (K1, K2 & K5)<br>**CO2.** To recognize the microorganisms involved in decay of foods and will be able to apply various counteracting measures. The students also will be able to relate the role of certain beneficial microbes in day-to-day's food consumption. (K1, K2 & K4)<br>**CO3.** To understand the common pathogenic bacterial and fungi that cause toxic effects and also will be able to employ curative measures. (K1 & K2)<br>**CO4.** To understand the role of various cells in immune system and their location in different organs. (K2, K5 & K6)<br>**CO5.** To apply knowledge gained during the study of basics of immunology for the prevention of infection and diseases. (K2, K4 & K5) |

| Units | |
|---|---|
| **I**<br>**15 Hours** | **Taxonomical classification:** Bacteria, viruses (DNA, RNA), algae, fungi and protozoa. Distribution and role of microorganisms in soil, water and air. Charaka's classification of microbes, lytic cycle and lysogeny. Types of culture media, isolation of pure culture, growth curve and the measurement of microbial growth. |
| **II**<br>**15 Hours** | **Food preservation and fermented foods:** General principles of traditional and modern methods of food preservation - Removal or inactivation of microorganisms, boiling, steaming, curing, pasteurization, cold processing, freeze drying, irradiation, vacuum packing, control of oxygen and enzymes. Microbes involved in preparation of fermented foods - cheese, yoghurt, curd, pickles, rice pan cake, appam, ragi porridge and bread. |
| **III**<br>**15 Hours** | **Food poisoning:** Bacterial food poisoning, *Salmonella*, *Clostridium blotulinum* (botulism), *Staphylococcus aureus*, fungal food poisoning – aflatoxin. Pathogenic microorganisms - *E. coli*, *Pseudomonas*, *Klebsilla, Streptococcus, Haemophilus,* and *Mycobacterium*, causes, control, prevention, cure and safety. Food microbiological screening- Real time PCR, ELISA, Aerobic and anaerobic Plate Count, dye reduction method, anaerobic lactic acid bacteria, anaerobic spore formers, Hazard analysis critical control point (HACCP) |
| **IV**<br>**15 Hours** | **Immune system:** Lymphoid organs – Primary, secondary; and tertiary organs - Bone marrow, thymus, lymph node, spleen, mucosal immune system and cutaneous immune system - Structure and functions. Cells of the immune system – Hematopoiesis – hematopoietic stem cells (HSC), lymphocytes (B cells and T cells), dendritic cells, natural killer cells, neutrophils, eosinophils, basophils, mast cells, monocytes, and macrophages. |
| **V**<br>**15 Hours** | **Antigens and Antibody:** Antigens: definition, properties - antigenicity and immunogenicity, factors that influence immunogenicity, antigenic determinants, Classes of antigen and haptens. Immunoglobulins: Genes, structure, classes and distribution of antibodies. Immune system in health and disease - Transplantation immunology - graft rejection and HLA antigens. Immunological technique - Flow cytometry and its application. |
| **Reading List**<br>**(Print and Online)** | https://www.ijam.co.in/index.php/ijam/article/view/1326 (Krumi (Microorganisms) in Ayurveda- a critical review) Virtual Lectures in Microbiology and Immunology, University of Rochester<br>https://www.frontiersin.org/articles/10.3389/fphar.2020.578970/full#h9<br>https://www.frontiersin.org/articles/10.3389/fmicb.2018.02151/full<br>https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7559905/ |
| **Self-Study** | 1. Microbial infections and gut microbiome with relevance to *tridoshas*.<br>2. Microbial population and pH variations in different dairy products. |

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| **Recommended Texts** | 1. Michael J.Pelczar Jr.(2001) Microbiology (5th ed), McGraw Hill Education (India) Private Limited.<br>2. Frazier WC, Westhoff DC, Vanitha NM (2010) Food Microbiology (5th ed), McGraw Hill Education (India) Private Limited.<br>3. Willey J and Sherwood L (2011), Prescott's Microbiology (8th ed) McGraw Hill Education (India).<br>4. Ananthanarayanan, Paniker and Arti Kapil (2013) Text book of Microbiology (9th ed) Orient BlackSwan.<br>5. Sharon Stranford, Judy Owen, Patricia Jones, Jenni Punt (2022), Kuby's Immunology (8th ed) W. H. Freeman & Co, ISBN: 978-1319498658.<br>6. Abul K. Abbas (2021), Cellular and Molecular Immunology (10th Ed,), Elsevier Publications. ISBN: 978-8131264577.<br>7. Brooks GF and Carroll KC (2013) Jawetz Melnick & Adelbergs Medical Microbiology, (26th ed) McGraw Hill Education.<br>8. Greenwood D (2012), Medical Microbiology, Elsevier Health. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, Observe, Explain.
**Analyse (K4)-** Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)**- Check knowledge in specific or offbeat situations, Discussion, Debating, Presentation

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | L | S | S | S | S | M | S | S | S | S | M | M | S | L |
| **CO 2** | S | S | S | S | S | M | L | M | S | S | S | M | S | M | L |
| **CO 3** | S | M | M | S | M | M | M | M | L | M | S | M | M | M | M |
| **CO 4** | S | M | M | M | M | M | M | S | S | S | S | M | S | S | L |
| **CO 5** | S | L | S | S | M | L | L | S | S | S | S | M | S | S | L |

**S-Strong M-Medium L-Low**

## SEMESTER II

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Enzymology** | Core | 5 | 1 | 0 | 0 | 5 | 6 | 25 | 75 | 100 |

| **Course** | **CORE PAPER IV** |
|---|---|
| **Title of the Course** | **ENZYMOLOGY** |
| **Credits** | **5** |
| **Pre-requisites** | Basic knowledge about catalysis, kinetics and chemical reaction mechanisms. |
| **Course Objectives** | 1. Students will be introduced to the theory and practice of enzymology.<br>2. Mechanisms of catalysis and factors affecting catalysis will be understood.<br>3. The kinetics of enzyme catalyzed reactions in the absence and presence of inhibitors will be studied and the options for applying enzymes and their inhibitors in medicine will be analyzed.<br>4. Students will learn about the applications of enzymes in research, medicine, and industry, which will prepare them for careers in industrial and biomedical research.<br>5. The control of metabolic pathways and cellular responses through enzyme regulation will be emphasized. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1:** Describe the catalytic mechanisms employed by enzymes. (K1, K2 & K5)<br>**CO2:** Choose and use the appropriate methods to isolate and purify enzymes and check the purity of the enzyme. (K1, K2, K3, K4 & K5)<br>**CO3:** Analyze enzyme kinetic data graphically, calculate kinetic parameters, determine the mechanism of inhibition by a drug/chemical and analyze options for applying enzymes and their inhibitors in medicine. (K1, K2, K3 & K4)<br>**CO4:** Explain allosterism and cooperativity and differentiate Michaelis-Menten kinetics from sigmoidal kinetics. The role played by enzymes in the regulation of vital cellular processes will be appreciated. (K1, K2, K5 & K6) |

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| | **CO5:** Highlight the use of enzymes in industries and biomedicine. (K1, K2 & K3) |

| **Units** | |
|---|---|
| **I**<br>**15 Hours** | **Mechanism of enzyme catalysis:** A short history of the discovery of enzymes and how they became powerful biochemical tools. Holoenzyme, apoenzyme, cofactors, coenzyme, prosthetic groups, Classification and Nomenclature, Specificity of enzyme action-group specificity, absolute specificity, substrate specificity, stereochemical specificity.<br><br>**Enzyme catalysis:** acid-base catalysis, covalent catalysis, electrostatic catalysis, metal ion catalysis, proximity and orientation effects, Structural flexibility. Mechanism of action of chymotrypsin and carboxypeptidase. |
| **II**<br>**15 Hours** | **Enzyme techniques:** Isolation and purification of enzymes - Importance of enzyme purification, methods of purification- choice of source, extraction, fractionation methods-based on size or mass (centrifugation, gel filtration); based on polarity (ion-exchange chromatography, electrophoresis, isoelectric focusing, based on solubility (change in pH, change in ionic strength); based on specific binding sites (affinity chromatography). Criteria of purity of enzymes. Enzyme units - Katal, IU. Measurement of enzyme activity - discontinuous, continuous, coupled assays, stopped flow method. Isoenzymes and their separation by electrophoresis with special reference to LDH |
| **III**<br>**15 Hours** | **Enzyme kinetics I** - Properties of enzymes, Enzyme specificity, Enzyme kinetics – Rate of enzymatic reaction, effect of substrate and enzyme concentration, pH, temperature on enzyme activity. M-M equation, L-B plot, Eadie Hofsee Plot. Determination of Km. Catalytic efficiency, Sigmoidal kinetics, Allosteric enzymes significance, structure and regulatory functions with special reference to aspartate transcarbomylase. Role of covalent modification in regulation of enzymes -regulation of glycogen synthase and glycogen phosphorylase. |
| **IV**<br>**15 Hours** | **Enzyme kinetics II:** Enzyme inhibition: Irreversible inhibition. Reversible inhibition-Competitive, uncompetitive, noncompetitive, mixed and substrate inhibition. Michaelis -Menten equation in the presence of competitive, uncompetitive and non-competitive inhibitors. Graphical analysis - Diagnostic plots for the determination of inhibition type. Bi - Substrate reactions: Single Displacement reactions (SDR) (Ordered and Random bi bi mechanisms), Double Displacement |

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| | reactions (DDR) (Ping pong mechanism), Examples, Cleland's representation of bisubstrate reactions. |
| **V**<br>**15 Hours** | **Enzyme technology:** Immobilization of enzymes – methods - Reversible immobilization (Adsorption), Irreversible immobilization (Covalent coupling, Entrapment and Microencapsulation, Crosslinking). Advantages and Disadvantages of each method, Properties of immobilized enzymes. Designer enzymes- ribozymes. Enzymes as therapeutic agents-therapeutic use of asparaginase and streptokinase. Application of enzymes in industry- Industrial application of rennin, lipases, lactases, invertase, pectinases, papain. |
| **Reading List (Print and Online)** | **Enzymes** \| MIT OpenCourseWare \| Free Online Course Materials<br>https://ocw.mit.edu/high-school/biology/exam-prep/chemistry-of-life/enzymes/<br>**Enzymology**<br>https://onlinecourses.swayam2.ac.in/cec20_bt20/preview<br>https://mooc.es/course/enzymology/<br>**The active site of enzymes**<br>https://dth.ac.in/medical/courses/biochemistry/block-1/1/index.php<br>**Enzymes and Enzyme Kinetics**<br>https://www.lecturio.com/medical-courses/enzymes-and-enzyme kinetics.course#/<br>Mechanistic enzymology in drug discovery: a fresh perspective<br>https://www.nature.com/articles/nrd.2017.219<br>Enzyme Biosensors for Biomedical Applications: Strategies for Safeguarding Analytical Performances in Biological Fluids<br>https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4934206/ |
| **Self-Study** | 1. Mechanistic enzymology in drug discovery.<br>2. Enzyme Biosensors for Biomedical Applications. |
| **Recommended Texts** | 1. Enzymes: Biochemistry, Biotechnology and Clinical chemistry, 2nd edition, 2007, Palmer T and Bonner P; Affiliated- East West press private Ltd, New Delhi.<br>2. Fundamentals of Enzymology, 3rd edition, 2003, Price NC and Stevens L; Oxford University Press, New York.<br>3. Voet's Biochemistry, Adapted ed, 2011, Voet,D and Voet JG; Wiley, India.<br>4. Lehninger Principles of Biochemistry, 8th edition, 2021, Nelson DL and Cox MM; WH Freeman & Co, New York.<br>5. Biochemistry, Berg JM, Stryer L, Gatto,G, 8th ed, 2015;WH Freeman & Co., New York.<br>6. Enzyme Kinetics and Mechanism; Cook PF, Cleland W, ;2007; Garland Science, London. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, solve problems, Observe, Explain.
**Analyse (K4)-** Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)-** Check knowledge in specific or offbeat situations, Discussion.

