

**SRI SANKARA ARTS AND SCIENCE COLLEGE**

**(Autonomous)**

**DEPARTMENT OF BIOCHEMISTRY**

**MASTER DEGREE COURSE IN BIOCHEMISTRY**

**CHOICE BASED CREDIT SYSTEM (CBCS)**

(With effect from the academic year 2020-2021)

**REGULATIONS**

**1. DURATION OF THE PROGRAMME**

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 REQUIREMENTS 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 The Course Components and Credit Distribution shall consist of the following:

(Minimum Number of Credits to be obtained)

<b>COURSE COMPONENTS/ NAME OF THE COURSE</b>	<b>NUMBER OF COURSES</b>	<b>CREDITS</b>	<b>CREDITS ALLOTTED</b>
Core subject including Project	<b>15 Courses</b>	<b>4</b>	<b>60</b>
Elective	<b>5 Courses</b>	<b>3</b>	<b>15</b>
Extra Disciplinary	<b>2 Courses</b>	<b>3</b>	<b>6</b>
Soft Skill	<b>4 Courses</b>	<b>2</b>	<b>8</b>
Internship	<b>1 Course</b>	<b>2</b>	<b>2</b>
<b>Total Credits</b>			<b>91</b>

#### 4.2 SCHEME OF EXAMINATIONS

##### SEMESTER - I

<b>Course Components/Title of the paper</b>	<b>Credits</b>	<b>MARKS</b>		
		<b>CIA</b>	<b>EXT</b>	<b>TOTAL</b>
Core Paper – I : Biomolecules	4	25	75	100
Core Paper – II : Biochemical Techniques	4	25	75	100
Core Paper – III : Physiology and Developmental Biology	4	25	75	100
Elective Paper – I :Microbiology	3	25	75	100
Soft Skill – I	2	40	60	100

## SEMESTER - II

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
Core Paper – IV: Enzymes and Enzyme Technology	4	25	75	100
Core Paper – V : Intermediary Metabolism-I	4	25	75	100
Core Paper – VI : Intermediary Metabolism-II	4	25	75	100
Core Paper – VII : Practical-I	3	40	60	100
Core Paper – VIII : Practical-II	3	40	60	100
Elective Paper – II : Energy and drug metabolism	3	25	75	100
Extra Disciplinary Paper – I : Plant Physiology	3	25	75	100
Soft Skill - II	2	40	60	100
*Internship	2	20	80	100

\* Internship will be carried out during the summer vacation of the first year and marks should be sent to the University by the College and the same will be included in the Third Semester Marks Statement.

## SEMESTER – III

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
Core Paper – IX :Biotechnology	4	25	75	100
Core Paper – X: Clinical Biochemistry-I	4	25	75	100
Core Paper – XI: Molecular Biology	4	25	75	100
Elective Paper – III: Biostatistics	3	25	75	100
Extra Disciplinary Paper – II : Proteomics and Genomics	3	25	75	100
Soft Skill - III	2	40	60	100

## SEMESTER - IV

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
Core Paper – XII: Hormones	4	25	75	100
Core Paper – XIII: Clinical Biochemistry-II	4	25	75	100
Core Paper – XIV: Practical-III	4	40	60	100
Core Paper – XV: Project and viva	5	20	80	100
Elective Paper IV: Signal transduction	3	25	75	100
Elective Paper V: Advanced Immunology	3	25	75	100
Soft Skill - IV	2	40	60	100

### 4.3 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 Syndicate from time to time.

**5.2 Attendance:** All Students must earn 75% and above of attendance for appearing for the University 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 University 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/- therefore together with the attendance details shall be forwarded to the College 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 University 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 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
<b>Theory Papers</b>	Tests (2 out of 3)	10
	Attendance	05
	Seminars	05
	Assignments	05
	<b>Total</b>	<b>25</b>
<b>Practical Papers</b>	Attendance	05
	Test best 2 out of 3	30
	Record	05
	<b>Total</b>	<b>40</b>
<b>Project</b>	Internal Marks (best 2 out of 3 presentations)	20
	Viva-Voce	20
	Project Report	60
	<b>Total</b>	<b>100</b>

#### 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 40% Marks in UG.
- (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-totalling:** 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** 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**, 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: **Best 91 Credits:** 75 Credits (Core and Elective), 16 Credits (Soft skills and Internship, Non-major Electives and Extra Disciplinary).

## 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:

<b>RANGE OF MARKS</b>	<b>GRADE POINTS</b>	<b>LETTER GRADE</b>	<b>DESCRIPTION</b>
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**

$$\text{GPA for a Semester:} = \frac{\sum_i C_i G_i}{\sum_i C_i}$$

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

$$\text{8.2.3 CGPA for the entire programme:} = \frac{\sum_n \sum_i C_{ni} G_{ni}}{\sum_n \sum_i C_{ni}}$$

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,

$C_i$  = Credits earned for course  $i$  in any semester,

$G_i$  = 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 - 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.**

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## **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, 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:**

- a) 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 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 Specific Outcomes**

**PSO-1:** Ability to acquire detailed knowledge and understanding the principles and theories of Biochemistry.

**PSO-2:** Apply knowledge and understanding of Biochemistry to the solution of problems in life sciences and practical areas of the subject.

**PSO-3:** Inducing research enthusiasm among student community and encouraging them to pursue higher studies in Biochemistry.

**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.

**PSO-5:** Developing the professional skills based on current trends in versatile fields by offering Job oriented certificate courses and Value-added courses.

# M. Sc DEGREE COURSE IN BIOCHEMISTRY

## SYLLABUS

(Effective from the academic year 2020 – 2021)

### I SEMESTER

#### CORE PAPER – I – BIOMOLECULES

CREDITS – 4

TOTAL HOURS – 60

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

**CO-1:** Understanding of chemistry and structure of Biological molecules.

**CO-2:** Acquire knowledge on functions of biomolecules, eg. Carbohydrates, Proteins, Lipids and Nucleic acids.

**CO-3:** Understand the basic component of signaling molecules like prostaglandins, thromboxanes and Leukotrienes.

**CO-4:** Recognize vitamins enrichment and fortification.

**CO-5:** Understand about Phytochemicals structure and their functions.

Biomolecules	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2	✓	✓			
Unit-3		✓	✓		
Unit-4	✓	✓		✓	
Unit-5	✓				✓

#### UNIT I

**Carbohydrates** - Classification, structure, function and properties of monosaccharides (glucose, galactose, fructose), Disaccharides (lactose, cellobiose, sucrose, maltose). Homopolysaccharides (starch, glycogen, cellulose, inulin, dextrin, agar, pectin, dextran) Glycosaminoglycans – source, structure, functions of hyaluronic acid, chondroitin sulphates, heparin, keratan sulphate, proteoglycans. O- Linked and N-linked glycoproteins. plant cell wall carbohydrates. Artificial or synthetic sweetner.

## **UNIT II**

**Lipids** - Classification of lipids, structure, properties and functions of fatty acids, triglycerides, phospholipids, glycolipids, sphingolipids and steroids. Eicosanoids-classification, structure and functions of prostaglandins, thromboxanes, leukotrienes. Lipoproteins – structure, function and mechanism of transport.

## **UNIT III**

**Amino acids** - Classification, structure and properties of amino acids. Proteins – classification based on composition, structure and functions. Primary, secondary, super secondary and quaternary structure of proteins. Determination of amino acid sequence. Forces involved in stabilization of protein structure. Ramachandran plot. Folding of proteins. Structural characteristics of collagen and hemoglobin.

## **UNIT IV**

**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. 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 and their structure.

## **UNIT V**

**Vitamins and Phytochemicals** - An overview of vitamins – source, structure and functions of water soluble and fat soluble vitamins – vitamin preparation, enrichment and fortification – overload and criteria of food sources. Antioxidants and oxidative stress. Phytochemicals – structure and functions of carotenoids, flavonoids, triterpenoids, polyphenols and lipoic acid.

### **Books Recommended**

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6<sup>th</sup> ed), W.H. Freeman.
2. Voet.D & Voet. J.G (2010). Biochemistry (4<sup>th</sup> ed), John Wiley & Sons, Inc.
3. Metzler D.E (2003). The chemical reactions of living cells (2<sup>nd</sup> ed), Academic Press.
4. Zubay G.L (1999). Biochemistry (4<sup>th</sup> ed), Mc Graw-Hill.
5. Lubert Stryer (2010). Biochemistry (7<sup>th</sup> ed), W.H.Freeman.
6. Satyanarayan,U (2014). Biochemistry (4<sup>th</sup> ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata.