**Mapping with Programme Outcomes:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | **S** | **M** | **S** | **L** | **M** | **S** | **L** | **S** | **S** | **M** | **S** | **S** | **S** | **S** | **S** |
| **CO 2** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **S** | **S** | **S** | **S** | **L** | **S** | **M** | **L** |
| **CO 3** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **L** |
| **CO 4** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **S** | **S** | **S** | **S** | **L** | **M** | **S** | **L** |
| **CO 5** | **S** | **S** | **S** | **S** | **M** | **L** | **M** | **S** | **S** | **S** | **S** | **L** | **S** | **M** | **S** |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Cellular Metabolism** | Core | 5 | 1 | 0 | 0 | 5 | 6 | 25 | 75 | 100 |

| **Course** | **CORE PAPER V** |
|---|---|
| **Title of the Course** | **CELLULAR METABOLISM** |
| **Credits** | **5** |
| **Pre-requisites** | Basic knowledge on biochemical reactions such as addition, deletion, rearrangement, transfer and breaking of bonds. |
| **Course Objectives** | 1. Familiarize on blood glucose homeostasis<br>2. Provide an insight into the metabolic path way of glycogen, glycoprotein, mucopolysaccharide and peptidoglycan with clinical correlation wherever required<br>3. Inculcate knowledge on nucleotide metabolism and disorders associated with it<br>4. Provide a platform to understand the versatile role of PLP in amino acid degradation, formation of specialized products and disorders associated with ammonia detoxification<br>5. Educate on heme and sulphur metabolism with associated clinical manifestation |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.** Appreciate the modes of synthesis and degradation of glucose and will be able to justify the pros and cons of maintain the blood sugar level (**K1, K2, K5**)<br>**CO2.** Gain knowledge on polysaccharide metabolism and glycogen storage disease **(K1, K2, K5)**<br>**CO3.** Acquaint with the making and braking of nucleotides **(K1, K2, K4)**<br>**CO4.** Differentiate the diverse reaction a particular amino acid can experience **(K1, K2, K3)**<br>**CO5.** Correlate the disturbance of metabolic reactions to clinical manifestations with reference to heme and sulphur metabolism (**K1, K2, K4, K5)** |
| | |

| Units | |
|---|---|
| **I**<br>**15 Hours** | **Metabolism of Carbohydrate:** Glycolysis - aerobic and anaerobic, inhibitors, and regulation. Feeder pathway- entry of hexoses into glycolysis. Pyruvate dehydrogenase complex-mechanism and regulation. Citric acid cycle and regulation. Glyoxalate cycle and its regulation. Gluconeogenesis- source, key enzymes, reaction sequence and its regulation. Pentose phosphate pathway- significance and its regulation. Metabolism of glycogen and its regulation. |
| **II**<br>**15 Hours** | **Metabolism of Lipid:** Oxidation of fatty acids-oxidation of saturated and unsaturated fatty acids (α, β & ω oxidation) Oxidation of fatty acids with odd and even numbered carbon atoms. Regulation of β oxidation. Ketogenesis and its regulation. Biosynthesis of fatty acid–saturated and unsaturated, chain elongation, regulation. Cholesterol biosynthesis and its regulation. Lipoprotein metabolism-chylomicrons, VLDL, HDL and LDL. |
| **III**<br>**15 Hours** | **Metabolism of nucleotides:** *De novo* synthesis and salvage pathways of purine and pyrimidine nucleotides. Regulation and inhibitors of nucleotide biosynthesis. Role of ribonucleotide reductase and its regulation. Degradation of purine and pyrimidine nucleotides. |
| **IV**<br>**15 Hours** | **Metabolism of Amino acids:** Biosynthesis of non- essential amino acids Biosynthesis of spermine and spermidine. Degradation of amino acids – glucogenic and ketogenic amino acids. Formation of acetate from leucine and aromatic amino acid, pyruvate from cysteine, threonine and hydroxy proline, α-keto glutarate from histidine and proline, succinate from methionine, threonine, valine and isoleucine, Oxaloacetate from aspartate, glycine and serine. |
| **V**<br>**15 Hours** | **Integration of Metabolism:** Interrelationship of carbohydrate, protein and fat metabolism - role of acetyl CoA and TCA cycle. Inter conversion of major food stuffs. Metabolic profiles of brain, muscle, liver, kidney, adipose tissue and their relationships. |
| **Reading List (Print and Online)** | 1. https://www.embopress.org/doi/full/10.1038/msb.2013.19<br>2. https://people.wou.edu/~guralnl/450Glycogen%20metabolism.pdf<br>3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3243375/<br>4. https://www.researchgate.net/publication/334458898_Urea_Cycle<br>5.https://www.researchgate.net/publication/51233381_Heme_biosynthesis_and_its_regulation_Towards_understanding_and_improvement_of_heme_biosynthesis_in_filamentous_fungi<br>6.https://www.researchgate.net/publication/349746691_Microbial_Sulfur_Metabolism_and_Environmental_Implications |

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|---|---|
| **Self-study** | 1. Cori's Cycle and Glucose- Alanine Cycle.<br>2. Coenzymes involved in Methanogenesis. |
| **Books Recommended** | 1.David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed), W.H.Freeman.<br>2.Voet.D and Voet. J.G (2010) Biochemistry, (4th ed), John Wiley & Sons, Inc.<br>3.Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.<br>4. Zubay G.L (1999) Biochemistry, (4th ed), Mc Grew-Hill.<br>5. Textbook of Biochemistry with Clinical Correlations, 7th Edition,Thomas M. Devlin (Editor), Wiley.<br>6. Human Biochemistry – James M.Orten & Otto.W.Neuhan- 10th edn- The C.V.Mosby Company. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, solve problems, Observe, Explain.
**Analyse (K4)-** Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)-** Check knowledge in specific or offbeat situations, Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | M | S | M | S | M | S | S | S | M | S | M | M | S | L |
| **CO 2** | S | M | S | S | S | M | S | S | S | M | S | M | M | S | L |
| **CO 3** | S | M | S | S | S | M | S | S | S | S | S | M | L | S | L |
| **CO 4** | S | M | S | M | S | M | S | S | S | M | S | M | L | M | L |
| **CO 5** | S | M | S | S | S | M | S | S | S | S | M | M | L | M | S |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Lab Course in Enzymology, Microbiology and Cell Biology** | Core | 0 | 1 | 5 | 0 | 4 | 6 | 40 | 60 | 100 |

| **Course** | **CORE PAPER -VI** |
|---|---|
| **Title of the Course** | **LAB COURSE IN ENZYMOLOGY, MICROBIOLOGY AND CELL BIOLOGY** |
| **Credits** | **4** |
| **Pre-requisites** | Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions. |
| **Course Objectives** | 1. To inculcate skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the assayof enzymes under investigation.<br>2. To inculcate the knowledge of isolation and purification techniques ofenzymes using alkaline phosphatase as an example<br>3. To perform experiments to study the factors affecting enzyme activity<br>4. To achieve training in assay of enzymes<br>5. To achieve training in basic microbiological techniques – preparation ofculture, sterilization and staining methods.<br>6. To perform the blood grouping test and to prepare blood smear to studydifferent types of blood cells<br>7. To learn molecular biology techniques like Gel electrophoresis and Blotting techniques |

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| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.**The student will be able to employ the relevant techniques for isolation and purification of enzymes and gain skill in kinetic studies which is essential for research activity (K1, K2, K4)<br>**CO2.** Student will acquire ability in performing enzyme assay, and explicate the methods that form the basis of enzyme characterization. (K1, K2, K4)<br>**CO3.** Learn the Basic concepts in microbiology and cell biology which will be helpful for interdisciplinary research work. (K1, K3, K4)<br>**CO4.** Students will be trained in separation techniques used in molecular Biology which will be supportive in their future research (K1, K3, K4 & K6)<br>**CO5.** Learn the separation of biomolecules by chromatography technique. (K1, K3, K6) |
| **Units** | |
| **I**<br>**18 Hours** | **Enzymology**<br>Alkaline Phosphatase<br>a. Isolation of Alkaline Phophatase from goat kidney.<br>b. Purification of alkaline phosphatase<br>c. Checking the purity using SDS-PAGE<br>d. Determination of optimum pH and temperature of alkaline phosphatase.<br>e. Determination of specific activity and Km of alkaline phosphatase.<br>f. Effect of activators and inhibitors on the activity of alkaline phosphatase.<br>**Assay of enzymes**<br>a. Salivary Amylase<br>b. Acid Phosphatase |
| **II**<br>**18 Hours** | **Microbiology**<br>a. Safety measures and Good Laboratory Practices in microbiology laboratory<br>b. Sterilization,Culture and inoculum preparation<br>c. Staining of bacteria – Gram Staining |
| **III**<br>**18 Hours** | **Physiology & Cell Biology**<br>a. Test for blood grouping (Haemagglutination).<br>b. Peripheral Blood smear –Staining and Interpretation |
| **IV**<br>**18 Hours** | **Chromatography Experiments**<br>1. Separation of Amino acid by TLC<br>**2.** Separation of Lipids by TLC<br>**Antioxidant Activity Assay**<br>Assay of antioxidant activity by DPPH method. |

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|---|---|
| **V**<br><br>**18 Hours** | **Group Experiments**<br>a. Separation of proteins based on molecular weight by SDS PAGE.<br>b. Agarose gel electrophoresis of genomic DNA. |
| **Reading List (Print and Online)** | 1.https://www.researchgate.net/publication/337146254_Kinetic_studies_with_alkaline_phosphatase<br>2.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4846332/<br>3.https://www.ijsr.net/archive/v3i8/MDIwMTU0MDk=.pdf<br>4.https://www.researchgate.net/publication/349318898_ABC_of_Periheral_smear<br>5.https://ncdc.gov.in/WriteReadData/l892s/File608.pdf<br>6.https://www.ncbi.nlm.nih.gov/books/NBK562156/ |
| **Self-Study** | 1. Preparation of Buffers and pH measurement.<br>2. Michaelis-Menten equation and Lineweaver Burk plot. |
| **Books Recommended** | 1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd.<br>2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers.<br>3. Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).<br>4. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).<br>5. Cappuccino JG & Sherman N (2005). Microbiology-A Laboratory Manual, Pearson Education Inc.<br>6. Practical Enzymology, Second Revised Edtion: Hans Bisswanger, Wiley – Blackwell; 2 edition (2011). |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, solve problems, Observe, Explain.
**Analyse (K4)-** Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)-** Check knowledge in specific or offbeat situations, Discussion.

**Mapping with Programme Outcomes:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | S | M | S | L | S | M | S | L | S | S | S | M |
| **CO 2** | S | S | S | S | M | S | L | S | M | S | L | S | M | L | S |
| **CO 3** | S | S | S | S | M | S | M | S | M | S | S | S | M | L | S |
| **CO 4** | S | S | S | S | S | S | S | S | S | S | L | S | S | S | S |
| **CO 5** | S | S | S | S | S | S | S | S | S | S | L | S | M | L | M |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Energy and Drug Metabolism** | Elective | 4 | 1 | 0 | 0 | 3 | 5 | 25 | 75 | 100 |

| **Course** | **DISCIPLINE CENTRIC ELECTIVE PAPER III** |
|---|---|
| **Title of the Course** | **ENERGY AND DRUG METABOLISM** |
| **Credits** | **3** |
| **Pre-requisites** | Basic knowledge on biochemical reactions such as addition, deletion, rearrangement, transfer and breaking of bonds. |
| **Course Objectives** | 1. Familiarize on concepts of enthalpy, entropy, free energy, redox system, biological oxidation and high energy compounds.<br>2. Provide an insight into the relationship between electron flow and phosphorylation.<br>3. Inculcate knowledge on processes involved in converting light energy to chemical energy and associated food production by autotrophs.<br>4. Provide a platform to understand the versatile role of Krebs cycle, transport of NADH across mitochondrial membrane and energetics.<br>5. Educate on the various phases xenobiotic metabolism. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.** Appreciate the relationship between free energy and redox potential and will be able to justify the role of biological oxidation and energy rich compounds in maintaining the energy level of the system. (**K1, K2, K3, K4**)<br>**CO2.** Gain knowledge on role of mitochondria in the production of energy currency of the cell. **(K1, K2, K5, K6)**<br>**CO3.** Acquaint with the process of photosynthesis. **(K1, K2, K5)**<br>**CO4.** Comprehend on the diverse role of TCA cycle and the energy obtained on complete oxidation of glucose and fatty acid. **(K1, K2, K4, K5)**<br>**CO5.** Correlate the avenues available to metabolize the xenobiotics. (**K1, K2, K4 & K5)** |
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| Units | |
|---|---|
| **I**<br>**15 Hours** | **Thermodynamics:** principles in biology- Concept of entropy, enthalpy and free energy change. Redox systems. Redox potential and calculation of free energy. Biological oxidation – Oxidases, dehydrogenases, hydroperoxidases, oxygenases. Energy rich compounds – phosphorylated and non-phosphorylated. Creatine Phosphate shuttle, Phosphogens. |
| **II**<br>**15 Hours** | **Electron transport chain:** various complexes of ETC, Q-cycle. Inhibitors of ETC. Oxidative phosphorylation-P/O ratio, chemiosmotic theory. Mechanism of ATP synthesis - role of F0-F1 ATPase, ATP-ADP cycle. Inhibitors of oxidative phosphorylation, ionophores and protonophores. Regulation of oxidative phosphorylation. |
| **III**<br>**15 Hours** | **Light reaction:** Hills reaction, absorption of light, photochemical event. Photo ETC-cyclic and non-cyclic electron flow. Photophosphorylation-role of CF0-CF1 ATPase. Dark reaction- Calvin cycle, control of C3 pathway, and Hatch-Slack pathway (C4 pathway), Photorespiration. Synthesis and degradation of starch |
| **IV**<br>**15 Hours** | **Interconversion of major food stuffs:** Energy sources of brain, muscle, liver, kidney and adipose tissue. Amphibolic nature of Citric acid cycle. Anaplerotic reaction. Krebs cycle, Inhibitors and regulation of TCA cycle. Transport of extra mitochondrial NADH – Glycerophosphate shuttle, malate aspartate shuttle. Energetics of metabolic pathways – glycolysis, (aerobic and anaerobic), citric acid cycle, beta oxidation |
| **V**<br>**15 Hours** | **Activation of sulphate ions:** PAPS, APS, SAM and their biological role. Metabolism of xenobiotics – Phase I reactions – hydroxylation, oxidation and reduction. Phase II reactions – glucuronidation, sulphation, glutathione conjugation, acetylation and methylation. Mode of action and factors affecting the activities of xenobiotic enzymes. |
| **Reading List**<br>**(Print and Online)** | 1. https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch21/gibbs.php<br>2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7767752/#:~:text=The%20mitochondrial%20electron%20transport%20chain,cellular%20ATP%20through%20oxidative%20phosphorylation.<br>3. https://www.researchgate.net/figure/Oxidative-phosphorylation-in-mitochondrial-electron-transport-chain-ETC-and-proton_fig1_230798915<br>4. https://www.lyndhurstschools.net/userfiles/84/Classes/851/photosynthesis%20light%20&%20dark%20reactions%20ppt.pdf?id=560837 |

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| | 5. https://bajan.files.wordpress.com/2010/05/amphibolic-nature-of-krebs-cycle.pdf<br>6. https://www.sciencedirect.com/topics/medicine-and-dentistry/xenobiotic-metabolism#:~:text=Xenobiotic%20metabolism%20can%20be%20defined,more%20readily%20excreted%20hydrophilic%20metabolites |
| **Self-Study** | 1. Calculation of Keq and △ G.<br>2. Interrelationship of carbohydrate, protein, and fat metabolism-role of acetyl CoA. |
| **Recommended Texts** | 1. David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed), W.H.Freeman.<br>2. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012), Harper's Illustrated Biochemistry, (29th ed), McGraw-Hill Medical.<br>3. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.<br>4. Zubay G.L (1999) Biochemistry, (4th ed), Mc Grew-Hill.<br>5. Devlin RM (1983) Plant Physiology (4th ed), PWS publishers.<br>6. Taiz L, Zeiger E (2010), Plant Physiology (5th ed), Sinauer Associates, Inc. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
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**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)-** Check knowledge in specific or offbeat situations, Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | M | S | M | S | S | S | M | S | L | S | S | L |
| **CO 2** | S | S | S | S | S | S | S | S | S | S | S | L | S | S | L |
| **CO 3** | S | S | S | S | S | S | S | S | S | S | S | L | S | S | L |
| **CO 4** | S | M | S | M | S | M | S | S | S | L | M | L | L | M | L |
| **CO 5** | S | M | S | S | S | M | S | S | S | S | S | L | L | S | L |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Nutritional Biochemistry** | Elective | 4 | 1 | 0 | 0 | 3 | 5 | 25 | 75 | 100 |

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|---|---|
| **Course** | **GENERIC ELECTIVE-IV** |
| **Title of the Course** | **NUTRITIONAL BIOCHEMISTRY** |
| **Credits** | **3** |
| **Pre-requisites, if any** | Basic Knowledge on Food, Nutrition & Dietetics, and Metabolism of Nutrients. |
| **Course Objectives** | 1. To understand basic concepts involved in growth, health, nutrition, physiology and metabolism<br>2. To discuss the concepts and applications of nutrition in correlation with biochemistry<br>**3.** To define nutritional needs in healthy individuals and modification of diet during illness. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.** Plan a balanced diet based on an individual's energy requirement, Assess nutritional status of an individual. (K3, K4, K5)<br>**CO2.** Describe the biochemical, physiological and nutritional functions of macronutrients and their integrated role. Understand the role played by antinutritional factors. (k1 to K6)<br>**CO3.** Evaluate the functions of vitamins and minerals, and fluids and electrolyte balance in different physiological states and in sports persons. (K1 to K6)<br>**CO4.** Identify nutritional deficiency conditions, its prevention and dietary management. ((K3, K4)<br>**CO5.** Acquire knowledge about the importance of balanced diet and diet therapy. (k5, K6) |
| **Units** | |
| **I**<br>**15 Hours** | **Basic concepts of Nutrition:** Food groups and balanced diet. Novel Foods. Calorific value of foods: Direct calorimetry by Bomb calorimetry. Empty calories. Basal metabolic rate: Factors affecting BMR. SDA and physical activity. Calculation of day's energy requirement. Assessment of nutritional status. Lactose intolerance. Nutritional requirement and biochemical changes in different |

| | |
|---|---|
| | physiological states - Childhood, Adults, pregnancy, lactation, and ageing. Paleo diet and consequences. |
| **II**<br>**15 Hours** | **Elements of nutrition:** Plant and animal sources of simple and complex carbohydrates, fats and proteins and their requirement. Biological significance, deficiency of macronutrients and micronutrients. Role of dietary fibre. Protein sparing action of carbohydrates and fats. Essential amino acids. Essential fatty acids. Effects of naturally occurring food toxins, preservatives and additives on health. |
| **III**<br>**15 Hours** | **Vitamins and Minerals:** Dietary sources, biochemical functions and requirements of Vitamin B1, B2, B3, B6, B9 and Vit-C. Vitamin B complex as coenzyme. Dietary sources, biochemical functions, and requirements of calcium, phosphorus, iron, iodine, zinc and copper. |
| **IV**<br>**15 Hours** | **Malnutrition:** Diseases arising due to Protein - Calorie Malnutrition and undernutrition (Kwashiorkor and Marasmus), Prevention of malnutrition. Deficiency diseases associated with vitamin B complex, vitamin C and A, D, E & K vitamins. Mineral deficiency diseases (Calcium, Iron and Iodine) - aetiology, symptoms and dietary supplementation. Enrichment and fortification (vitamins and minerals). Rickets and osteomalasia, anemia. Paleo diet and consequences. |
| **V**<br>**15 Hours** | **Nutrition in diseases:** Dietary management during fever and infectious diseases, Jaundice, obesity, hyper acidity (Ulcer), Atherosclerosis, Hypertension, kidney diseases and diabetes in adults. |
| **Reading List (Print and Online)** | 1. https://www.jmedscindmc.com/article.asp?issn=1011-4564;year=2014;volume=34;issue=5;spage=211;epage=213;aulast=Shrivastava<br>2. https://www.researchgate.net/figure/Relationship-between-malnutrition-infection-and-immunity-Malnutrition-is-considered-the_fig1_280722727<br>3. https://en.wikipedia.org/wiki/Novel_food<br>4. https://www.chemicalsafetyfacts.org/preservatives/<br>5. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/food-enrichment |
| **Self-Study** | 1. Antabuse drugs and food.<br>2. Selection of foods and market visit, reading and understanding the food labels. |

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|---|---|
| **Recommended Texts** | 1. Srilakshmi. E. (2016) Nutrition Science, New Age International Publishers.<br>2. Mahan, Kathleen L. (2004) Krause's Food, Nutrition and Diet Therapy, W.B.Saunder's 11th Edition.<br>3. Andreas M. Papas (1998). Antioxidant Status, Diet, Nutrition, and Health (1st ed) CRC Press.<br>4. M. Swaminathan (1995) Principles of Nutrition and Dietetics. Bappco.<br>5. Margaret Mc Williams (2012). Food Fundamentals (10th ed) Prentice Hall.<br>6. Tom Brody (1998) Nutritional Biochemistry (2nd ed). Academic Press, USA. |

**Methods of assessment:**

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**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.
**Analyse (K4) –** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons
**Create(K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | S | S | S | S | S | M | M | S | L | L | L | M |
| **CO 2** | S | S | S | S | S | S | S | S | M | M | S | L | S | L | M |
| **CO 3** | S | S | S | S | S | S | S | S | M | M | S | L | L | M | M |
| **CO 4** | S | S | S | S | S | S | S | S | M | L | S | L | L | L | L |
| **CO 5** | S | S | S | S | S | S | S | S | M | M | S | L | L | M | L |

**S-Strong M-Medium L-Low**

## SEMESTER – III

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Gene Editing, Cell and Gene Therapy** | Core | 5 | 1 | 0 | 0 | 5 | 6 | 25 | 75 | 100 |

| **Course** | **CORE PAPER – VII** |
|---|---|
| **Title of the Course** | **GENE EDITING, CELL AND GENE THERAPY** |
| **Credits** | **5** |
| **Pre-requisites, if any** | The students should have a basic knowledge of genome, gene transfer techniques and gene therapy. The students are also expected to possess basic understanding about the vectors, cell culture and transgenesis. |
| **Course Objectives** | 1. To understand the role of gene editing in treating human diseases.<br>2. To emphasize the strategy and applications of gene therapy.<br>3. To inculcate knowledge on recombinant DNA technology and its applications.<br>4. To understand the wide varieties of vectors and their features in addition to their applications.<br>5. To educate about the characteristics of cell culture, therapeutic strategies in gene therapy and transgenesis. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.** Know about the various gene editing techniques and the applications of gene editing in treating human diseases (K1, & K2)<br>**CO2.** Explore about the wide variety of applicable gene delivery vectors, gene therapy strategies and immune therapy. (K1, K2 & K5)<br>**CO3.** Know about the various cloning vectors employed in gene cloning technology and also to understand the methods of selection and screening of recombinants. (K2, K3 & K4)<br>**CO4.** Understand the principle, procedure and applications of animal cell culture and plant tissue culture techniques. (K2, K4 & K5)<br>**CO5.** Explain the basic principles and methodology of producing transgenic animals and transgenic plants with their applications. (K2, K5 & K6) |
| | |

| Units | |
|---|---|
| **I**<br>**15 Hours** | **Gene Editing:** Basics of gene editing, DNA repair mechanisms, Double strand DNA breaks, Nonhomologous End-Joining (NHEJ), Homology directed repair, Programmable nucleases for gene editing, Meganucleases, Zinc-Finger nucleases, Transcription Activator-Like Effector Nucleases (TALEN), CRISPR-Cas systems, gene editing using CRISPR-Cas, gene editing for human disease therapy. |
| **II**<br>**15 Hours** | **Gene and Cell Therapy**: Basics of Gene and cell therapy, types of gene therapy, gene therapy strategies. Non-viral and viral vectors for gene therapy: Physical methods of gene delivery- Polymer, Lipid and inorganic material based chemical systems for gene delivery. Viral vectors- Lentiviral, adenoviral and vaccinia vectors for gene delivery. Therapeutic targets for gene therapy, delivery systems, cell targeting. Immunological response to the therapy. Gene therapy applications- Gene therapy for SCID, cancer and thalassemia. Ethical and issues concerns about gene and cell therapy. |
| **III**<br>**15 Hours** | **Cloning Strategies:** Cloning vectors – pUC 18, phage λ, cosmid, shuttle vectors, expression vectors and YAC vector. Cutting DNA molecules- Restriction endonucleases. Joining DNA molecules – DNA ligase, linkers, adaptors and homopolymer tailing. Selection of recombinants and screening – genetic methods, immuno chemical methods, South-Western screening, colony hybridization methods. Production of insulin and growth hormone in *E. coli*. |
| **IV**<br>**15 Hours** | **Genetic Engineering in Animals:** Animal cell culture - Media, primary culture, contamination, disaggregation, sub culturing. Introduction of genes into animal cells**:** Reporter genes, selectable markers. Viral vectors– SV 40, retroviruses, baculovirus and adenoviruses. Transferring genes into animal cells in culture, oocytes, eggs, embryos and specific tissues. Applications of transgenic animals. Creation of knock out mice. Expression of foreign DNA in transgenic mice. |
| **V**<br>**15 Hours** | **Genetic Engineering in Plants:** Plant tissue culture - Media, callus and organogenesis. Protoplast cultures-Isolation of protoplast, protoplast culture and regeneration, prototoplast fusion. Micropropagation. Somatic embyrogenesis, Somaclonal variation. Plant based vectors - Ti and Ri plasmids. Agrobacterium mediated gene transfer to plant cells, microprojectiles and electroporation. Transgenic plant technology for pest resistance, herbicide tolerance, delay of fruit ripening and use of plants to produce commercially important proteins. Consequences of Plant Engineering and Use of Hybrid Varieties. |
| **Reading List (Print and Online)** | 1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5131771/<br>2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3648974/<br>3. https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/66/2019/et/MCB |

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| | %20Mooc%205%20Module%2035%20Academic%20script20033 1121203033636.pdf<br>4. https://www.nature.com/scitable/knowledge/library/transgenic-animals-in-agriculture-105646080/<br>5. https://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732/ |
| **Self-Study** | 1. Applications of gene editing strategies.<br>2. Applications of transgenic animals. |
| **Recommended Texts** | 1. An Introduction to Human Molecular Genetics (2nd Edition), J.J. Pasternak, 2005<br>2. An Introduction to Molecular Medicine and Gene Therapy 1st Edition by Thomas F. Kresina Upadhyay, S. K. (Ed.). (2021).<br>3. Human Molecular Genetics (4th Edition), Tom Strachan & Andrew Read, 2010.<br>4. Dubey R C, A Textbook of Biotechnology ($5^{th}$ ed), S Chand and Company Limited, 2022.<br>5. Sandy B. Primrose and Richard M. Twyman (2002). Principles of Gene Manipulation($6^{th}$ ed), Wiley-Blackwell.<br>6. Satyanarayana U (2008). Biotechnology, Books & Allied (P) Ltd.<br>7. Brown TA, (2010). Gene Cloning and DNA Analysis ($6^{th}$ ed), Wiley-Blackwell<br>8. Green MR and Sambrook J (2012). Molecular Cloning: A Lab Manual($4^{th}$ ed), Cold Spring Harbor Laboratory Press |

**Methods of assessment:**

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**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, Observe, Explain.
**Analyse (K4)-** Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)**- Check knowledge in specific or offbeat situations, Discussion, Debating, Presentation

**Mapping with Programme Outcomes:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | L | M | S | M | M | M | M | M | M | S | M | S | S | M |
| **CO 2** | S | S | S | S | M | M | M | M | M | S | S | S | M | S | S |
| **CO 3** | S | M | S | S | M | S | S | S | S | S | S | M | S | M | M |
| **CO 4** | S | L | M | M | M | M | S | M | M | S | S | S | S | S | S |
| **CO 5** | S | S | S | S | S | S | S | S | S | S | S | S | M | S | M |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Biostatistics and Data Science** | Core | 5 | 1 | 0 | 0 | 5 | 6 | 25 | 75 | 100 |