## CORE PAPER – II - BIOCHEMICAL TECHNIQUES

CREDITS – 4

TOTAL HOURS – 60

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

**CO-1:** Recognize the basic principles and instrumentation of cell sorting, manometric and electrochemical techniques.

**CO-2:** To understand the principles and applications of chromatographic techniques used in biochemical studies.

**CO-3:** To obtain wide knowledge on latest electrophoretic techniques employed in research.

**CO-4:** Understand the principle, instrumentation and determination of biomolecules, activity of enzymes in biological samples, determination of minerals by various spectroscopic techniques like Visible and UV spectroscopy, spectrofluorimetry and flame photometry etc

**CO-5:** Express wide knowledge on detection and measurement of radioisotopes.

Biochemical Techniques	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

### UNIT

**Electrochemical techniques** - General approaches to biochemical investigation. Organ and tissue slice technique, cell disruption and homogenization techniques, cell sorting and cell counting, cryopreservation, tissue culture techniques. Manometric technique. Electrochemical techniques: Basic principles. Ion selective electrodes, gas sensing and oxygen electrodes. Biosensors - principle and applications.

### UNIT II

**Chromatography** - Basic principles of chromatography - adsorption and partition techniques. Adsorption Chromatography - Hydroxy apatite chromatography and

hydrophobic interaction Chromatography. Column Chromatography – Ion Exchange, Gel Permeation and Affinity chromatography. Partition Chromatography - Gas liquid chromatography- principle, instrumentation, column development, detectors-flame ionisation detectors (FID), nitrogen phosphorus detectors (NPD), electron capture detector (ECD), Flame photometric detector. Mass spectrometer detector and applications. High pressure liquid chromatography- principle, instrumentation, delivery pump, sample injection unit, column packing, development, detection and application.

### **UNIT III**

**Electrophoresis** - General principles of electrophoresis, supporting medium, factors affecting electrophoresis, Isoelectric focusing- principle, ampholyte, development of pH gradient and application. Polyacrylamide Gel Electrophoresis, SDS PAGE- principle and application in molecular weight, 2D PAGE. Agarose gel electrophoresis of DNA, DNA sequencing gels, Electrophoresis of RNA, Pulsed field gel electrophoresis- principle, apparatus, application. Field inversion gel electrophoresis. Capillary electrophoresis- principle, instrumentation and applications, Immuno electrophoresis – types and applications.

### **UNIT IV**

**Spectroscopy** - Basic laws of light absorption. Principle, instrumentation and applications of UV, IR, ESR, NMR, Mass spectroscopy, Turbidimetry and Nephelometry, Luminometry, Atomic flame and flameless spectrophotometry. Principle, working and uses of x-ray diffraction, optical rotatory dispersion (ORD) and circular dichroism spectroscopy.

### **UNIT V**

**Radioisotopes** - 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.

### **Books Recommended**

1. Keith Wilson, John Walker (2010). Principles and Techniques of Biochemistry and Molecular Biology (7th ed), Cambridge University Press
2. David Sheehan (2009). Physical Biochemistry: Principles and Applications (2nd ed), Wiley-Blackwell
3. David M. Freifelder (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W.H.Freeman
4. Rodney F.Boyer (2012). Biochemistry Laboratory: Modern Theory and techniques,(2<sup>nd</sup> ed), Prentice Hall
5. Kaloch Rajan (2011). Analytical techniques in Biochemistry and Molecular Biology, Springer
6. Segel I.H (1976). Biochemical Calculations (2<sup>nd</sup> ed), John Wiley and Sons



## CORE PAPER – III – PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY

CREDITS – 4

TOTAL HOURS – 60

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

**CO1:** Understand the basics of respiratory system, fluid maintenance, acidosis and alkalosis.

**CO2:** Explore about the nervous system, structure of neurons, mechanism nerve impulse transmission.

**CO3:** Explain the principle, instrumentation and applications of electrophysiological methods like ECG, EEG, MRI, CT scan, etc.

**CO4:** Understand the structure and functions of reproductive system, glands, hormones, gametogenesis.

**CO5:** Know the formation cell fate, zygote, blastula, gastrula, germ layers, cytoplasmic determinants and organogenesis

Physiology and Developmental Biology	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3		✓	✓		
Unit-4				✓	
Unit-5					✓

### UNIT I

**Respiratory system** - Respiratory system-Gaseous transport and acid-base homeostasis. Mechanism of the movement of O<sub>2</sub> and CO<sub>2</sub> through lungs, arterial and venous circulation. Bohr effect, oxygen and carbon dioxide binding hemoglobin. Metabolic acidosis and alkalosis. Respiratory acidosis and alkalosis. Regulation of fluid and electrolyte balance.

### UNIT II

**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, neurotransmitters receptors, synaptosomes, synaptotagmin.

### **UNIT III**

**Electrophysiology** - Principle and Applications - Single neuron recording, patch-clamp recording, Electrocardiography, Brain activity recording, lesion and stimulation of brain, pharmacological testing, Positron Emission Tomography, Magnetic Resonance Imaging, Computerized Axial Tomography.

### **UNIT IV**

**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, Menopause, Placenta. Cell surface molecules in sperm-egg recognition.

### **UNIT V**

**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.

### **Books Recommended**

1. Wayne M. Baker (2008). The World of the Cell (7<sup>th</sup> ed), Pearson Benjamin Cummings Publishing, San Francisco.
2. P.S.Verma and V.K.Agarwal. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology (14<sup>th</sup> ed), S.Chand and Company Ltd
3. John E. Hall (2010). Guyton and Hall Textbook of Medical Physiology (12<sup>th</sup> ed), Saunders
4. Best and Taylor (1990). Medical Physiology (12<sup>th</sup> ed), Lippincott Williams and Wilkins
5. Walter F. Boron , Emile L. Boulpaep (2012). Medical Physiology (2<sup>nd</sup> ed), Saunders  
Anne Waugh (2010). Ross and Wilson Anatomy and Physiology in Health and Illness, Elsevier.
6. Vishram Singh (2012), Text Book of Clinical Embryology, Reed Elsevier India Private Limited

## ELECTIVE PAPER - I – MICROBIOLOGY

CREDITS – 3

TOTAL HOURS – 60

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

**CO-1:** Understand the molecular taxonomy of various microorganisms. Know about the isolation of pure culture from various sources and to understand the microbial growth measurement.

**CO-2:** To study the contamination and spoilage of various foods, fruits, vegetables, poultry. Explore the knowledge about principles of food preservation.

**CO-3:** Know the various bacterial and fungal food poisoning including toxin produced by the microbes. To study the some pathogenic microorganism causes, control prevention and cure.

**CO-4:** Understand the mechanism of action of various antibiotics including sulfonamides, Penicillin and Streptomycin. Known about antiviral and antiretroviral agents.

**CO-5:** Know the isolation, screening and maintenance of industrial important microbes. To know the industrial production of alcohol, citric acid, streptomycin and  $\alpha$ -amylase and Single Cell Protein.

Microbiology	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3		✓	✓		
Unit-4			✓	✓	
Unit-5					✓

### UNIT I

**General Microbiology** - Microbiology History, classification, Taxonomy - molecular taxonomy. Bacteriophages: lytic cycle and lysogeny cycle. Distribution of microorganism in soil, water and air. Types of culture media, isolation of pure culture - Streak plate, spread plate, pours plate. Growth curve and measurement methods (turbidity, biomass and cell count). Microscopy – Bright field, Dark field, phase contrast, Electron Microscopy – TEM & SEM.

## UNIT II

**Contamination and spoilage of foods** - cereals, fruits, vegetables, meat, fish, poultry, eggs, milk. General principles of food preservation - low temperature, drying, Pasteurization, radiation, canning. Food fermentation- cheese, yoghurt, pickles and bread.

## UNIT- III

**Bacterial cell structure** - Gram negative, Gram positive bacteria and halophiles. Food poisoning - bacterial food poisoning, *Salmonella*, *Clostridium botulinum* (botulism), *Staphylococcus aureus*. Bacterial food borne infection and diseases caused by *Clostridium* sp., *Streptococcus* sp., *Salmonella* sp., *E.coli*, *Pseudomonas* sp., *Klebsilla* sp, causes, control, prevention and cure. Fungal food poisoning - Aflatoxin,

## UNIT- IV

**Antimicrobial Activity** – chemotherapy, General characteristics of antimicrobial agents – penicillin, streptomycin. Mode of administration, mode of action, adverse effects and sensitivity test. Antiviral agents, Antibiotic sensitivity testing method.