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|---|---|
| **Course** | **CORE PAPER –VIII** |
| **Title of the Course** | **BIOSTATISTICS AND DATA SCIENCE** |
| **Credits** | **5** |
| **Pre-requisites, if any** | Basic knowledge of Statistics and Computer Applications. |
| **Course Objectives** | 1. To summarize the data and to obtain its salient features from the vast mass of original data.<br>2. To understand the concept of various measures of dispersion.<br>3. To understand the concepts of sampling and learning test of significance.<br>4. To understand the concept of various attributes and relate to biological studies.<br>5. To gain knowledge in SPSS, a software package which gives a perfect graphical representation and appropriate result for the data that has been entered |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1:** Concepts of statistical population and sample, variables and attributes. Tabular and graphical representation of data based on variables. (K1, K2, K3)<br>**CO2:** Conditions for the consistency' and criteria for the independence of data based on attributes. Measures of central tendency, Dispersion, Skewness and Kurtosis. (K1, K2, K3)<br>**CO3**: Learning different sampling methods and analysing statistical significance. (K1, K2, K3, K4)<br>**CO4:** Understanding students t test, ANOVA, Chi square test to analyse the significance of various research. (K1, K2, K3, K4)<br>**CO5:** Learning on data science, algorithm for machine learning, artificial intelligence and big data, their applications in clinical and pharma domain. (K1, K2, K3, K4, K6) |
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| Units | |
|---|---|
| **I**<br>**15 Hours** | **Nature of biological and clinical experiments:** Collection of data in experiment- Primary and secondary data. Methods of data collection. Classification and tabulation. Different forms of diagrams and graphs related to biological studies. Measures of Averages- Mean, Median, and mode. Use of these measures in biological studies. |
| **II**<br>**15 Hours** | **Measures of Dispersion for biological characters:** Quartile deviation, Mean deviation, Standard deviation and coefficient of variation. Measures of skewness and kurtosis. Correlation and regression – Rank correlation – Regression equation. Simple problems based on biochemical data. |
| **III**<br>**15 Hours** | **Basic concepts of sampling:** Simple random sample stratified sample and systemic sampling. Sampling distribution and standard error. Test of significance based on large samples. Test for mean, difference of means, proportions and equality of proportions. |
| **IV**<br>**15 Hours** | **Small sample tests:** Students't' test for mean, difference of two way means, tests for correlation and regression coefficients. Chi-square test for goodness of a non-independence of attributes. F test for equality of variances. ANOVA- one way and two way. Basic concept related to biological studies |
| **V**<br>**15 Hours** | **Data Science:** Introduction to Data Science, Definition of data science, importance, and basic applications, Machine Learning Algorithms, Deep Learning, Artificial Neural Networks and their Application, Artificial Intelligence (AI), Data Visualization, Data Analysis, Optimization Techniques, Big Data, Predictive Analysis. Application of AI in medical, health and pharma industries. |
| **Reading List (Print and Online)** | 1. https://www.ibm.com/docs/en/SSLVMB_28.0.0/pdf/Accessibility.pdf<br>2. https://pure.tue.nl/ws/portalfiles/portal/19478370/20160419_CO_Mzolo.pdf<br>3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5453888/<br>4. https://home.ubalt.edu/ntsbarsh/excel/excel.htm<br>5. https://students.shu.ac.uk/lits/it/documents/pdf/analysing_data_using_spss.pdf<br>6. https://www.ibm.com/support/pages/ibm-spss-statistics-28-documentation |
| **Self-Study** | 1.Simple problems on probability, theoretical distributions, hypothesis testing.<br>2. Relationship between mean, median and mode pros and cons of the measures of central tendency and deviation. |
| **Recommended Texts** | 1. Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition.<br>2. Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to |

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| | Biostatistics", 2nd edition, Prestographik, Vellore, India.<br>3. Warren,J; Gregory,E; Grant,R (2004), "Statistical Methods in Bioinformatics",1st edition, Springer.<br>4. Milton,J.S.(1992),. "Statistical methods in the Biological and Health Sciences", 2nd edition, Mc Graw Hill.<br>5. Rosner,B (2005), "Fundamentals of Biostatistics", Duxbury Press.<br>6. Introducing Data Science, Davy Cielen, Anro DB Meysman, Mohamed Ali. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.
**Analyse (K4) -** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6) -** Check knowledge in specific or off beat situations, Discussion, Presentations.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | S | M | S | L | S | S | S | S | L | M | M | L |
| **CO 2** | S | S | S | S | M | S | L | S | S | S | S | L | M | S | L |
| **CO 3** | S | S | S | S | S | S | M | S | S | S | S | L | M | S | M |
| **CO 4** | S | S | S | S | S | S | M | S | S | S | S | M | M | M | S |
| **CO 5** | S | S | S | S | S | S | M | S | S | S | S | M | M | M | S |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Laboratory Course on Clinical Biochemistry** | Core | 0 | 1 | 5 | 0 | 4 | 6 | 40 | 60 | 100 |

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|---|---|
| **Course** | **CORE PAPER – IX** |
| **Title of the Course** | **LABORATORY COURSE ON CLINICAL BIOCHEMISTRY** |
| **Credits** | **4** |
| **Pre-requisites, if any** | Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions. |
| **Course Objectives** | 1. To instill skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the investigation of biological samples, clinical approach, normal values of biochemical constituents and clinical interpretations.<br>2. To inculcate the knowledge of collection, preservation of blood sample and learning various hematological parameters and their significance.<br>3. To perform experiments to assess liver functions. And also, to study the marker enzymes of liver.<br>4. To evaluate lipid profile and assess their relation to cardiac function.<br>5. To perform experiments to estimate blood glucose and glycosylated hemoglobin.<br>6. To perform urine analysis, estimate BUN and clearance test to assess renal function.<br>7. To learn basic immuno technniques antigen –antibody reactions.<br>8. To perform data interpretation.<br>9. To introduce visit to hospital so that students may be aware of Phleobotomy, Collection and storage of specimen, good laboratory practices, Automation and current methods adopted in the diagnostic labs. |

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| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.** Acquire knowledge and skill in hematology techniques. They will get familiar with methods and knowledge to interpret the electrolyte concentration in serum. (K1, K2, K3, K4, K5)<br>**CO2.** The student will be able to assess the Liver Function and interpret the biochemical investigation in a given clinical situation. (K1, K2, K3, K4, K5)<br>**CO3**. Perform the Renal function test to assess the function of Kidney and report the abnormal parameters with reference range will be achieved by the student. (K1, K2, K3, K4, K5)<br>**CO4**. Estimate the blood glucose content and lipid profile and to evaluate the alterations and record the observation in accordance to reference range will be acquired by the student. (K1, K2, K3, K4, K5, K6)<br>**CO5:** Acquire practical skills to work in health care sector and assist them to understand the automation process in clinical labs through group experiments. (K1, K2, K3, K4, K5, K6) |
| **Units** | |
| **I**<br>**18 Hours** | **Haematology:** RBC count, WBC count – total and differential count, ESR, PCV, MCV. Bleeding Time, Clotting Time and Estimation of hemoglobin. Determination of Electrolytes: Sodium, Potasium and Calcium. |
| **II**<br>**18 Hours** | **Liver function test:** Estimation of bilirubin – direct and indirect. Estimation of plasma protein, A/G ratio, Thymol turbidity test, Assay of serum glutamate oxaloacetate transaminase, alkaline phosphatase, Gamma-glutamyltransferase (GGT), isoenzyme separation of LDH by electrophoresis. |
| **III**<br>**18 Hours** | **Renal function test:** Collection and Preservation of Urine sample Qualitative tests for normal and pathological components of urine. BUN: Estimation of blood Urea, creatinine, and uric acid. Urea Clearance test. |
| **IV**<br>**18 Hours** | **Blood Glucose Estimation:** Estimation of blood glucose by orthotoluidine and glucose oxidase method. Determination of glycosylated Hb. Glucose tolerance test Kit method.<br>**Lipid profile:** Estimation of cholesterol by Zak's method, lipoprotein profile, estimation of ketone bodies, estimation of triglycerides, free fatty acids and phospholipids. |
| **V**<br>**18 Hours** | **Group Experiments**<br>a. Antigen – Antibody Reaction - HCG kit method, RA kit method.<br>b. Phlebotomy –Venipuncture, Different techniques of venipuncture.<br>c. Collection of blood, Serum or Plasma separation and Storage.<br>d. Automation in Clinical Biochemistry – Semiautoanalyser |

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| **Reading List (Print and Online)** | 1. https://www.researchgate.net/publication/260182512_ Practical_Manual_in_Biochemistry_and_Clinical_Biochemistry<br>2. https://main.icmr.nic.in/sites/default/files/upload_documents/ GCLP_Guidelines_2020_Final.pdfhttps://www.westgard.com/clia.html<br>3. https://www.researchgate.net/publication/263929434_Biochemistry<br>4. https://ucms.ac.in/Lectures-C-2020/Renal%20function%20Tests%20-%20PPT.pdf<br>5. https://youtu.be/i2PfjEks4GQ<br>6. https://www.euro.who.int/__data/assets/pdf_file/0005/268790/WHO-guidelines-on-drawing-blood-best-practices-in-phlebotomy-Eng.pdf |
| **Self-Study** | 1. Laboratory handling of human biological specimen.<br>2. Automation in Clinical Biochemistry. |
| **Recommended Texts** | 1 Practical Clinical Biochemistry- Varley's by Alan H Gowenlock, published by CBS Publishers and distributors, India Sixth Edition ,1988.<br>2. Manipal Manual of Clinical Biochemistry (For Med.Lab.And Msc Stud.) 2013 (4 Edition ).<br>3. Case Oriented Approach in Biochemistry-Dr. Rajesh Kawaduji Jambhulkar, Dr. Abhijit D. Ninghot: 2019 First Edition .<br>4. Medical Lab Technology Vol I& II, Kanai L Mukerjee New Delhi: Tata Mcgraw Hill Publishing Company, 1996.<br>5. Practical Biochemistry – Plummer, New Delhi: Tata Mcgraw Hill Publishing Company, 2000.<br>6. Introductory practical Biochemistry – S.K. Sawhney, Randhir Singh, 2nd ed, 2005. |

**Methods of assessment:**

**Recall (K1)** - Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2)** - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.
**Application (K3)** - Suggest idea/concept with examples, Solve problems, Observe, Explain.
**Analyse (K4)** – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5)** - Longer essay/ Evaluation essay, Critique or justify with pros and cons
**Create(K6)** – Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | S | M | S | L | S | M | S | L | S | M | L | S |
| **CO 2** | S | S | S | S | M | S | L | S | M | S | L | S | S | M | S |
| **CO 3** | S | S | S | S | M | S | M | S | M | S | L | S | L | M | S |
| **CO 4** | S | S | S | S | M | S | M | S | S | S | L | S | L | L | S |
| **CO 5** | S | S | S | S | S | S | S | S | S | S | L | S | M | L | S |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Pharmaceutical Biochemistry** | Core Industry Module | 4 | 1 | 0 | 0 | 3 | 5 | 25 | 75 | 100 |

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| **Course** | **CORE INDUSTRY MODULE** |
| **Title of the Course** | **PHARMACEUTICAL BIOCHEMISTRY** |
| **Credits** | **3** |
| **Pre-requisites, if any** | The student should have a basic knowledge of drug discovery and development. Student should possess basic knowledge bioinformatics to understand and correlate the drug development process. |
| **Course Objectives** | 1. To understand the different types of bioinformatic tools for drug discovery.<br>2. To get an overview of how different bioinformatic tools aid in the process of target identification, drug screening and quantitative structure activity relationship.<br>3. To assimilate the involvement of different metabolic pathways involved in drug metabolism and correlate their involvement in elimination process<br>4. To understand the biochemical basis of drug action at the target tissue.<br>5. To understand different phases in drug clinical trials and its assessment. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.** To understand and explain the basic concepts of drug discovery and drug development process.<br>**CO2.** To review the different software and computational tools which aid in the design of drugs and its rationalization.<br>**CO3.** To analyze the different stages of the drug discovery process with the target & hit identification, assays for drug screening and preclinical studies.<br>**CO4.** To identify the mode of actions of drugs<br>**CO5.** To understand the various phases of the clinical trails and the method of conduct of clinical trials. |
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| Units | |
|---|---|
| **I**<br>**15 Hours** | **Drug discovery and development:** Overview, drug target identification and validation, Hit identification, General principles of screening, correlations between various animal models and human situations, Special emphasis on cell-based assay, biochemical assay, radiological binding assay, Pharmacological assay, In vitro, In vivo and Ex-vivo experiments, lead optimization. |
| **II**<br>**15 Hours** | **Computer Aided Drug Design (CADD):** Identification of target in pathogen, Identification of potential molecules (ligands), chemical compound library preparation, High throughput virtual screening, Pharmacophore development, Quantitative structure activity relationship - 3D-QSAR, Molecular docking - Ligand and protein preparation, Binding free energy estimation, and validation of results, Pharmacokinetics and Pharmacodynamics - ADME and toxicity prediction, Molecular dynamic simulation, Drug likeliness - Lipinski rule. |
| **III**<br>**15 Hours** | **Drug metabolism:** Drug-receptor theories and drug action, Xenobiotics, xenobiotics phases (Phase-I, Phase-II and Phase-III), role of cytochrome P450 oxidases and glutathione S-transferases in drug metabolism, factors affecting drug metabolism, Enzymes as a drug target, Kinase inhibitors, ATPase inhibitors, Protein-drug and DNA-drug interaction. Receptor Pharmacology - agonist, antagonist, partial agonist, inverse agonist. Forces involved in drug-receptor complexes. Receptor classification – the four super families. Receptor binding assays- measurement of Kd, Bmax, and $IC_{50}$. |
| **IV**<br>**15 Hours** | **Drugs:** Biochemical mode of action of antibiotics - penicillin and chloramphenicol, antiviral and antimalarial substances. Biochemical mechanism of drug resistance - sulphonamides. Drug affinity and drug efficacy. General principles of chemotherapy: chemotherapy of parasitic infections, fungal infections, viral diseases. Introduction to immunomodulators and chemotherapy of cancer. |
| **V**<br>**15 Hours** | **Clinical Drug Development:** History of Ethical Medical Research, Regulations of Medical Research, Preclinical Development, Clinical Development - Main features of clinical trials, design, sample size and assessment of clinical trials, Phase-I Clinical trials, Phase-II Clinical trials, Phase-III Clinical trials and Phase-IV clinical trials. |
| **Self-Study** | 1. Examples of pharmaceutical development of a drug.<br>2. Basic pharmacology of drug action and kinetics. |
| **Reading List (Print and Online)** | 1. Textbook of Drug Design. Krogsgaard - Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002.<br>2. Drug Discovery Handbook S.C. Gad (Editor) Wiley-Inter science |