## UNIT- V

**Microbial Production** - Isolation, screening and maintenance of isolates of microbial strains. strain improvement - mutant selection. Downstream processing and *in situ* recovery of products. Industrial production of alcohol and  $\alpha$ -amylase. Industrial production of antibiotics - streptomycin. Organic acids- citric acid. Biofertilizers - *Rhizobium* sp., and blue green algae – *Nostoc* sp., Single cell protein and biomass production - Spirulina.

### Reference:

1. Add old references also except Prescott 8<sup>th</sup> ed reference
2. Tortora, G.J., Funke, B.R. and Case, C.L. (2016) *Microbiology: An Introduction*, 11th Edition, Pearson Education, India.
3. Alexopoulos, C.J. and Mims, C.W. (1996) *Introductory Mycology*. 4TH Edition, Wiley Eastern Ltd. New Delhi.
4. Baveja, C.P. and Baveja, V. (2017) *APC Text Book of Microbiology*. 4th Edition, Arya Publications, New Delhi.
5. Johanne, M.W., Linda, M.S. and Christopher, J.W. (2017) Willey Prescott's *Microbiology* 10E. 10th Edition. McGraw Hill Education, India.
6. Dubey, R.C. and Maheshwari, D.K. (2013) *A Textbook of Microbiology*. Revised Edition, Chand and company, New Delhi.

## SEMESTER II

### CORE PAPER- IV - ENZYMES AND ENZYME TECHNOLOGY

CREDITS – 4

TOTAL HOURS – 60

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

**CO-1:** Know about the isolation and purification of enzymes from various sources and to understand the various enzyme assays for quantitative determination in biological sample.

**CO-2:** Explore the knowledge about isoenzymes and the separation of LDH with the help of electrophoresis. To study the allosteric regulation of enzymes and also intracellular location of enzymes by Histoenzymology.

**CO-3:** Know about the various factors affecting enzyme activity such as pH, temperature, substrate concentration, product concentration and to determine the active site of enzyme.

**CO-4:** Understand the role of various coenzymes and cofactors in enzyme activity. To study the mechanism of enzyme action.

**CO-5:** Know the immobilization of enzymes with applications. To know the industrial and therapeutic applications of enzymes.

Enzymes & Enzyme Technology	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓	✓			
Unit-2		✓	✓		
Unit-3				✓	
Unit-4			✓	✓	
Unit-5					✓

### UNIT I

**Enzyme techniques** – IUB classification of enzymes. Intracellular localization of enzymes-Histoenzymology, Isolation and purification of enzymes. Criteria of purity of enzymes, Enzyme activity units. Katal and International units. Enzyme assay- Different types - coupled enzyme assay. Applications of stopped flow techniques. Isoenzymes and

their separation by electrophoresis with special reference to LDH. Significance of LDH and CK isoenzymes.

## **UNIT II**

**Enzyme kinetics** - 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  $K_m$ . Catalytic efficiency, Sigmoidal kinetics, Allosteric enzymes significance, structure and regulatory functions with special reference to aspartate transcarbamylase. Role of covalent modification in regulation of enzymes -regulation of glycogen synthase and glycogen phosphorylase.

## **UNIT III**

**Coenzymes** – cofactors and prosthetic groups. Structures and functions of coenzymes - reactions involving CoA, TPP, NAD<sup>+</sup>, NADP, biotin, folic acid, FMN, FAD, tetrahydrofolate and cobamide. Multienzyme complexes. Functions of pyruvate dehydrogenase and fatty acid synthase complexes. Methanogenesis, coenzymes involved in methanogenesis. Significance of Vitamin K- dependent carboxylation in blood clotting process.

## **UNIT IV**

**Mechanism of enzyme action** - Enzyme active site, mapping of active site, identification of amino acids like lysine, cysteine, serine and histidine in the active site. Enzyme specificity. Mechanism of enzyme action – Lock and key theory and induced fit model. Mechanisms of enzyme catalysis - covalent catalysis, proximity and orientation effect, acid-base catalysis

## **UNIT V**

**Enzyme technology** – production and industrial uses of enzymes like amylase, protease, pectinase, lipases and cellulase. Designer enzymes, abzymes, biosensors and ribozyme, Methods of Immobilization of enzymes and their applications. Enzymes as Diagnostic and therapeutic agents.

### **Books Recommended**

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6<sup>th</sup> ed), W.H.Freeman
2. Voet.D and Voet. J.G (2010). Biochemistry (4th ed), John Wiley & Sons, Inc.
3. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012). Harper's Illustrated Biochemistry (29<sup>th</sup> ed), McGraw-Hill Medical.
4. Trevor Palmer (1995). Understanding Enzymes (4<sup>th</sup> ed), Ellis Horwood Ltd.
5. Metzler D.E (2003). The chemical reactions of living cells (2<sup>nd</sup> ed), Academic Press.
6. Zubay G.L (1999). Biochemistry (4<sup>th</sup> ed), Mc Grew-Hill.
7. Marangoni AG (2002). Enzyme Kinetics:A Modern Approach, Wiley-Blackwell.

## CORE PAPER - V - INTERMEDIARY METABOLISM I

CREDITS – 4

TOTAL HOURS – 60

On Successful completion of course, students will be able to

**CO-1:** Understand the pathways of synthesis and breakdown of biomolecules and about feeders pathway.

**CO-2:** Obtain knowledge on Carbohydrate metabolism which helps to understand the conversion of simple nutrients after absorption into energy and synthesis of cell macromolecules.

**CO-3:** Acquire knowledge about Purine and Pyrimidine metabolism.

**CO-4:** Gain information on specialized products formed from aminoacids.

**CO-5:** Learn about the metabolism of macro and microminerals.

Intermediary Metabolism I	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓	✓			
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

### UNIT I

**Carbohydrate metabolism** - Glycolysis – aerobic and anaerobic, inhibitors and regulation. Feeder pathway - entry of hexoses into glycolysis, Pyruvate dehydrogenase complex - mechanism and regulation. Citric acid cycle - regulation. Glyoxalate cycle and its regulation. Gluconeogenesis - source, key enzymes, reaction sequence and its regulation.

### UNIT II

**Carbohydrate metabolism** - Pentose phosphate pathway - significance and its regulation. Metabolism of glycogen and its regulation. Uronic acid pathway. Biosynthesis of N-linked and O-linked glycoproteins, Metabolism of Heme – Biosynthesis and degradation of heme.



### **UNIT III**

**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.

### **UNIT IV**

**Aminoacid metabolism** - Versatile role of PLP as coenzyme.- transamination, deamination and decarboxylation. Trans methylation and one carbon transfer. Regulation of urea cycle, Inherited disorders of urea cycle enzymes. Conversion of amino acids to specialized products- Serotonin, GABA, epinephrine, nor-epinephrine, melanin, creatinine and NAD.

### **UNIT V**

**Mineral metabolism** - macro, micromineral nutrients - daily requirements, sources, biochemical functions, regulation of intake, turnover, metabolism and disorders - calcium, phosphorus, iron, copper, zinc, magnesium, chromium, selenium, sodium and potassium.

### **Books Recommended**

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6<sup>th</sup> ed), W.H.Freeman
2. Voet.D and Voet. J.G (2010) Biochemistry (4th ed), John Wiley & Sons, Inc.
3. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012). Harper's Illustrated Biochemistry (29<sup>th</sup> ed), McGraw-Hill Medical.
4. Metzler D.E (2003). The chemical reactions of living cells (2<sup>nd</sup> ed), Academic Press.
5. Zubay G.L (1999) Biochemistry (4<sup>th</sup> ed), Mc Grew-Hill.
6. Ferrier DR (2013). Lippincott's Illustrated Reviews Biochemistry (6<sup>th</sup> ed), Ippincott Williams & Wilkins
7. M.N.Chatterjee and Rana Shinde (2007). Textbook of Medical Biochemistry (7<sup>th</sup> ed).

## CORE PAPER- VI - INTERMEDIARY METABOLISM II

CREDITS – 4

TOTAL HOURS – 60

On Successful completion of course, students will be able to

**CO-1:** Understand metabolic pathways that lead to synthesis and catabolism of major bio-molecules. Get an idea about the structure, biosynthesis, oxidation and storage of fatty acids.

**CO-2:** Describe what happens when lipids are metabolized, cholesterol, prostaglandins etc. are synthesized, emphasizing the genetic defects of lipid metabolism.

**CO-3:** The students will have knowledge of metabolic pathways leads to biosynthesis of essential amino acids

**CO-4:** Differentiate between ketogenic and glucogenic amino acids and common pathways of amino acid catabolism to release ammonia and carbon skeletons.

**CO-5:** Understand the inter conversion of major food stuffs.

Intermediary Metabolism II	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3	✓		✓		
Unit-4	✓			✓	
Unit-5					✓

### UNIT I

**Fatty acid Metabolism** - Oxidation of saturated and unsaturated fattyacids ( $\alpha$ ,  $\beta$  &  $\omega$  oxidation) Oxidation of fatty acids with odd and even numbered carbon atoms. Regulation of  $\beta$  oxidation. Ketogenesis and its regulation. Biosynthesis of fatty acid – saturated and unsaturated, chain elongation, regulation.

### UNIT II

**Lipid Metabolism** - Biosynthesis and degradation of triacylglycerol, phosphoglycerolipids-lecithin, cephalin, plasmalogens and phosphatidyl inositol, Sphingolipid-sphingomyelin, cerebrosides, sulfatides, and gangliosides. Biosynthesis of prostaglandins, thromboxanes and leukotrienes and hydroxyl eicosanoic acids. Cholesterol biosynthesis

and its regulation. Biosynthesis of bile acids. Lipoprotein metabolism - chylomicrons, VLDL, HDL and LDL.

### **UNIT III**

**Biosynthesis of Amino acids** - Biosynthesis of non - essential amino acids - Role and biological significance of glutamate dehydrogenase, glutamine and asparagine synthetase, lysine, proline and phenylalanine hydroxylase. Interconversion of amino acids - proline to glutamate, methionine to cysteine, serine to glycine. Biosynthesis of spermine and spermidine.

### **UNIT IV**

**Degradation of aminoacids** – glucogenic and ketogenic aminoacids. Formation of acetate from leucine and aromatic aminoacid, pyruvate from cysteine, threonine and hydroxy proline,  $\alpha$ -keto glutarate from histidine and proline, succinate from methionine, threonine, valine and isoleucine, Oxaloacetate from aspartate, glycine and serine.

### **UNIT V**

**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.

### **Books Recommended**

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6<sup>th</sup> ed), W.H.Freeman
2. Voet.D and Voet. J.G (2010). Biochemistry (4<sup>th</sup> ed), John Wiley & Sons, Inc.
3. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012). Harper's Illustrated Biochemistry (29<sup>th</sup> ed), McGraw-Hill Medical.
4. Metzler D.E (2003). The chemical reactions of living cells (2<sup>nd</sup> ed), Academic Press.
5. Zubay G.L (1999). Biochemistry (4<sup>th</sup> ed), Mc Grew-Hill.
6. Ferrier DR (2013). Lippincott's Illustrated Reviews Biochemistry (6<sup>th</sup> ed), Lippincott Williams & Wilkins.

## CORE PAPER VII - PRACTICAL –I

CREDITS – 3

TOTAL HOURS – 60

On successful completion of the course, students will be able

**CO-1:** To understand the procedure of isolation and estimation of Nucleic acids from goat liver, RNA from Yeast, Glycogen from liver.

**CO-2:** To know about the UV absorption studies of nucleic acids and protein.

**CO-3:** To assay the activity of Lactate dehydrogenase and glutamate dehydrogenase from goat liver sample.

**CO-4:** To perform the technique of homogenization and differential centrifugation for the separation of organelles.

**CO-5:** To know about the quantitative determination of pyruvate, Tryptophan, protein, Iron and total carbohydrate by colorimetric procedures.

### PSO- CO MATRIX

Core Practical I	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Higher studies)	PSO-4 (Competitive Exams)	PSO-5 (Employment)
CO-1		✓			
CO-2		✓	✓		✓
CO-3		✓	✓	✓	
CO-4		✓	✓		
CO-5		✓		✓	✓

#### I. Biochemical studies and estimation of macromolecules

1. Isolation and estimation of glycogen from liver.
2. Isolation and estimation of DNA from animal tissue.
3. Isolation and estimation of RNA from yeast.
4. Preparation of genomic DNA from plant tissue.
5. Denaturation of DNA and absorption studies at 260nm.
6. Denaturation of Protein and absorption studies at 280nm.

#### II. Colorimetric estimations

1. Estimation of total carbohydrate by anthrone method.
2. Estimation of pyruvate.

3. Estimation of tryptophan.
4. Estimation of protein by Lowry's method.

### **III. Estimation of minerals and vitamins**

1. Estimation of calcium and iron.

### **IV. Group experiment**

Sub-cellular Organelles - Separation of Mitochondria and Nucleus and identification of the sub-cellular organelles using marker enzymes-Lactate Dehydrogenase, Glutamate Dehydrogenase.

### **Books Recommended**

1. David Plummer (2001). An Introduction to Practical Biochemistry (3<sup>rd</sup> ed), McGraw Hill Education (India) Private Ltd.
2. Jayaraman, J (2011). Laboratory Manual in Biochemistry, New age publishers.
3. Varley H (2006). Practical Clinical Biochemistry (6<sup>th</sup> ed), CBS Publishers.

## CORE PAPER – VIII - PRACTICAL-II

CREDITS – 3

TOTAL HOURS – 60

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

**CO-1:** Understand and perform the determination of activity of enzymes and carryout the kinetic assay of enzymes in biological samples.

**CO-2:** Find out the blood group of the given blood sample.

**CO-3:** Understand and perform the microbial culture and staining techniques.

**CO-4:** Perform the separation of biomolecules by TLC and SDS-PAGE techniques.

**CO-5:** Analyse the antioxidant activity of the given biological samples.

### PSO- CO MATRIX

Core Practical II	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Higher studies)	PSO-4 (Competitive Exams)	PSO-5 (Employment)
CO-1		✓	✓	✓	
CO-2		✓			✓
CO-3	✓	✓			✓
CO-4		✓	✓	✓	✓
CO-5		✓	✓		

1. Assay of acid phosphatase.
2. Effect of pH, temperature substrate concentration and inhibitors on activity of alkaline phosphatase
3. Assay of ATPase.
4. Test for blood grouping (Haemagglutination).
5. Culture and inoculum preparation.
6. Separation of amino acids by TLC
7. Separation of lipids by TLC.
8. Separation of proteins by SDS-PAGE.
9. Separation of DNA by agarose gel electrophoresis.
10. Assay of antioxidant activity by DPPH method.

### **Books Recommended**

1. David Plummer (2001). An Introduction to Practical Biochemistry (3<sup>rd</sup> ed), McGraw Hill Education (India) Private Ltd.
2. Jayaraman, J (2011). Laboratory Manual in Biochemistry, New age publishers.
3. Varley H (2006). Practical Clinical Biochemistry (6<sup>th</sup> ed), CBS Publishers.

## ELECTIVE PAPER – II - ENERGY AND DRUG METABOLISM

CREDITS – 3

TOTAL HOURS – 60

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

**CO-1:** Understand the concepts on thermodynamics and bio energetics.

**CO-2:** Elucidate the components and electron transport chain and mechanism of oxidative phosphorylation.

**CO-3:** Gain knowledge about photosynthesis and their components.

**CO-4:** Know the various energy sources for visceral organs.

**CO-5:** Relate drug structure with metabolic processes and specific enzymes involved in metabolism.

Energy & Drug Metabolism	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

### UNIT I

**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, cyt-P450 hydroxylase cycle. Energy rich compounds – phosphorylated and non-phosphorylated. Creatine phosphate shuttle. Phosphagens.

### UNIT II

**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  $F_0-F_1$  ATPase, ATP-ADP cycle. Inhibitors of oxidative phosphorylation ionophores, protonophores. Regulation of oxidative phosphorylation.



### **UNIT III**

**Energetics** - Energy sources of brain, muscle, liver, kidney and adipose tissue. Energetics of pyruvate. Amphibolic nature of Citric acid cycle. Anaplerotic reaction. 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.

### **UNIT IV**

**Drug Metabolism** - 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.

### **UNIT V**

**Chemotherapy** - Basic concept. Structure, Mode of action and uses of antimicrobial drugs: antibacterial- penicillin, chloramphenicol, ciprofloxacin (Fluroquinone), antifungal - miconazole, fluconazole, antiviral – acyclovir and indinavir (For HIV) and antimalarial drug – Quinidine.