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| | Hoboken USA, 2005.<br>3. Umscheid CA, Margolis DJ, Grossman CE. Key concepts of clinical trials: a narrative review. Postgrad Med. 2011 Sep;123(5):194-204. doi: 10.3810/pgm.2011.09.2475. PMID: 21904102; PMCID: PMC3272827.<br>4. Kandi V, Vadakedath S (February 16, 2023) Clinical Trials and Clinical Research: A Comprehensive Review. Cureus 15(2): e35077. doi:10.7759/cureus.35077. |
| **Recommended Texts** | 1. Drug Discovery and Development; Technology in Transition. HP Rang. Elsevier Ltd 1st edition 2006.<br>2. Pharmacology in Drug Discovery. T. P. Kenakin. Elsevier, 1st Edition 2012.<br>3. Drug Discovery and Development - Vol 1, Drug Discovery, M. Chorghade, Wiley and Sons Inc., 1st edition 2006.<br>4. Color atlas of pharmacology, Heinz Luellmann Klaus, Mohr Lutz Hein, Detlef Bieger, Thieme, 3rd edition, 2005.<br>5. Practice of medicinal chemistry, Camille Georges Wermuth, Academic Press, 3rd edition, 2003.<br>6. Foye's Principles of Medicinal Chemistry, Thomas Lemke, David A. Williams, Lippincott Williams and Wilkins, 7th edition, 2012.<br>7. Medicinal Chemistry, Gareth Thomas, Wiley-Interscience, 2nd edition, 2008.<br>8. Computational Drug Design, D. C. Young, Wiley Interscience. 1st edition, 2009.<br>9. Drug Discovery and Evaluation, Hans Gerhard Vogel, Hans Gerhard Vogel, Springer Berlin Heidelberg, 3rd edition, 2008. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Shortsummary or overview.
**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.
**Analyse (K4) –** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons
**Create(K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | M | S | M | S | M | M | S | S | S | S | L | M | M | M |
| **CO 2** | S | S | S | M | M | S | S | S | S | S | S | L | M | M | M |
| **CO 3** | S | S | S | L | S | M | M | S | S | M | S | L | S | M | M |
| **CO 4** | S | M | S | L | S | L | M | S | S | M | S | L | M | M | S |
| **CO 5** | S | S | S | L | S | M | M | S | S | S | S | L | S | M | S |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Molecular Basis of Diseases and Therapeutics Strategies** | Elective | 4 | 1 | 0 | 0 | 3 | 5 | 25 | 75 | 100 |

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| **Course** | **DISCIPLINE CENTRIC ELECTIVE PAPER - V** |
| **Title of the Course** | **MOLECULAR BASIS OF DISEASES AND THERAPEUTIC STRATEGIES** |
| **Credits** | **3** |
| **Pre-requisites, if any** | Knowledge of Human Physiology, Metabolism and Clinical Biochemistry |
| **Course Objectives** | 1. To understand the concepts of the mechanisms involved in regulation of blood sugar and management of diabetes mellitus.<br>2. To gain in-depth knowledge of the mechanisms of cancer and of tumor metastasis.<br>3. The student will review the basic organization of the central and peripheral nervous system that coordinate the sensory and motor functions of the body. In addition, the student will explore impaired features underlying the major neuropathological complications.<br>4. To gain knowledge in renal diseases.<br>5. To understand the mechanisms involved in cardiac disorders. |
| **Course Outcomes** | **On completion of this course the student will be able to understand:**<br>**CO1.**Overall view about the complications of diabetes mellitus and its management.<br>**CO2.**Comprehensive understanding of the concepts of cancer biology and implicating the theoretical concepts for further research<br>**CO3**.Understand and appreciate the pathophysiology of conditions affecting the nervous system.<br>**CO4**.A thorough knowledge of renal and cardiac diseases with emphasis related to mechanistic aspects and therapeutic interventions.<br>**CO5.** A thorough knowledge on the experimental models of non-communicable diseases that will be applied for future research or project dissertation. An in-depth knowledge on development of drugs against non-communicable diseases. |
| | |

| Units | |
|---|---|
| **I**<br>**15 Hours** | **Diabetes:** Type I and Type II diabetes, types, causes, biochemical manifestations, diagnosis and treatment. Glycated hemoglobin. Complications related to diabetes – Diabetic cardiovascular disease, retinopathy, neuropathy and nephropathy. Diagnosis by GTT. Cellular and molecular mechanism of development of diabetes, drugs for the treatment of diabetes. |
| **II**<br>**15 Hours** | **Biology of cancer:** Overview of hallmarks of cancer. Tumorigenesis, Tumor progression and mechanism of Metastasis. Proto-oncogene to oncogene. Oncogene- myc and src family. Tumor suppressor gene-Rb and p53 pathway in cancer. Diagnosis- Non-invasive imaging techniques, Tumor diagnosis, Interventional radiology, new imaging technique, Molecular techniques in cancer diagnosis. Treatment of cancer- surgery, radiotherapy, chemotherapy, hormonal treatment, and biological therapy. |
| **III**<br>**15 Hours** | **Neuronal Diseases:** Brain- neuronal network- memory- Neurogenerative diseases- Parkinson, Alzheimer Disease Dementia - molecular understanding of the neurodegenerative diseases- treatment modalities. Developmental, Biochemical and Electrical abnormalities in Central Nervous System and Peripheral Nervous System. Glioma. |
| **IV**<br>**15 Hours** | **Renal Diseases:** Acute and chronic renal failure, glomerular diseases– glomerulonephritis, nephrotic syndrome, diabetes insipidus, kidney disease - causes, biochemical manifestations, diagnosis and treatment. |
| **V**<br>**15 Hours** | **Cardiovascular Diseases:** Introduction to cardiovascular diseases, Lipids and lipoproteins in coronary heart disease-cardiac enzymes, Molecular changes during cardiac remodeling – hypertrophy of hearts – heart failure- treatment modalities. |
| **Reading List (Print and Online)** | 1. The Biochemical basis of disease:2018, **Barr AJ;** Portland Press<br>2. Biochemical Basis of Diseases<br>3. https://www.biologydiscussion.com/diseases-2/biochemical-basis-of-diseases/44276 |
| **Recommended Texts** | 1. Wills' Biochemical Basis of Medicine: 2nd edition, Thomas H, Gillham B;Elsevier<br>2. Molecular Biochemistry of Human Diseases,2021, Feuer G, de la Iglesia F; CRC Press |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Short summary or overview
**Application (K3) -** Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
**Analyse (K4) -** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | M | M | S | S | S | S | S | S | S | S | L | S |
| **CO 2** | S | M | S | L | M | M | M | M | M | S | S | S | S | S | L |
| **CO 3** | S | S | M | L | S | S | M | M | S | M | S | S | S | S | S |
| **CO 4** | S | M | M | M | M | M | S | S | M | S | S | S | S | S | S |
| **CO 5** | S | S | M | M | S | M | M | M | S | S | S | M | S | L | L |

**S-Strong M-Medium L-Low**

## SEMESTER-IV

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Clinical Biochemistry** | Core | 5 | 1 | 0 | 0 | 5 | 6 | 25 | 75 | 100 |

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| **Course** | **CORE PAPER – X** |
| **Title of the Course** | **CLINICAL BIOCHEMISTRY** |
| **Credits** | **5** |
| **Pre-requisites, if any** | The student should have a basic knowledge of body fluids and their composition and metabolism; anatomy and physiology of vital organs. |
| **Course Objectives** | 1. To understand the need and methods of various biological sample collection.<br>2. To explicitly understand the etiopathogenesis, symptoms and complications of metabolic and hormonal disorders and the relevant diagnostic markers<br>3. To emphasize the diagnostic significance of serum enzymes in different pathologies and other Laboratory investigations of diagnostic importance so as to differentiate normal from disease<br>4. To conceive the role of inherited genes in inborn errors of metabolism and methodologies pertaining to *in utero* diagnosis and post-natal screening.<br>5. To get updated about electrolyte and hormonal imbalances and the biochemical tests to diagnose them. |

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| **Course Outcomes** | **CO1.** To appreciate the biological significance of sample collection and awareness of the diagnostic/screening tests to detect common non-communicable diseases so as to understand role of laboratory investigations for biochemical parameters and understand the disorders associated with blood cells<br><br>**CO2.** To understand the etiology of metabolic diseases like diabetes and atherosclerosis and avoid such lifestyle disorders by healthy eating and correlate the symptoms with underlying pathology based on diagnostic and prognostic markers.<br><br>**CO3.** To understand the diagnostic application of serum/plasma enzymes to correlate their levels with the organ pathologies associated with specific diseases.<br><br>**CO4.** To appreciate the role of pre- and post-natal diagnosis leading to healthy progeny.<br><br>**CO5.** To link the serum hormone levels and clinical symptoms with underlying hormonal disturbances. To review the onward transmission of signal via downstream signaling molecules from cell surface to the nucleus by different pathways by comparing and contrasting them and critically evaluate the network between them resulting in the biological outcome. |
| **Units** | |
| **I**<br>**15 Hours** | **Disorders of blood cells**: Hemolytic, iron deficiency and aplasticanemia, sickle cell anaemia and thalassemia. Porphyrias, Thrombocytopenia, Causes of leucopenia and leukemia. Disorders of blood clotting mechanism - Von willebrand's disease, Hemophilia A, B and C, diagnostic test for clotting disorders, D-dimer and its clinical significance. |
| **II**<br>**15 Hours** | **Renal function tests**: Tests for glomerular and tubular function - inulin, urea and creatinine clearance tests. Concentration and dilution tests. Phenol red test. Urinary calculi - Nephrolithiasis - causes, pathology and symptoms. Dialysis- Hemodialysis and peritoneal dialysis. |
| **III**<br>**15 Hours** | **Pre- and post-natal testing:** Amniocentesis, prenatal detection of inborn errors of metabolism in developing fetus- Autosomal recessive mode of inheritance - cystic fibrosis, X linked recessive inheritance-Duchenne muscular dystrophy. New born screening (NBS) for in born errors of metabolism, Tandem mass spectrometry application in NBS. |

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| **IV**<br>**15 Hours** | **Liver function tests:** Liver function tests based on bilepigments, metabolism, enzymes, excretion and detoxification. Jaundice - classification, pathology and differential diagnosis. Plasma protein changes in liver diseases. Hepatitis A, B and C. Gall stones – types, pathogenisis, diagnosis and treatment. Cirrhosis and fibrosis. |
| **V**<br>**15 Hours** | **Hormonal disorders**: Causes and pathology of thyroid disorders - Hypothyroidism and Hyperthyroidism - Diagnostic methods. Disorders associated with adrenal, pituitary and sex hormones - Addison's disease, Cushing's syndrome, pituitary tumour, Hypopituitarism, Hypogonadism - Causes, pathology, symptoms and diagnosis. |
| **Reading List (Print and Online)** | 1.**Utility of HIL in Clinical Chemistry:**<br>https://www.aacc.org/science-and-research/clinical-chemistry-trainee-council/trainee-council-in-english/pearls-of-laboratory-medicine/2018/utility-of-hil-in-clinical-chemistry<br>**Post and Analytical Errors in Clinical Chemistry laboratory**<br>DOI: 10.7860/NJLM/2016/22587:2173<br>https://doi.org/10.2147/JMDH.S286679<br>3. **Standards of Medical Care in Diabetes—2022 Abridged for Primary Care Providers**<br>https://diabetesjournals.org/clinical/article/40/1/10/139035/Standards-of-Medical-Care-in-Diabetes-2022<br>https://doi.org/10.2337/diaspect.16.1.32<br>http://www.ngsp.org/<br>4. Quality control in clinical laboratory<br>https://www.researchgate.net/publication/335830829_Quality_Control_in_a_Clinical_Laboratory<br>https://labpedia.net/quality-control-of-the-clinical-laboratory/<br>https://journals.sagepub.com/doi/full/10.1016/j.jala.2008.12.001<br>https://doi.org/10.1016/B978-0-12-407821-5.00004-8<br>https://www.westgard.com/clia.htm<br>https://www.labroots.com/webinar/bio-rad-unity-solution-molecular-quality-control-data-management |
| **Self-Study** | **1. Potential sources of variability in the estimation of the analytes:**<br>Pre-analytical phase: acceptance rejection criteria in terms of haemolysis/icteric/lipemia (HIL) interferences.<br>Analytical phase: Linearity, detection limits precision, accuracy, specificity, sensitivity; Total Allowable Error. (Definitions and examples).<br>Post-analytical phase: Units of reporting of clinical chemistry parameters. |

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| | **2. Interpretation of results in clinical chemistry based on laboratory investigations and quality control:**<br>1.critical / alert values<br>2.American Diabetes Association (ADA) Standards of Medical Care in Diabetes (yearly update); HBA1C testing: NGSP<br>3.Case studies to review<br>4.Quality control for clinical chemistry in laboratory |
| **Recommended Texts** | 1. Thomas M. Devlin (2014) Textbook of Biochemistry with Clinical Correlations (7th ed). John Wiley & Sons.<br>2. Montgomery R, Conway TW, Spector AA (1996), Biochemistry: A Case-Oriented Approach (6th ed), Mosby Publishers, USA.<br>3. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (2018) (8th ed), Saunders.<br>4. Dinesh Puri, (2020) Text book of Biochemistry: A clinically oriented approach – 4th Edition, Elsevier.<br>5. M.N.Chatterjee and Rana Shinde (2012).Textbook of Medical Biochemistry (8th ed), Jaypee Brothers Medical Publishers.<br>6. Clinical Case Discussion in Biochemistry A Book on Early Clinical Exposure (ECE), Poonam Agrawal, 2021, CBS Publishers & distributors pvt. Ltd. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, Observe, Explain.
**Analyse (K4)-** Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)**- Check knowledge in specific or offbeat situations, Discussion, Debating, Presentation

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | M | S | S | S | S | M | M | S | M | S | L | S | S |
| **CO 2** | S | M | S | M | S | S | S | M | M | M | S | S | M | S | S |
| **CO 3** | S | S | S | S | S | M | S | S | M | M | S | M | M | S | S |
| **CO 4** | S | M | M | M | S | M | S | S | S | M | S | S | L | M | S |
| **CO 5** | S | M | S | M | S | S | S | S | S | S | M | S | L | M | S |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Molecular Biology** | Core | 5 | 1 | 0 | 0 | 5 | 6 | 25 | 75 | 100 |

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| **Course** | **CORE PAPER –XI** |
| **Title of the Course** | **MOLECULAR BIOLOGY** |
| **Credits** | 5 |
| **Pre-requisites, if any** | Knowledge of the basics of genetics, cell biology and molecular biology. |
| **Course Objectives** | 1. To introduce the students to the process of inheritance, concepts of genes, genome, chromatin and chromosomes.<br>2. To impart a thorough understanding of the key events of molecular biology, including the mechanisms of DNA replication, transcription and translation along with DNA repair mechanisms.<br>3. To provide a detailed understanding of Co-transcriptional and posttranslational modifications and processing of eukaryotic RNA and proteins.<br>4. To give a detailed explanation of transcriptional regulation with lac operon and tryptophan operon as examples.<br>5. To impart adequate information of the types of regulatory RNAs along with key concepts of gene silencing. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1:** Comprehend the organization of genomes, the molecular basis of DNA replication, recombination and transposition, the significance of these processes, the various ways in which the DNA can be damaged leading to mutations and lesions and the different ways in which they are repaired. (K1, K2, K3, K5)<br>**CO2:** Gain knowledge about how genes are transcribed and translated in eukaryotes and how these processes are regulated, recognize the nature of the genetic code and the various experimental approaches used to crack the code. (K1, K2, K3, K4, K5)<br>**CO3:** Acquire knowledge of the molecular basis of RNA processing and RNA splicing and the various human pathologies that can result from. (K1, K2, K4, K5)<br>**CO4:** Comprehend the techniques of regulations. (K1, K2, K3, K4, K5, |

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| | K6)<br>**CO5:** Apply the knowledge they have gained in understanding the above vital life processes to enhancing their analytical and problem-solving skills and develop an interest to pursue high quality research. (K2, K3, K4, K5, K6) |
| **Units** | |
| **I**<br>**15 Hours** | **Mendel's laws of inheritance:** Dominance-complete, incomplete and co-dominance, multiple alleles-gene mapping in haploids and diploids, modes of gene information transfer in bacteria- conjugation, transformation and transduction. Eukaryotic genome- chromosome structure – Histones, Nucleosome, chromatin- heterochromatin, euchromatin. Genome organization – gene amplification, telomerase, pseudogenes, split genes. organelle genomes – mitochondrial and chloroplast genome. Epigenetic variations and epigenetic regulation of genes |
| **II**<br>**15 Hours** | **DNA replication and repair:** Enzymes of replication, eukaryotic DNA replication, the role of topoisomerases and telomerase, regulation of replication. Mutations -Types of mutations, mechanisms of mutations, mutagenic agents. DNA repair mechanisms – Direct repair, excision repair, mismatch repair, recombination repair, SOS repair. |
| **III**<br>**15 Hours** | **Transcription:** Eukaryotic transcription- Initiation, promoter elements, RNA polymerases, transcription factors, regulatory sequences in eukaryotic protein – coding genes, CpG islands, enhancers.<br>**Translation:** organization of the ribosome, the genetic code, evidence for a triplet code, deciphering the genetic code, wobble hypothesis, deviation in the genetic code, unusual codons. Eukaryotic Translation Process-activation, initiation, elongation and termination of translation. The role of tRNA and rRNA, suppressor tRNAs and inhibitors of protein synthesis. |
| **IV**<br>**15 Hours** | **Regulation of gene expression:** Positive and negative control, the lac operon, identification of operator and regulator sequences by mutations, induction and repression. Catabolite repression. *Trp* operon – Attenuation, alternative secondary structures of *trp* mRNA. Response elements, DNA-binding motifs, steroid receptors, association of methylation and histone acetylation with gene expression. |
| **V**<br>**15 Hours** | **Post/Co transcriptional modifications in eukaryotes:** RNA processing-mRNA 5' capping and 3'poly-adenylation, introns and exons, RNA splicing - spliceosome assembly, alternative splicing, processing of tRNA and rRNA, self-splicing, ribozymes, RNA editing- substitution and insertion/deletion editing. Protein sorting – signal peptides, transport of secretory proteins, Golgi and post-golgi sorting, coated vesicles, targeting of lysosomal and nuclear proteins, Protein Degradation-Ubiquitination of proteins, Protein folding-chaperones |

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| **Reading List (Print and Online)** | 1. Molecular Biology Free Online Course by MIT Part 3: RNA Uploaded by edX<br>2. https://mooc.es/course/molecular-biology/<br>3. https://onlinecourses.swayam2.ac.in/cec20_ma13/preview<br>4. https://learn.genetics.utah.edu/<br>5. https://www.cellbio.com/education.html<br>6. https://lifescienceinteractive.com/category/molecular-biology/ |
| **Self-Study** | 1. Multiple roles of noncoding RNAs (long ncRNA, siRNA and miRNA) in development and differentiation; implication of ncRNAs in pathologies.<br>2. mRNA degradation- nonsense-mediated decay. |
| **Recommended Texts** | 1.Lewin's Genes XII: 12th edition, Krebs JE, Goldstein ES, Kilpatrick ST; Prentice Hall, Delhi.<br>2.Molecular Biology of the Gene: 6th edition, Watson JD, Baker TA, Bell S, Gann A, Levine M, Losick R; Cold Spring Harbor Laboratory Press, New York.<br>3.Essential Cell Biology :3rd edition, Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P; Garland Science, New York.<br>4.Molecular Cell Biology: 8th edition, Lodish H, Arnold Berk; W.H.Freeman & Co, New York.<br>5.Karp's Cell and Molecular Biology: Concepts and Experiments, 8th Edition; Wiley, India.<br>6.An Introduction to Genetic Analysis 12th edition, Griffith A. F, Doebley J, Peichel C, David A, Wassarman DA; Albion Press.W.H.Freeman & Co ,New York. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.
**Analyse (K4)-** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)**- Check knowledge in specific or offbeat situations, Discussion.

**Mapping with Programme Outcomes:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | L | M | L | S | S | S | S | S | M | S | S | S |
| **CO 2** | S | S | S | M | M | L | M | S | S | S | S | S | S | S | S |
| **CO 3** | S | S | S | L | M | L | M | S | S | S | S | S | S | S | S |
| **CO 4** | S | S | S | M | M | L | S | S | S | S | S | M | S | S | S |
| **CO 5** | S | S | S | S | S | M | M | S | S | S | S | S | S | S | S |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Hormones** | Core | 4 | 1 | 0 | 0 | 4 | 5 | 25 | 75 | 100 |

| **Course** | **CORE PAPER – XII** |
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| **Title of the Course** | **HORMONES** |
| **Credits** | 4 |
| **Pre-requisites, if any** | The student should have a basic knowledge of endocrine glands, hormones secreted by the glands and understanding on their biological actions. |
| **Course Objectives** | 1. To study the basics of endocrine system and signal transduction.<br>2. To understand the classification of hormones.<br>3. To gain knowledge on biosynthesis and regulation of hormones.<br>4. To understand about the mechanism of action of hormones.<br>5. To study the structure of hormones. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO-1:** Understand the classification, biosynthesis, regulation and mechanism of action of hormones. (K1, K2 & K4).<br>**CO-2:** Understand the various endocrine glands, their secretion and functions of various hormones. (K1, K2 & K4).<br>**CO-3:** Elucidate the biosynthesis, regulation and functions of hypothalamus and pituitary hormones. (K1, K2 & K5).<br>**CO-4:** Explain the synthesis and functions of thyroid, parathyroid, calcitriol and Calcitonin hormones. (K2, K3 & K4).<br>**CO-5:** Understand the secretion and functions of gonadal hormones, their effects in target cells. (K1, K2 & K6). |
| **Units** | |
| **I**<br><br>**15 Hours** | **Hypothalamus and Pituitary hormones:** Hormones – Classification, Biosynthesis, circulation in blood, modification and degradation. Mechanism of hormone action, Target cell concept – Feedback control and regulation. Hormones of Hypothalamus: Biological action, regulation and mechanism of action. Hormones of pituitary – Biological action, regulation and mechanism of action - Growth promoting, Lactogenic hormones. Glycoprotein hormones, POMC family, Endorphins. Vasopressin and oxytocin. |

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| **II**<br><br>**15 Hours** | **Pancreatic and Gastrointestinal hormones:** Pancreatic hormones – cell types of the islets of Langerhans. Insulin – structure, Biosynthesis, regulation of secretion, biological actions and mechanism of action. Glucagon, somatostatin - Structure, regulation of secretion, biological actions and mechanism of action. Insulin like growth factors – structure, biological action. Gastrointestinal hormones – secretin, gastrin, cholecystokinin and Motilin – biological action, regulation of secretion. |
| **III**<br><br>**15 Hours** | **Thyroid and Parathyroid hormone:** Thyroid hormones – synthesis, secretion, transport, biological action, mechanism of action and regulation. Thyroid function tests. Parathyroid hormone – synthesis, biological action, regulation of calcium and phosphorus metabolism. Calcitonin - biological action and regulation. Calcitriol – Biosynthesis, transport, functions, mechanism of action. |
| **IV**<br><br>**15 Hours** | **Adrenal hormones:** Adrenal cortex – Glucocorticoids and mineralocorticoids - synthesis, secretion, transport, biological effects, mechanisms of action, metabolism and excretion. Adrenal androgens - metabolic effects and functions. Adrenal medulla – Catecholamines-biosynthesis, storage, metabolism, regulation of synthesis. Structure and actions of adrenergic receptors. |
| **V**<br><br>**15 Hours** | **Gonadal Hormones:** Gonadal Hormones – Chemical nature, biosynthesis, metabolism and mechanism of action of androgen, estrogen and progesterone. Factors involved in the regulation of gonadal hormone activities. Hormonal changes in menstrual cycle and pregnancy. Synthetic agonists of estrogen and progesterone. |
| **Reading List (Print and Online)** | 1. https://www.news-medical.net/health/Pituitary-Gland-Hormones-and-Functions.aspx<br>2. https://pressbooks-dev.oer.hawaii.edu/anatomyandphysiology/chapter/the-pituitary-gland-and-hypothalamus/<br>3. https://www.endocrine.org/patient-engagement/endocrine-library/hormones-and-endocrine-function/thyroid-and-parathyroid-hormones<br>4. https://www.ncbi.nlm.nih.gov/books/NBK54093/<br>5. https://www.adrenal.com/adrenal-gland/function<br>6. https://collegedunia.com/exams/gonads-definition-function-and-sex-hormones-biology-articleid-1155 |
| **Self-Study** | 1. Analysis of hormone levels in biological samples.<br>2. Regulation of hormone biosynthesis. |
| **Recommended Texts** | 1. Larsen PR (2002). Williams Text Book of Endocrinology ($10^{th}$ ed), Saunders.<br>2. Wilson JD and Foster DW (1998). Williams Textbook of Endocrinology ($9^{th}$ ed), Saunders. |

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| | 3. Laycock J and Lee J (1979). Essential Endocrinology (1st ed), Oxford University Press.<br>4. Tietz (2014). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7th ed), Saunders. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, solve problems, Observe, Explain.
**Analyse (K4) –** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons
**Create(K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | L | S | L | M | M | S | S | M | M | S | L | S | M | L |
| **CO 2** | S | S | S | L | L | L | M | M | S | S | S | L | M | S | L |
| **CO 3** | M | L | M | S | L | S | S | S | L | S | S | L | S | S | S |
| **CO 4** | S | M | S | M | S | L | S | S | M | M | S | S | M | M | L |
| **CO 5** | S | M | L | L | M | M | M | M | S | S | S | L | M | M | S |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Biosafety, Lab Safety and IPR** | Elective | 4 | 1 | 0 | 0 | 3 | 5 | 25 | 75 | 100 |

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| **Course** | **ELECTIVE PAPER VI** |
| **Title of the Course** | **BIOSAFETY, LAB SAFETY AND IPR** |
| **Credits** | **3** |
| **Pre-requisites, if any** | The student should have a basic knowledge of hazards associated with the handling of biological agents and importance of intellectual property from scientific research. |
| **Course Objectives** | 1. To assimilate the hazards associated with the handling of biological and chemical agents.<br>2. To understand how to protect from the hazards by the implementation of various safety measures in biochemical laboratories.<br>3. To implicate the importance of protecting the scientific intellect by filing patent and understand the various offices for filing and maintaining patents.<br>4. To understand the scope of patenting in biological research.<br>5. To create an awareness of ethics associated with used of genetically modified organisms/cells and its rationale for use in living organisms. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1.**To understand and implement various aspects of biosafety and carry out risk assessment of products in biological research<br>**CO2. U**nderstand the basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights.<br>**CO3.** To appreciate the intellectual property rights and its implementation of on the invention related to biological research.<br>**CO4.** To understand the statutory bodies that regulate the property rights and its validity in various countries.<br>**CO5.** Critique the ethical concerns associated with modern biotechnology processes and plan accordingly. |

| Units | |
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| **I**<br>**15 Hours** | **Biosafety:** Historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; recommended biosafety levels for infectious agents and infected animals; biosafety guidelines - government of India, roles of IBSC, RCGM, GEAC. |
| **II**<br>**15 Hours** | **Laboratory safety:** Chemical, electrical and fire hazards; handling and manipulating human or animal cells and tissues, toxic, corrosive or mutagenic solvents and reagents; mouth pipetting, and inhalation exposures to infectious aerosols, Safe handling of syringe needles or other contaminated sharps, spills and splashes onto skin and mucous membranes. Health aspects; toxicology, allergenicity, antibiotic resistance. |
| **III**<br>**15 Hours** | **Intellectual Property Rights (IPR):** Introduction to patents, types of patents, process involved in patenting in India, trademarks, copyright, industrial design, trade secrets, traditional knowledge, geographical indications, WTO, GATT, Patent Cooperation Treaty (PCT) and TRIPS. Patent databases: Searching international databases; analysis and report formation. Indian Patent Act 1970; recent amendments. |
| **IV**<br>**15 Hours** | **Patent filing and infringement:** Patent application forms and guidelines, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and convention patent applications, Publication of patents-gazette of India. Research Patenting: Patenting by researchers and scientists-University/organizational rules in India and abroad. Detailed information on patenting biological products and patent infringement. |
| **V**<br>**15 Hours** | **Bioethics:** Introduction to bioethics, human genome project and its ethical issues, genetic manipulations and their ethical issues, ethical issues in GMOs, foods and crops in developed and developing countries, environmental release of GMOs, ethical issues involved in stem cell research and use, use of animals in research experiments, animal cloning, human cloning and their ethical aspects, testing of drugs on human volunteers. |
| **Self-Study** | 1. Review of drug patent documents<br>2. Safety in biological research laboratories |
| **Reading List (Print and Online)** | 1. V. Shree Krishna, (2007). Bioethics and Biosafety in Biotechnology, New Age International Pvt. Ltd. Publishers. (Unit III, Unit IV and Unit V)<br>2. Deepa Goel, Shomini Parashar, (2013). IPR, Biosafety and Bioethics, Pearson. (Unit II) |