### **Books Recommended**

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6<sup>th</sup> ed), W.H.Freeman
2. Voet.D and Voet. J.G (2010). Biochemistry (4th ed), John Wiley & Sons, Inc.
3. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012). Harper's Illustrated Biochemistry (29<sup>th</sup> ed), McGraw-Hill Medical.
4. Metzler D.E (2003). The chemical reactions of living cells (2<sup>nd</sup> ed), Academic Press.
5. Zubay G.L (1999). Biochemistry (4<sup>th</sup> ed), Mc Grew-Hill.
6. Ferrier DR (2013). Lippincott's Illustrated Reviews Biochemistry (6<sup>th</sup> ed), Ippincott Williams & Wilkins.
7. Devlin RM (1983). Plant Physiology (4th ed), PWS publishers.
8. Taiz L, Zeiger E (2010). Plant Physiology (5<sup>th</sup> ed), Sinauer Associates, Inc

## EXTRA DISCIPLINARY PAPER – I - PLANT PHYSIOLOGY

CREDITS – 3

TOTAL HOURS – 60

On Successful completion of course, students will be able to

**CO-1:** Gain knowledge about various phytohormones and response of plants to biotic and

abiotic stresses.

**CO-2:** Obtain knowledge on Photosynthetic mechanism in higher plants.

**CO-3:** Provide information regarding Plant metabolic processes.

**CO-4:** Understand about the structure and functions of various phytochemicals.

**CO-5:** Learn about Phytochromes and Phytoremediation.

Plant Physiology	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

### UNIT I

**Plant hormones and stress tolerance** - Plant hormones – auxins, gibberellins, cytokinins, ethylene, abscisic acid- Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

### UNIT II

**Photosynthesis** - Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, path of carbon in photosynthesis – C<sub>3</sub> and C<sub>4</sub> pathway of carbon reduction and its regulation, Photorespiration.

### **UNIT III**

**Plant metabolism** - Plant Metabolic Processes, Uptake and metabolism of mineral nutrients in plants, Sulphur metabolism. Nitrogen cycle, nitrate and nitrite reduction, denitrification, symbiotic and non-symbiotic nitrogen fixation. Biochemical and physiological role of hydrogenase. Chemoautotrophy in rhizobia and nitrifying bacteria.

### **UNIT IV**

**Phytochemicals** - Structure and functions of alkaloids, polyphenols, terpenes, lignin, tannins, pigments. Biosynthesis, Structure and functions of nicotine. Structure and effects of toxins of plant origin – mycotoxins, phytohemagglutinins, lathyragens, protease inhibitors, protein toxins.

### **UNIT V**

**Sensory photobiology** - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks. Bioremediation- Phytoremediation: types of mechanisms and applications.

#### **Reference Books:**

1. Buchann (2015), Biochemistry and Molecular Biology of Plants, 2nded. Publisher: I K International. ISBN-10: 8188237116, ISBN- 978047 0714218
2. Taiz and Zeiger, Plant Physiology, 5thedition, Sinauer Associates Inc.ISBN-13: 978- 0878938667, ISBN-10:0878938664
3. Caroline Bowsher, Martin steer, Alyson Tobin (2008), Plant Biochemistry, Garland science ISBN978-0-8153-4121-5.
4. P.M Dey and J.B. Harborne (Editors) (1997), Plant Biochemistry, Publisher: Academic Press ISBN-10:0122146743,ISBN-13:978-0122146749.
5. H.S. Srivastava and N. Shankar. Plant Physiology and Biochemistry Rastogi Publications.

## SEMESTER III

### CORE PAPER-IX – BIOTECHNOLOGY

**CREDITS – 4**

**TOTAL HOURS – 60**

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

**CO-1:** Know about the various cloning vectors employed in gene cloning technology and also to understand the methods of DNA sequencing and polymorphism.

**CO-2:** Explore about the applications of rDNA technology in producing therapeutically important proteins. To know about the separation and molecular weight determination of proteins using 2D-gel electrophoresis and mass spectroscopy.

**CO-3:** Get an idea about various bioinformatics tools and databases for structural and functional analysis of DNA and proteins.

**CO-4:** Understand the principle, procedure and applications of animal cell culture and plant tissue culture techniques. To know about the importance of patents and IPR.

**CO-5:** Explain the basic principles and methodology of producing transgenic animals and transgenic plants with their applications.

Biotechnology	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2	✓				
Unit-3				✓	✓
Unit-4				✓	✓
Unit-5		✓	✓		

#### UNIT I

**Basic techniques** - Cutting DNA molecules, Restriction endonucleases, isoschizomers. Joining DNA molecules – DNA ligase, linkers and double linkers, adaptors, homopolymer tailing. Selection of recombinants and screening – genetic methods, immuno chemical methods, South-Western screening, Nucleic acid hybridization methods. Synthesis of probes- radio-active and non-radioactive labelling of probes.

#### UNIT II

**Cloning strategies** - Cloning vectors – plasmids (pBR 322, pUC 18), phage  $\lambda$  and M 13, cosmids, phasmids, expression vectors, ; pMal; GST; pET-based vectors, Protein

purification, His-tag; GST-tag; MBP-tag, Inclusion bodies- Methodologies to reduce formation of inclusion bodies, yeast vectors – YEP, YIP, YRP, YCP and YAC, shuttle vectors. Genomic library and c-DNA library, chromosome walking, RACE, RAPD. Site directed mutagenesis of cloned genes.

### **UNIT III**

**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.

### **UNIT IV**

**Plant tissue culture** - Media, callus and organogenesis. Protoplast cultures-Isolation of protoplast, protoplast culture and regeneration, Protoplast fusion. Production of biochemicals from plant cell culture. Micropropagation. Somatic embryogenesis, Somaclonal variation. Plant based vectors - Ti and Ri plasmids. Agro bacterium mediated gene transfer to plant cells, microprojectiles and electroporation.

### **UNIT V**

**Applications of recombinant DNA technology** - Production of insulin and growth hormone in *E. coli*. Recombinant Vaccines, Gene therapy, transgenic plant technology – for pest resistance, herbicide tolerance, delay of fruit ripening and use of plants to produce commercially important proteins. Hazards and safety aspects of biotechnology. Patents and IPR.

### **Books Recommended**

1. David Freifelder (1992). Essentials of Molecular Biology (2<sup>nd</sup> ed), Jones & Bartlett Pub
2. Click B.R. and Pasternark J.J (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. (4<sup>th</sup> ed), American Society for Microbiology

3. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan Witkowski (2006). Recombinant DNA: Genes and Genomes - a Short Course (3<sup>rd</sup> ed), W.H.Freeman & Co
4. Satyanarayana U (2008). Biotechnology, Books & Allied (P) Ltd.
5. Brown TA, (2010). Gene Cloning and DNA Analysis (6<sup>th</sup> ed), Wiley-Blackwell
6. Green MR and Sambrook J (2012). Molecular Cloning: A Lab Manual(4<sup>th</sup> ed), Cold Spring Harbor Laboratory Press
7. Sandy B. Primrose and Richard M. Twyman (2002). Principles of Gene Manipulation(6<sup>th</sup> ed), Wiley-Blackwell.

## CORE PAPER –X - CLINICAL BIOCHEMISTRY-I

**CREDITS – 4**

**TOTAL HOURS – 60**

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

**CO-1:** Understand the Basic concepts and principles of Clinical Biochemistry, detail on the

various biological specimens including the process of collection, preservation and storage.

**CO-2:** Understand the causes, symptoms and diagnosis of cancer.

**CO-3:** Enumerate of the different types of anemia based on aetiology and the blood clotting pathways and the blood clotting disorders.

**CO-4:** Elaborate on the role of Serum lipids including triglycerides, cholesterol and phospholipids in diseases. Detail the clinical role of serum cholesterol and state the Clinical features of atherosclerosis

**CO-5:** Appreciate the clinical application of enzymes in diagnosis, discussion on isoenzymes and understanding their role in diagnosis. Understanding the enzyme patterns in diseases of various organs such as liver and heart.

<b>Clinical Biochemistry I</b>	<b>CO-1</b>	<b>CO-2</b>	<b>CO-3</b>	<b>CO-4</b>	<b>CO-5</b>
<b>Unit-1</b>	✓				
<b>Unit-2</b>	✓	✓			
<b>Unit-3</b>			✓		
<b>Unit-4</b>				✓	
<b>Unit-5</b>					✓

### **UNIT I**

**Biochemical Investigations** -Biochemical investigations in diagnosis, prognosis, monitoring, screening. Specimen collection and Processing: Collection of blood - venipuncture, skin puncture, arterial puncture. Anticoagulants. Collection and analysis of normal and abnormal urine. Factors influencing biochemical variables. Sample analysis and reporting - precision, accuracy, specificity, sensitivity. normal reference ranges. Good laboratory practices.