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| | 3. R. Ian Freshney, 2016. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Ed, John Wiley & Blackwell.<br>4. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007. (Unit I) |
| **Recommended Texts** | 1. Biosafety in Microbiological and Biomedical Laboratories, (2020) 6th Ed. (https://www.cdc.gov/labs/pdf/SF__19_308133-A_BMBL6_00-BOOK-WEB-final3.pdf)<br>2. Kankanala C., (2007), Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Shortsummary or overview.
**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.
**Analyse (K4) –** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons
**Create(K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | M | S | M | S | S | S | S | M | M | L | S | S |
| **CO 2** | S | S | S | L | M | M | S | S | S | S | M | M | L | S | S |
| **CO 3** | S | M | M | M | S | M | S | S | S | M | M | M | L | S | S |
| **CO 4** | S | M | M | L | S | L | S | S | S | M | M | M | L | S | S |
| **CO 5** | S | S | S | L | S | M | S | S | S | S | S | S | S | S | S |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Industrial Microbiology** | Core | 4 | 1 | 0 | 0 | 4 | 5 | 25 | 75 | 100 |

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| **Course** | **CORE PAPER** |
| **Title of the Course** | **INDUSTRIAL MICROBIOLOGY** |
| **Credits** | **4** |
| **Pre-requisites, if any** | Basic Knowledge of Microbiology and microbial techniques. |
| **Course Objectives** | 1. To gain knowledge of the structure, classification and use of microorganisms in various industries.<br>2. To know various fermenter designs, culture systems and the application of fermentation process in industry.<br>3. To understand the production and purification of fermented products and their industrial applications.<br>4. Understand the basic concepts of food and agricultural microbiology. |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1**.Students will be able to understand the structure and classification of microorganisms (K2, K4)<br>**CO2**.Gain knowledge of the uses of microorganisms in various industrial applications (K3, K4)<br>**CO3**.Understand the concepts of fermentation process, harvest and recovery. (K1, K5)<br>**CO4**.Students will know the types of microbial fermentation processes and their applications in pharmaceutical industry. (K2, K3)<br>**CO5**.Students will learn about the use of microorganisms in beverages, diary and food industries. (K3, K6) |
| **Units** | |
| **I**<br>**15 Hours** | **Micro-organisms:** Structure of bacteria, fungi and viruses and their classification. Types and characteristics of microorganisms used in Industry (a) Food Industry (b) Chemical Industry (c) Pharmaceutical Industry |
| **II**<br>**15 Hours** | **Fermentation techniques:** Fundamentals and principles of microbial fermentation techniques – application in industry and pharmaceutical Biochemistry. Fermentation – types, techniques, design and operation of |

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| | fermenters including addition of medium. Types and characteristics of microorganisms, environmental conditions required for the growth and metabolism of industrially and pharmaceutically important microbes. Sterilization methods in fermentation techniques, air, gas, culture medium sterilization. Steam-filtration and chemicals. Types and constituents of fermentative culture medium and conditions of fermentations, Antifoaming devices. |
| **III**<br>**15 Hours** | **Recovery and estimation of products of fermentation:** Production of ethanol, acetic acid, glycerol, acetone, butanol and citric acid by fermentation. Production of Enzymes- amylase, protease, lipase,Production of pharmaceuticals by fermentation– penicillin, streptomycin, tetracycline, riboflavin, vitamin B12.Beverages-wine, beer and malt beverages. |
| **IV**<br>**15 Hours** | **Food Microbiology:** Production of dairy products-bread, cheese and yoghurt (preparation and their types). Food borne diseases- Bacterial and Non- Bacterial. Food preservation - Principles–Physical methods: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, Chemical methods - salt, sugar, organic acids, $SO_2$, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins. |
| **V**<br>**15 Hours** | **Agricultural Microbiology:** General Properties of soil, microorganisms in soil – decomposition of organic matter in soil. Biogeochemical cycles, nitrogen fixation, Production of bio fertilizers and its field applications – Rhizobium, azotobacter, blue green algae, mycorrhizae, azospirilium, Production of biofuels (biogas- methane), soil inoculants. |
| **Self-Study** | 1. Micro-organisms in food processing and pharma industries<br>2. Upstream and Downstream processes in Biopharma |
| **Reading List (Print and Online)** | Industrial biotechnology:<br>https://nptel.ac.in/courses/102/105/102105058/<br>Bioreactors:<br>https://nptel.ac.in/courses/102/106/102106053/<br>Food Microbiology:<br>https://nptel.ac.in/courses/126/103/126103017/<br>Agriculture Microbiology:<br>https://www.youtube.com/watch?v=f7UXyVImZ_c |
| **Recommended Texts** | 1. Food Microbiology: An Introduction: 4th edition, Matthews KR, Kniel KE, Montville TJ; American Society for Microbiology.<br>2. Food, Fermentation and Micro-Organisms,2nd edition, Charles, BW; Blackwell Science Ltd.<br>3. Microbiology. 5th edition, Pelczar MJ, Chan ECS and Krieg NR; McGraw Hill Book Company.<br>4. Text book of Microbiology:11th edition, Ananthanarayanan R and Paniker CKJ; Universities Press (India) Pvt. Ltd. |

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| | 5. Food Microbiology, 3rd edition, Frazier WC and Westhoff DC; Tata McGrawHill Publishing Company Ltd, New Delhi<br>6. New Methods of Food Preservation:1st edition, Gould GW; Springer Manual of Industrial Microbiology and Biotechnology**:** 3rd edition, Baltz |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.
**Analyse (K4)-** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons.
**Create (K6)-** Check knowledge in specific or offbeat situations, Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | M | S | S | S | M | M | S | S | S | M | M | M | L |
| **CO 2** | S | M | S | S | M | S | S | M | M | M | S | L | M | S | L |
| **CO 3** | S | M | L | S | M | M | S | S | M | S | S | M | M | M | M |
| **CO 4** | M | S | S | S | L | M | S | M | S | M | S | M | M | S | M |
| **CO 5** | S | S | M | S | S | M | M | S | S | S | S | M | M | S | S |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Biochemical Toxicology** | Core | 4 | 1 | 0 | 0 | 4 | 5 | 25 | 75 | 100 |

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|---|---|
| **Course** | **CORE PAPER** |
| **Title of the Course** | **BIOCHEMICAL TOXICOLOGY** |
| **Credits** | **4** |
| **Pre-requisites, if any** | The student should have a basic knowledge of pharmacology of drug action and understanding on their biochemical pathways. |
| **Course Objectives** | 1. To understand the detailed study of biochemical basis of drugs and its toxicity, particularly their actions on living systems.<br>2. To understand the relevance and methods to identify the chemotherapeutic value of drug.<br>3. To understand the fundamentals of toxicology and dose- response relationships.<br>4. To understand the toxicological drug testing procedures based on in vitro and animal studies<br>5. To understand biochemical pathways of drug toxicity and its manifestation on vital organs. |
| **Course Outcomes** | **On completion of this course, the student will be able:**<br>**CO1:** To appreciate and understand the role of toxicological biomarkers to assess drug toxicities.<br>**CO2:** To conceive the role of disposition of drug in human system and their metabolism and methodologies pertaining to toxicological studies.<br>**CO3:** To understand and evaluate the functions of different organs on drug disposition and associated drug toxicities.<br>**CO4 :** To understand the toxicological response to foreign compounds and their pharmacological, physiological and biochemical effects.<br>**CO5:** To link the mechanism of toxicity and clinical symptoms with underlying physiological disturbances. |
| | |

| Units | |
|---|---|
| **I**<br>**15 Hours** | **Fundamentals of Toxicology and dose-Response Relationships:** Introduction Biomarkers Criteria of Toxicity New Technologies Evaluation of Toxicity Interactions; Dose Response; Measurement of Dose-Response; Relationships Linear Dose Response Hormesis; Hazard and Risk Assessment Duration and Frequency of Exposure and Effect**.** |
| **II**<br>**15 Hours** | **Factors Affecting Toxic Responses:** Disposition: Absorption, Sites of absorption, distribution, Excretion; Metabolism: types of Metabolic change phase I reactions; Phase 2 reactions; control of Metabolism, Toxication vs. Detoxication**.** |
| **III**<br>**15 Hours** | **Toxicity testing;** Test protocol, Genetic toxicity testing & Mutagenesis assay: In vitro test systems: bacterial mutation tests-Reversion test,Ames test, Fluctuation test, and Eukaryotic mutation test. In vivo test system Mammalian mutation test-Host mediated assay and Dominant Lethal test. Biochemical basis of toxicity: Mechanism of toxicity: Disturbance of excitable membrane function, Altered Calcium homeostasis, Covalent binding to cellular macromolecules & genotoxicity, Tissue specific toxicity. |
| **IV**<br>**15 Hours** | **Toxic Responses to Foreign Compounds:** Direct Toxic Action: Tissue Lesions; Mechanism and response in cellular toxicity, pharmacological, physiological and Biochemical effects; Developmental Toxicology-Teratogenesis; Immunotoxicity Genetic Toxicity; Chemical Carcinogenesis. |
| **V**<br>**15 Hours** | **Biochemical Mechanisms of Toxicity:** Tissue Lesions: Liver Necrosis; kidney Damage; Lung Damage, Liver damage, Cardiac damage; Neurotoxicity; Exaggerated and Unwanted pharmacological effects; Physiological effects; Biochemical Effects: Lethal Synthesis and Incorporation, Interaction with specific Protein Receptors; Teratogenesis; Immunotoxicity; multi-Organ Toxicity |
| **Self-Study** | 1. Case studies to review |
| **Reading List (Print and Online)** | 1. Preclinical Safety Evaluation of Biopharmaceuticals: A Science-Based Approach to Facilitating Clinical Trials by Joy A. Cavagnaro<br>2. A Comprehensive Guide to Toxicology in Nonclinical Drug Development 2nd Edition by Ali S. Faqi |

| | |
|---|---|
| **Recommended Texts** | 1. Principles Of Toxicology by: Karen E Stine, Thomas M Brown 2006 Publisher. Crc Press<br>2. Principles of Biochemical Toxicology by John A. Timbrell Publisher: Informa Healthcare<br>3. Environmental Toxicology by Sigmund F. Zakrzewski, (2002) Publisher: Oxford University Press, USA |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Shortsummary or overview.
**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.
**Analyse (K4) –** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons
**Create(K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | L | S | L | M | M | M | M | S | S | M | M | S |
| **CO 2** | M | M | S | M | M | L | M | S | S | S | S | S | M | S | M |
| **CO 3** | S | S | S | M | M | L | S | S | M | M | S | S | M | M | S |
| **CO 4** | S | M | S | M | M | M | S | S | M | M | S | S | M | S | M |
| **CO 5** | M | S | S | S | S | M | M | M | S | S | S | S | M | S | M |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Developmental Biology** | Elective | 4 | 1 | 0 | 0 | 3 | 5 | 25 | 75 | 100 |

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|---|---|
| **Course** | **ELECTIVE PAPER** |
| **Title of the Course** | **DEVELOPMENTAL BIOLOGY** |
| **Credits** | **3** |
| **Pre-requisites, if any** | Comprehensive Knowledge of Cell Biology |
| **Course Objectives** | The candidates undertaking this course will understand the concepts of developmental biology.<br>1. To understand the background of developmental biology<br>2. To gain in-depth knowledge of various model organisms<br>3. To gain insight into aspects of stem cell technology<br>4. To gain insights into morphogenesis and oranogenesis<br>5. To acquire in-depth understanding of cell death mechanisms and cell fate decision |
| **Course Outcomes** | **After completion of the course, the students should be able to:**<br>**CO1**.Grasp knowledge about the background of developmental biology..<br>**CO2**.Gain abundant knowledge about model oraganisms and gametogenesis<br>**CO3**.Gain knowledge about stem cells and their applications in regenerative therapy.<br>**CO4**.Good knowledge about organogenesis.<br>**CO5**.Learn the basics of cell death mechanisms and cell fate decision. |
| **Units** | |
| **I**<br>**15 Hours** | **Overview of Developmental biology:** Background of developmental biology - Principles of developmental biology –Potency, commitment, specification, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and imprinting; mutants and transgenics in analysis of development. |