## **UNIT II**

**Applications of Clinical Biochemistry and Cancer** - Applications of Clinical Biochemistry and Cancer - Biological specimens used for the diagnosis. Preservation of biological specimens - blood, urine, CSF and amniotic fluid. Cancer - types of cancer, causes, symptoms, diagnosis and treatment. Breast cancer – aetiology, diagnosis and treatment. Lung cancer - aetiology, diagnosis and treatment.

## **UNIT III**

**Disorders of blood cells** - Hemolytic, iron deficiency and aplastic anemia and diagnosis. Hemoglobinopathies, Thrombocytopenia, Causes of leucopenia, leukemia and leucocytosis. Disorders of blood clotting mechanism - Von Willebrand's disease, Hemophilia A, B and C, diagnostic test for clotting disorders.

## **UNIT IV**

**Disorders of lipid metabolism** - Normal levels of blood lipids and their functions. Hyperlipidemia, Atherosclerosis – causes, symptoms, diagnosis and treatment. Fatty liver - causes, symptoms, diagnosis and treatment. Hypolipidemic agents. Hyper and Hypolipoproteinemia - Types and pathology.

## **UNIT V**

**Clinical Enzymology** - Clinical enzymology, functional and non-functional serum enzymes – Normal levels. Clinical significance of AST, ALT, ALP, ACP, CK,  $\gamma$ -GT, amylase, pseudocholinesterase. Enzyme pattern in diseases - myocardial infarction and liver diseases. Isoenzymes – LDH, CK and ALP. Enzymes as therapeutic agents.

### **Books Recommended**

1. Thomas M. Devlin (2014). Textbook of Biochemistry with Clinical Correlations (7<sup>th</sup> ed). John Wiley & Sons
2. Montgomery R, Conway TW, Spector AA (1996). Biochemistry: A Case-Oriented Approach (6<sup>th</sup> ed), Mosby Publishers, USA.
3. Tietz (2014). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7<sup>th</sup> ed), Saunders.
4. Dinesh Puri, (2002). Text book of Biochemistry: A clinically oriented approach - Churchill Livingstone Inc., India.
5. M.N. Chatterjee and Rana Shinde (2007). Textbook of Medical Biochemistry (7<sup>th</sup> ed).



## CORE PAPER –XI -MOLECULAR BIOLOGY

CREDITS – 4

TOTAL HOURS – 60

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

**CO-1:** To understand process of central dogma of molecular biology.

**CO-2:** Exhibit a knowledge base in cells and to analyze it.

**CO-3:** To draw and prepare charts about different molecular biology process.

**CO-4:** To describe the mechanism of molecular biology.

**CO-5:** Apply and develop the principles of molecular biology to the betterment of human life.

Molecular Biology	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1		✓	✓		
Unit-2	✓	✓	✓	✓	✓
Unit-3		✓	✓	✓	✓
Unit-4	✓		✓	✓	✓
Unit-5	✓		✓	✓	✓

### UNIT I

**Replication** – Eukaryotic gene and genome structure – Various stages of DNA condensation into chromosome. Central dogma of molecular biology. Replication in eukaryotes – Pre-replication complex formation, eukaryotic replication fork assembly formation, Elongation and termination of eukaryotic replication, End replication problem – Role of telomerase in eukaryotic replication; Regulation of eukaryotic replication.

### UNIT II

**Transcription** – Definition, Eukaryotic RNA polymerases – RNA Polymerase I, RNA polymerase II and RNA polymerase III, structure and function, Promoters of transcription, Transcription factors, rRNA Transcription by RNA Polymerase I, mRNA transcription by RNA polymerase II and tRNA transcription by RNA polymerase-III. Post transcriptional modifications of m-RNA, rRNA and tRNA, Splicing – Spliceosome, self splicing, alternative splicing and RNA editing; Regulation of eukaryotic transcription.

### **UNIT III**

**Translation** - Initiation of translation in eukaryotes, Cycle of peptidyl chain elongation during eukaryotic translation, Termination in eukaryotic translation, Model of protein synthesis in circularized eukaryotic m-RNA, Protein folding, Protein sorting - Overview of secretory and endocytic pathways of protein sorting, Vesicle mediated protein trafficking between ER and cis-golgi, Trafficking of soluble enzymes from trans-golgi and cell surface to lysosomes.

### **UNIT IV**

**DNA damage and repair** – Mutation – Spontaneous and induced mutation, Point mutations, Chemical mutagenesis, transitions, transversions, Misalignment mutagenesis, Intragenic suppression, Mutator and antimutator mutations; Repair system – Direct reversal repair system, Base excision repair system, Mismatch repair system, Nucleotide excision repair system, Double strand break repair system, Post replication repair and SOS repair; Invitro site directed mutagenesis.

### **UNIT V**

**Molecular Biology techniques** - Blotting techniques – Southern, Northern and Western blotting – principle and applications. DNA sequence methods: Automated sequencing, Next Generation Sequencing (NGS). DNA finger printing. PCR – principle, methodology and applications.

### **Books Recommended**

1. Molecular biology of the gene - James D. Watson, Tania A. Baker, Stephen P. Bell and Alexander Gann, Michael Levine, and Richard Losick, 7<sup>th</sup> Edition, 2013, Pearson Education. (Unit II)
2. Molecular Cell Biology - Harvey Lodish, Matthew P. Scott, Paul T. Matsudaira, Arnold Berk, Chris A. Kaiser, Monty Krieger, Lawrence Zipursky, James E. Darnell, 5<sup>th</sup> Edition, W. H. Freeman, 2004 (Unit III and Unit IV)
3. Principles of Genetics - Robert H. Tamarin, 7<sup>th</sup> Edition, 2002, Tata McGraw-Hill Education. (Unit II and Unit V)
4. The Cell A Molecular Approach - Cooper and Hausman, 4<sup>th</sup> Edition, 2007, ASM Press. (Unit I).

6. Principles of Biochemistry – Donald, Voet, Judith G., Pratt, Charlotte W. Voet, 3<sup>rd</sup> Edition, 2008, Wiley.
7. Genetics: Principles and Analysis-Daniel L. Hartl and Elizabeth W. Jones, 4th Edition, 1998, Jones and Bartlett Publishers.

## ELECTIVE PAPER – III – BIOSTATISTICS

CREDITS – 3

TOTAL HOURS – 60

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

**CO-1:** understand collection of data, tabulation and graph making.

**CO-2:** study correlation and regression of biological data.

**CO-3:** understand about basic concepts sampling.

**CO-4:** gain knowledge about ANOVA and chisquare test

**CO-5:** know the various operating systems and application programmes for data analysis.

Biostatistics	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4			✓	✓	
Unit-5	✓				✓

### UNIT I

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

### UNIT II

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

### **UNIT III**

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

### **UNIT IV**

**Small sample tests** – Students‘t’ test for mean, difference of two way means, tests for correlation and regression coefficients. Chi-square test for goodness of a non independence of attributes. F test for equality of variances. ANOVA- one way and two way. Basic concept related to biological studies.

### **UNIT V**

**Operating systems and application programmes -** MS excel and Statistical package for social sciences (SPSS) for basic statistical functions, Regression, correlation, ANOVA, Chi square test with specific biological examples.

### **Books Recommended**

1. Zar, J.H. (1984). Bio Statistical Methods, Prentice Hall, International Edition
2. Sundar Rao P. S.S., Jesudian G. & Richard J. (1987). An Introduction to Biostatistics (2<sup>nd</sup> ed), Prestographik, Vellore, India.
3. Warren,J, Gregory,E, Grant,R (2004). Statistical Methods in Bioinformatics (1<sup>st</sup> ed), Springer.
4. Milton,J.S.(1992). Statistical methods in the Biological and Health Sciences (2<sup>nd</sup> ed), Mc Graw Hill.
5. Rosner,B (2005), Fundamentals of Biostatistics, Duxbury Press.
6. A.Rajathi and P.Chandran. SPSS for you, MJP publishers.
7. N.Gurumani, An introduction to Biostatistics (2<sup>nd</sup> ed).
8. S.Palinichamy and M.Manoharan. Statistical methods for biologists.

## EXTRA DISCIPLINARY PAPER – II - GENOMICS AND PROTEOMICS

CREDITS – 3

TOTAL HOURS – 60

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

**CO-1:** Exhibit a knowledge base in genetics and to analyze it.

**CO-2:** Understand the methods of karyotyping, genome mapping and goals & benefits of Human genome project.

**CO-3:** Know about the separation and molecular weight determination of proteins using 2D-gel electrophoresis and mass spectroscopy.

**CO-4:** Get an idea about various bioinformatics tools and databases for structural and functional analysis of DNA and proteins.

**CO-5:** Understand the principle, methodology and applications of genomics.

<b>Genomics &amp; Proteomics</b>	<b>CO-1</b>	<b>CO-2</b>	<b>CO-3</b>	<b>CO-4</b>	<b>CO-5</b>
<b>Unit-1</b>	✓				
<b>Unit-2</b>		✓			✓
<b>Unit-3</b>			✓		
<b>Unit-4</b>				✓	✓
<b>Unit-5</b>					✓

### UNIT I

**Genetics** - Mendel laws of inheritance – dominance - complete, incomplete and co dominance, multiple alleles, restriction mapping- mode of gene information transfer in bacterial- conjugation, transformation and transduction. Population genetics – Genetic pool - Hardy-Weinberg law of equilibrium

### UNIT II

**Genomics** - Karyotyping- method and applications, Fluorescent In-Situ Hybridization(FISH), Genome mapping, types of gene map, molecular markers. The Human Genome Project- goals, results, potential benefits and risks.

### **UNIT III**

**Proteomics** - Techniques for separation and identification of proteins - 2D-gel electrophoresis, mass spectrometry, MALDI-TOF. Protein arrays. Applications of proteomics.

### **UNIT IV**

**Database and similarity studies** - Introduction, biological databases-Nucleic acid sequence database, protein sequence database and protein structure database data base similarity searches- pairwise sequence alignment, Multiple sequence alignment, construction of a phylogenetic tree.

### **UNIT V**

**Functional Genomics** - DNA Microarray Technology, Serial Analysis of Gene Expression (SAGE), Protein-Protein Interaction Mapping-Two hybrid assay, Restriction Fragment length Polymorphism (RFLP), Massive parallel reporter assay (MPRA),

### **Books Recommended**

1. David Freifelder (1992). Essentials of Molecular Biology (2<sup>nd</sup> ed), Jones & Bartlett Pub
2. Click B.R. and Pasternark J.J (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. (4<sup>th</sup> ed), American Society for Microbiology
3. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan Witkowski (2006). Recombinant DNA: Genes and Genomes - a Short Course (3<sup>rd</sup> ed), W.H.Freeman & Co
4. Satyanarayana U (2008). Biotechnology, Books & Allied (P) Ltd.
5. Brown TA, (2010). Gene Cloning and DNA Analysis (6<sup>th</sup> ed), Wiley-Blackwell
6. Green MR and Sambrook J (2012). Molecular Cloning: A Lab Manual(4<sup>th</sup> ed), Cold Spring Harbor Laboratory Press
7. Sandy B. Primrose and Richard M. Twyman (2002). Principles of Gene Manipulation(6<sup>th</sup> ed), Wiley-Blackwell.
8. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6<sup>th</sup> ed), John Wiley and Sons. Inc.

**SEMESTER IV**  
**CORE PAPER – XII - HORMONES**

**CREDITS – 4**

**TOTAL HOURS – 60**

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

**CO-1:** Understand the classification, biosynthesis, regulation and mechanism of action of hormones.

**CO-2:** Understand the various endocrine glands, their secretion and functions of various hormones.

**CO-3:** Elucidate the biosynthesis, regulation and functions of hypothalamus and pituitary hormones.

**CO-4:** Explain the synthesis and functions of thyroid, parathyroid, calcitriol and Calcitonin hormones

**CO-5:** Understand the secretion and functions of gonadal and pancreatic hormones, their effects in target cells. To explore the secretion of adrenal hormones, their effects in target cells and its deficiency status

<b>Hormones</b>	<b>CO-1</b>	<b>CO-2</b>	<b>CO-3</b>	<b>CO-4</b>	<b>CO-5</b>
<b>Unit-1</b>	✓	✓	✓		
<b>Unit-2</b>		✓			
<b>Unit-3</b>	✓	✓		✓	
<b>Unit-4</b>		✓			✓
<b>Unit-5</b>		✓			✓

**UNIT I**

**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.



## **UNIT II**

**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.

## **UNIT III**

**Thyroid and Parathyroid hormone** -Thyroid hormones – synthesis, secretion, transport, biological action, mechanism of action and regulation. Thyroid function tests. Parathyroid hormone – biological action, regulation of calcium and phosphorus metabolism. Calcitonin - biological action and regulation. Calcitriol – Biosynthesis, transport, functions, mechanism of action.

## **UNIT IV**

**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.

## **UNIT V**

**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.

### **Books Recommended**

1. Larsen PR (2002). Williams Text Book of Endocrinology (10<sup>th</sup> ed), Saunders.
2. Wilson JD and Foster DW (1998). Williams Textbook of Endocrinology (9<sup>th</sup> ed), Saunders.
3. Laycock J and Lee J (1979). Essential Endocrinology (1<sup>st</sup> ed), Oxford University Press.
4. Tietz (2014). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7<sup>th</sup> ed), Saunders.

## CORE PAPER – XIII - CLINICAL BIOCHEMISTRY-II

CREDITS – 4

TOTAL HOURS – 60

On Successful completion of course, students will be able to

**CO-1:** Understand the biochemical basis of disease based on clinical investigations.

**CO-2:** Inborn errors of Carbohydrate. Protein, lipid metabolism with clinical symptoms, diagnosis and treatment,

**CO-3:** Provides information on Gastric and renal function tests and latest instrumentation for assessing gastric and renal function.

**CO-4:** Gain knowledge on functions of liver and assessing its function through various diagnostic tests.

**CO-5:** Obtain information regarding disorders of Thyroid, Pituitary and sex hormones.

Clinical Biochemistry II	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1		✓			
Unit-2	✓		✓		
Unit-3	✓		✓		
Unit-4	✓			✓	
Unit-5	✓				✓

### UNIT I

**Inborn errors of metabolism** - Inborn errors of carbohydrate metabolism - Galactosemia, fructosuria, Glycogen storage diseases - causes and symptoms, Inborn errors of lipid metabolism - Taylach's disease, Gaucher's and Niemannpick's disease - causes and symptoms. Inborn errors of aminoacid metabolism- Phenyl ketonuria, Tyrosinemia, Maple syrup urine disease and alkaptonuria - causes and symptoms. Prenatal detection of inborn errors of metabolism in developing fetus - Autosomal recessive mode of inheritance - cystic fibrosis, X linked recessive inheritance - Duchenne muscular dystrophy.

## **UNIT II**

**Gastric function tests** – Collection and examination of gastric juice – resting contents – Volume, Colour, Consistency, Blood, Bile, Mucus, Free and Total acidity. Fractional gastric analysis, stimulation test – Alcohol, Caffeine, Histamine, Insulin and Pentagastrin stimulation tests. Tubeless gastric analysis

## **UNIT III**

**Liver Function tests** - Liver function tests based on synthesis, excretion and detoxification. Jaundice -classification, pathology and Differential diagnosis. Plasma protein changes in liver diseases. Hepatitis A, B and C. Gall stones – types, pathogenesis, diagnosis and treatment.

## **UNIT IV**

**Renal function tests** - tests for glomerular and tubular function - Acute and chronic renal failure - Glomerulonephritis, Nephrotic syndrome, urinary calculi - Nephrocalcinosis and Nephrolithiasis - causes, pathology and symptoms. Dialysis- Hemodialysis and peritoneal dialysis.

## **UNIT V**

**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.

### **Books Recommended**

1. Thomas M.Devlin (2014). Textbook of Biochemistry with Clinical Correlations (7<sup>th</sup> ed). John Wiley and Sons.
2. Montgomery R, Conway TW, Spector AA (1996). Biochemistry: A Case-Oriented Approach (6<sup>th</sup> ed), Mosby Publishers, USA.
3. Tietz (2014). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7<sup>th</sup> ed), Saunders.
4. Dinesh Puri, (2002). Text book of Biochemistry: A clinically oriented approach - Churchill Livingstone Inc., India.
5. M.N.Chatterjee and Rana Shinde (2007). Textbook of Medical Biochemistry (7<sup>th</sup> ed).

## CORE PAPER XIV - PRACTICAL-III

CREDITS – 4

TOTAL HOURS – 60

**On Successful completion of course, students will be able to**

CO-1: Demonstrate the principles of laboratory practices in clinical biochemistry.

CO-2: Design and develop antioxidant assay for biochemical project work.

CO-3: Able to visualize the blood cells under microscope.

CO-4: Interpret the results of liver function test and renal function test.

CO-5: Develop a strategy to record the biochemical parameters to diagnose and prevent physiological defective conditions.