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| **II**<br>**15 Hours** | **Model organisms:** Gametogenesis – structure of gametes, Formation of zygote, fertilization and early development: molecules in sperm-egg recognition in animals; embryo sac development, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis and organogenesis. |
| **III**<br>**15 Hours** | **Regeneration and developmental biology**: Stem cells – Definition, Classification, Embryonic and adult stem cells, properties, identification, Culture of stem cells, Differentiation and dedifferentiation, Stem cell markers, techniques and their applications in modern clinical sciences. Transplantation of engineered cells. Tissue engineering and applications - skin, bone and neuronal tissues. |
| **IV**<br>**15 Hours** | **Organogenesis:** Organs from embryonic germ lineage, neural tube formation and differentiation. Development of eye, neurons, bone and digestive tract. sex determination. |
| **V**<br>**15 Hours** | **Cellular senescence and Cell fate decision:** Cellular senescence – concepts & Frizzled receptor in Development and disease. Diabetes and developmental biology, Cell death pathways in developments. Markers of important diseases. |
| **Reading List (Print and Online)** | 1. Developmental Biology – Gilbert Scott http://bgc.org.in/pdf/study-material/developmental-biology-7th-ed-sf-gilbert.pdf |
| **Recommended Texts** | 1. Developmental biology: VIII edition, **Gilbert, S**F; Sinauer Associates, Inc |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.
**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, Short summary or overview.
**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.
**Analyse (K4) –** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.
**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons
**Create(K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Programme Outcomes:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | M | M | S | S | M | L | S | S | M | S | M | S | M | L |
| **CO 2** | M | M | M | M | M | S | M | S | M | M | S | M | S | S | L |
| **CO 3** | M | M | L | M | M | S | L | S | L | L | S | S | S | S | S |
| **CO 4** | S | M | L | S | S | M | S | S | M | M | S | S | S | S | S |
| **CO 5** | S | S | M | S | L | M | M | S | M | M | S | M | S | M | L |

**S-Strong M-Medium L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Biomedical Technology** | SEC | 1 | 1 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |

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|---|---|
| **Course** | **SKILL ENHANCEMENT COURSE I** |
| **Title of the Course** | **BIOMEDICAL TECHNOLOGY** |
| **Credits** | **2** |
| **Pre-requisites, if any** | Basic knowledge on biochemical techniques. |
| **Course Objectives** | This course will make the students adept in the working of analytical instruments. They also become confident to use biomedical instruments and work with different tools in upcoming fields, which in turn make them competent for jobs in clinical and medical labs. |
| **Course Outcomes** | **On successful completion of the course, the students should be able to:**<br>**CO1** Provide basic knowledge about biomedical technology.<br>**CO2** Understand the handling of different biomedical tools.<br>**CO3** Apply basic techniques for the biomedical applications.<br>**CO4** Understand the production and applications of nanoparticles in medical field.<br>**CO5** Explain the principle, procedure and applications of histochemical analysis. |
| **Units** | |
| **I**<br>6 Hours | **Biochemical Autoanalyzer:** Working principle, sampler, proportionating pumps, dialyser, constant temperature bath, flow through colorimeter, recorder and applications.<br>**ELISA Reader:** Working principle, sample loading, procedure, results analysis, applications. |
| **II**<br>6 Hours | **Phytochemical Analysis:** Classification – Plant secondary metabolites. Preparation of extracts for biochemical investigations. methods of extraction of phytochemicals - Maceration, Soxhlet, Microwave assisted, Ultrasonic, Pressurized liquid extraction. Choice of solvents. Medicinal uses of phytochemicals. |
| **III**<br>6 Hours | **Nanotechnology:** Nanoparticles definition, Types of nanomaterials, methods of nanoparticle synthesis, nanoparticles characterization techniques and applications of nanotechnology in biomedical field. |

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|---|---|
| **IV**<br>6 Hours | **Histology:** Tissue fixation techniques, Processing of tissues; tissue embedding, Sectioning, Microtome types and their uses; histological staining techniques. Study of animal tissues, histology of various organs. |
| **V**<br>6 Hours | **Experiments:**<br>1. Analysis of blood specimen using autoanalyzer. Interpret results.<br>2. Preparation of at least two extracts using Soxhlet Apparatus.<br>3. Extraction and quantification of flavonoids from plant leaf extract.<br>4. synthesising nanoparticle. Characterizing the nanoparticles by UV-Vis spectroscopy.<br>5. Preparation of tissue section and staining. |
| **Reading List (Print and online)** | 1. https://www.researchgate.net/publication/283076818<br>2. https://www.researchgate.net/publication/308116783_Phytopharmaceutical_applications_ of_Nutraceuticals_Functional_foods |
| **Self-Study** | 1. Prepare the list of phytochemicals used in biomedical field.<br>2. Applications of histochemical analysis. |
| **Recommended Texts** | 1. Practical methods in ecology & Environmental science by R.K. Trivedi, P.K. Goel, C.L. Trisal.<br>2. Fundamentals of Analytical Chemistry. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, 9th Ed. 2014; Mary Finch, USA.<br>3. Basic Medical Laboratory Technology – Reynolds Walte. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.

**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.

**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.

**Analyse(K4) –** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons

**Create (K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Program Outcomes:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | M | S | M | S | M | S | M | M | S | S | M | L | L | L |
| **CO 2** | M | S | M | S | L | M | S | S | S | L | L | S | M | L | L |
| **CO 3** | M | M | S | L | M | L | M | L | M | M | M | L | L | S | L |
| **CO 4** | L | M | M | M | S | S | L | M | L | S | M | L | S | L | L |
| **CO 5** | S | S | S | M | S | M | S | M | L | S | L | L | L | S | M |

**S-Strong** **M-Medium** **L-Low**

| Course Code | Course Name | Category | L | T | P | S | Credits | Inst. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | Ext | Total |
| | **Research Tools** | SEC | 1 | 1 | 0 | 0 | 2 | 2 | 40 | 60 | 100 |

| **Course** | **SKILL ENHANCEMENT COURSE II** |
|---|---|
| **Title of the Course** | **RESEARCH TOOLS** |
| **Credits** | **2** |
| **Pre-requisites, if any** | Basic knowledge on research, experimental design and statistical analysis. |
| **Course Objectives** | **The main objectives of this course are to:**<br>1. Explain the experimental design.<br>2. Introduce the components of research.<br>3. Analyse the significance of data statistically.<br>4. Explain the importance of computation in research.<br>5. Gain knowledge about writing a research report. |
| **Course Outcomes** | **On successful completion of the course, the students should be able to:**<br>**CO1:** Design experimental setup, review the literature, compile and document the data.<br>**CO2:** Interpret the data using computational tools.<br>**CO3:** Analyze and validate the experimental data using statistical tools.<br>**CO4:** Write a research report, present results findings and publish.<br>**CO5:** Analyze the plagiarism and present the report. |
| **Units** | |
| **I**<br>6 Hours | **Basic Principles of Experimental design**: Objective, design of work, guidelines for design of experiments, Literature Search - Databases for literature search - PubMed, data collection tools, compilation and documentation of data. |
| **II**<br>6 Hours | **Computer and its role in research**: Basics of word, Excel: tabulation, calculation and data analysis, preparation of graphs, histograms and charts. Power Point: preparation of presentations and scientific poster designing. |
| **III**<br>6 Hours | **Statistical Analysis and Plagiarism**: statistical software SAS- basics of SAS, analysis of significance of data by SAS. Detection of plagiarism by computer software - Plagiarism Checker by Grammarly. |
| **IV**<br>6 Hours | **Thesis and Scientific writing for journals**: Thesis writing: format, content and chapters, drafting titles and sub-titles. Writing results, discussion and conclusions. Writing research paper for publishing in journal. Bibliography and references – software - Mendeley. |

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| **V**<br>6 Hours | **Practicals –**<br>1. Preparation of graph and chart by using excel.<br>2. Power point presentations.<br>3. Statistical analysis of data by SAS.<br>4. Writing a research paper for publication.<br>5. Plagiarism analysis of research papers. |
| **Reading List (Print and online)** | **Web Resources**<br>1. https://explorable.com/research-methodology<br>2. http://www.scribbr.com<br>3. http://www.open.edu<br>4. http://www.macmillan .ihe.com. |
| **Self-Study** | ➢ Prepare the list of problems for research.<br>➢ Learn the basics of computer operation. |
| **Recommended Texts** | **Text Books**<br>1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.<br>2. Kothari, C.R., Research Methodology: Methods and Techniques. 2004, New Age International.<br>3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications.2 volumes.<br>4. Gurumani.N, Research Methodology for biological Sciences, 2014, MJP Publishers.<br>**Reference Books**<br>1) Dr. Prabhat Pandey, Dr.Meenu Mishra Pandey, Research Methodology: Tools and Techniques 2015<br>2) 2.Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.<br>3) Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.<br>4) Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications<br>5) Scientific Thesis Writing and Paper Presentation . MJP Publishers.2010 Research Methodology (2 Vols-Set) ,Suresh C. Sinha and Anil K. Dhiman, Vedams Books (P) Ltd.2002. |

**Methods of assessment:**

**Recall (K1) -** Simple definitions, MCQ, Recall steps, Concept definitions.

**Understand/ Comprehend (K2) -** MCQ, True/False, Short essays, Concept explanations, short summary or overview.

**Application (K3) -** Suggest idea/concept with examples, Solve problems, Observe, Explain.

**Analyse(K4) –** Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

**Evaluate (K5) -** Longer essay/ Evaluation essay, Critique or justify with pros and cons

**Create (K6) –** Check knowledge in specific or offbeat situations. Discussion.

**Mapping with Program Outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | M | S | M | S | M | S | M | M | S | S | M | L | L | L |
| **CO 2** | M | S | M | S | L | M | S | S | S | L | L | S | M | L | L |
| **CO 3** | M | M | S | L | M | L | M | L | M | M | M | L | L | S | L |
| **CO 4** | L | M | M | M | S | S | L | M | L | S | M | L | S | L | L |
| **CO 5** | S | S | S | M | S | M | S | M | L | S | L | L | L | S | M |

**S-Strong** **M-Medium** **L-Low**

**The board of studies approved the syllabus with effect from the academic year 2023-2024 and the distinguished members suggested the incorporation of following changes:**

**First Semester:**

- Basics of Biochemistry, Biochemical and Molecular Biology Techniques, Lab Course on Biomolecules and Biochemical Techniques are offered as core papers.
- Physiology and Cell Biology and Microbiology and Immunology are offered as core elective papers.
- In Biochemical and Molecular Biology Techniques, Low pressure column chromatography, Reverse HPLC, capillary electro chromatography and perfusion chromatography are removed in unit II. Ion exchange chromatography is included in unit II. Microchip electrophoresis and 2D electrophoresis in Unit III are removed. Immuno electrophoresis technique is included in unit III.
- In Physiology and cell Biology paper, hormones involved in digestive system, pH maintenance by cellular and intracellular proteins in unit I and Chemistry of muscle contraction topics in unit II are removed. Developmental biology topics are included in unit V.
- Microbiology and Immunology is offered as elective paper. Unit V topics are split into unit IV and unit V.

**Second Semester:**

- Enzymology, Cellular Metabolism and Lab Course on Enzymology, Microbiology and Cell Biology are offered as core papers.
- Energy and Drug Metabolism and Nutritional Biochemistry are offered as core elective papers.
- In Enzymes, Identification of amino acids at the active site is removed and Mechanism of action of carboxypeptidase topic is included in unit I. Therapeutic use of enzyme (unit III), Graphical analysis to differentiate SDR from DDR (unit IV) topics are removed. Metabolism of heme is removed and Integration of Metabolism is added in unit V.
- In Energy and Drug Metabolism, High energy linkages is removed. Phosphate shuttle and Phosphogens are included in unit I.
- In nutritional Biochemistry, Paleo diet and consequences topics are included in unit I. Effect of alcohol and tobacco on health is removed in unit II. Starvation and Obesity,

Inter-relationship of nutrition, infection, immunity and poverty topics are removed, Rickets, osteomalasia and anemia, topics are included in unit V.

- In Practical II, unit V is removed since industrial visit is considered as extension activity. The group experiments from unit IV are changed into unit V. TLC techniques and DPPH assay are included in Unit IV.

**Third Semester:**

- Gene Editing, Cell and Gene Therapy, Biostatistics and Data Science, and Laboratory Course on Clinical Biochemistry are offered as core papers.
- Pharmaceutical biochemistry is offered as core Industrial Module.
- Molecular basis of disease and therapeutic strategies is offered as core elective paper.
- In Gene Editing, Cell and Gene Therapy, unit III topics are merged with unit II. Unit III, IV and V are replaced with Cloning Strategies, Genetic Engineering in Animals, and Genetic Engineering in Plants respectively. Consequences of Plant Engineering and Use of Hybrid Varieties topics are included.
- In pharmaceutical Biochemistry, Drug metabolism topics (Phase I and Phase II) removed from unit III since the same topics are repeated in Energy and Drug Metabolism paper.
- In Molecular basis of disease and therapeutic strategies, Introduction to personalized medicine is removed. Biochemical and Electrical abnormalities in Central Nervous System and Peripheral Nervous System, dementia, glioma topics are included in unit III.

**Fourth Semester:**

- Clinical Biochemistry, Molecular Biology and Hormones are offered as core papers.
- Bio-safety, Lab Safety and IPR, is offered as core elective paper.
- In Clinical Biochemistry, Biochemical investigations in diagnosis, prognosis, monitoring, screening (unit I), diabetes mellitus (unit II), Diagnostic Enzymology (unit III) and there topics are included in molecular basis of diseases. Electrolyte disorder (unit V) topics are removed.
- In Molecular Biology, Chromatin remodeling (unit I), Prokaryotic replication (unit II), Prokaryotic Transcription (unit III), Foot-printing and gel-shift assays (unit IV), Genome editing (unit V) topics are removed for the reason that prokaryotic mechanism are already included in UG syllabus. Epigenetic variations and epigenetic regulation of genes topics are included in unit I.

- In Biosafety, Lab Safety and IPR, GMO applications (unit I), History of biosafety microbiology (unit II) and filing of a patent application (unit III) (repetitions) topics are removed.