### PSO- CO MATRIX

Core Practical-III	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Higher studies)	PSO-4 (Competitive Exams)	PSO-5 (Employment)
CO-1		✓			✓
CO-2		✓	✓		✓
CO-3		✓			✓
CO-4		✓			✓
CO-5		✓			✓

1. **Antioxidant analysis:** Determination of activity of super oxide dismutase, catalase and Gpx. Estimation of vitamin E, C and glutathione
2. **Haematology:** RBC count, WBC count – total and differential count, ESR, PCV, MCV. Estimation of hemoglobin..
3. **Liver function test:** Estimation of bilirubin – direct and indirect. Estimation of plasma protein, A/G ratio, alkaline phosphatase, transaminases(AST,ALT)
4. **Renal function test:** Qualitative tests for normal and pathological components of urine. Estimation of blood and urine urea, creatinine, creatine and uric acid. Urea Clearance tests.
5. Estimation of blood glucose by orthotoluidine and glucose oxidase method. Determination of glycosylated Hb. Glucose tolerance test.
6. Estimation of cholesterol by Zak's method, estimation of phospholipids.

### **Books Recommended**

1. Varley's Practical Clinical Biochemistry – Alan H Gowenlock, Janet R. McMurray, Donald M. McLauchlan, 6<sup>th</sup> Edition, 1988, CRC Press. (Antioxidant status).
2. Tietz Fundamentals of Clinical chemistry – Carl A. Burtis, Edward R. Ashwood, Barbara Border, Norbert W. Tietz, 5<sup>th</sup> Edition, 2001, Palme yayıncılık. (Immunological studies).
3. Principles and Techniques of Biochemistry and Molecular Biology– Keith Wilson and John Walker, 5<sup>th</sup> Edition, 2010, Cambridge University Press. (Immunological studies).
4. Principles of Instrumental analysis – Skoog, Holler, Nieman, 5<sup>th</sup> Edition, 1998, Saunders College Publishing. (Immunological studies).
5. Manual for Medical Laboratory Technology - S Ramakrishnan, KN Sulochana, 1<sup>st</sup> Edition, 2012, Jaypee Brothers Medical Publishers Pvt. Ltd. (Hematological parameters).

## ELECTIVE PAPER –IV - SIGNAL TRANSDUCTION

CREDITS – 3

TOTAL HOURS – 60

On successful completion of the course students will be able to

**CO-1:** Understand the basic elements of intracellular and intercellular signal transduction pathways

**CO-2:** know about nuclear receptors and cell surface receptors their signal transduction pathways

**CO-3:** Gain knowledge on receptors that couple to G proteins its signal transduction in eukaryotic cells

**CO-4:** Acquire information about JAK-STAT and MAPK pathways

**CO-5:** Obtain information regarding structure and regulation of protein kinases and protein phosphatases

Signal Transduction	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

### Unit I

**General functions and structure of signalling pathways** - Mechanism of intracellular and intercellular signal transduction, regulation of inter and intracellular signalling, Hormone and hormone analogues. Recognition and interaction of hormones with receptors, Signal amplification, Receptor super families and subtypes. Intra cellular signaling molecules - secondary messengers, Divergence, convergence and cross talk.

### Unit II

**Receptors** - Nuclear receptors, Principles of signaling by nuclear receptors, Classification and structure of nuclear receptors, ligands of nuclear sectors, Mechanism of transcriptional regulation by nuclear receptors, transactivation .Steroid hormone signaling

### **Unit III**

**G - protein coupled signal transduction pathways** - Transmembrane Receptors – Structure, Major classes of trimeric G proteins based on Gs unit, mechanism of signal transmission, toxins as tools in characterization of G- protein, GTPase switches, G proteins that regulate ion channels; G-protein and gene control

### **Unit IV**

**Signalling and Gene control** - TGF receptors, Cytokine receptors and JAK – STAT; Receptor Tyrosine Kinases (RTK), activation of ras, genetic analysis – drosophila eye development; MAPK; Phosphoinositide cascade-insulin signalling pathway, NF-kB; signal induced protein cleavage, down modulation of receptor signaling.

### **Unit V**

**Protein kinases and protein phosphatases** - Classification, structure protein kinases, ser/thr protein kinases, Regulation of PKA, PKB, PKC, Ca<sup>2+</sup>/ calmodulin - dependent protein kinases, Structure and regulation of phosphatases, I,2A,2B,PP2A.

### **Books Recommended**

1. John Hancock (2010). Cell signalling (3<sup>rd</sup> ed), Oxford University Press
2. Wendell Lim, Bruce Mayer (2014). Cell Signalling (Garland Science).
3. Lewin B (2004). Genes 8, Prentice Hall, International edition.
4. Watson JD, Baker TA, Bell S, Gann A, Levine M, Losick R, (2004). Molecular Biology of the Gene, Addison Wesley.
5. Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P (2003). Essential Cell Biology, Garland Science.
6. Lodish H, Darnell JE (2003). Molecular Cell Biology, W.H.Freeman and Co Ltd.
7. *Gerhard Krauss*(2014), Biochemistry of Signal Transduction and regulation, Wiley Publications

## ELECTIVE PAPER –V - ADVANCED IMMUNOLOGY

CREDITS – 3

TOTAL HOURS – 60

On successful completion of the course students will be able to

**CO-1:** To understand different defects of immune system.

**CO-2:** Acquaint the knowledge of immune components.

**CO-3:** To draw and prepare charts about different immunological process.

**CO-4:** To describe the mechanism of immunological reactions.

**CO-5:** Apply and develop the principles for the protection of human life.

Advanced Immunology	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1		✓		✓	✓
Unit-2		✓	✓	✓	✓
Unit-3	✓	✓	✓	✓	✓
Unit-4	✓	✓	✓	✓	✓
Unit-5	✓	✓	✓	✓	✓

### UNIT I

**Basics of Immune system** – Cells and Organs of immune system, Immunity – Types of immunity, Innate and acquired immunity, Active and passive immunity, humoral and cell mediated immunity, Basics of antigens and antibodies.

### UNIT II

**Immunochemical techniques** – Estimation of antibody – Antigen antibody interactions in solution, agglutination of antigen coated particles, immunoassay for antibody using solid phase antigen, Detection of immune complex formation, Identification and measurement of antigens – precipitations in gel, nephelometric assay, immunoelectrophoresis and immunoblotting, epitope mapping, Monoclonal antibody production, Purification of antigens and antibodies by affinity chromatography.



### **UNIT III**

**Immunodeficiency Diseases** – Classification of immunodeficiency diseases, Primary immunodeficiency diseases – B-cell abnormalities (X-linked agammaglobinemia, Duncan's syndrome), T-cell abnormalities (Di George syndrome and Wiskott-Aldrich syndrome), B-cell and T-cell abnormalities (SCID and Bare lymphocyte syndrome), Abnormalities associated with phagocytic cells (Chediak-Higashi syndrome), Abnormalities associated with complements (Hereditary angioedema), Secondary immunodeficiency disease – AIDS.

### **UNIT IV**

**Hypersensitivity and Autoimmunity** – Types of Hypersensitivity diseases, Effector mechanisms of immunologic tissue injury and diseases – Diseases caused by antibodies, Diseases caused by T-lymphocytes, Pathogenesis of autoimmunity – Genetic susceptibility to autoimmunity, Role of infection in autoimmunity, Therapeutic approaches for immunological diseases.

### **UNIT V**

**Transplantation immunology** – Major Histocompatibility Complex (MHC) – Nomenclature and genetic organization of MHC, Structure and functions of MHC molecules (MHC-I and MHC-II), HLA typing – Lymphocytotoxicity and Mixed lymphocyte reaction, Definition of Transplantation, Classification of grafts, Immunology of graft rejections, Mechanisms of graft rejections, Precaution against graft rejection,

### **Books Recommended**

1. Kuby's Immunology - Janis Kuby, Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, 4<sup>th</sup> Edition, 2000, W.H. Freeman. (Unit I)
2. Roitt's Essential Immunology - Ivan Roitt and Peter Delves, 10<sup>th</sup> Edition, 2001, Wiley. (Unit II)
3. Immunology for Life Scientists – Lesley and Jane Eales. (Unit III)
4. Cellular and molecular immunology - Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, 7<sup>th</sup> Edition, 2011, Elsevier Health Sciences. (Unit IV)
5. Immunology: Introductory text book – Nandini Shetty, 1<sup>st</sup> Edition, 2005, New Age International.(Unit V)

6. Immunology: An Introduction - Tizard, I.R., 4<sup>th</sup> edition, 1995. Saunders College Publishing, New York.
7. Immunobiology - Janeway CA, Travers P, Walport M, and Shlomchik M, 6<sup>th</sup> edition, 2001, Garland Publishing, New York.