

SRI SANKARA ARTS AND SCIENCE COLLEGE

(Autonomous)

DEPARTMENT OF BIOCHEMISTRY

BACHELOR 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 Three years (six 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 Candidate for admission to the first year of B.Sc. Degree Course in Bio-Chemistry shall be required to have passed the Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry.

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 three academic years and passed the examinations of all the Six Semesters prescribed earning a minimum of **140 credits as per the distribution given in Regulation for Part I, II, III, IV & V** 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)

Course Component	Name of the Course	Credits allotted for Four Semester Language Papers *
PART I	Tamil or Other Languages	12
PART II	English	12
PART III	Core Courses	60
	Allied Courses	20
	Project/ Three Elective Courses	15
PART IV	i. Basic Tamil/ Advanced Tamil/ NME	04
	ii. Soft Skill Courses	12
	iii. Environmental Studies	02
	iv. Value Education	02
PART V	Extension Activities	01
Total Credits		140

4.2 DETAILS OF COURSE OF STUDY OF PARTS I – V

4.2.1 PART I: Tamil and Other Languages: Tamil or Sanskrit (Classical language) at the option of candidates and according to the syllabus and text-books prescribed from time to time:

4.2.2 PART II: English: According to the syllabus and text-books prescribed from time to time

4.2.3 PART III: Core, Allied and Project/Three Elective Courses: As prescribed by the concerned Board of Studies

4.2.4 PART IV:

i. Basic Tamil/ Advanced Tamil/ NME:

- a. Students who have not studied Tamil up to XII STD and have taken any Language other than Tamil in Part I shall take Basic Tamil comprising of Two Courses (level will be at 6th Standard).
- b. Students who have studied Tamil up to XII STD and have taken any Language other than Tamil in Part I shall take Advanced Tamil comprising of Two Courses.
- c. Students who have studied Tamil up to XII STD and also have taken Tamil in Part I shall take Non-Major Elective comprising of Two Courses.

ii. Soft Skill Courses

iii. Environmental Studies

iv. Value Education

4.2.5 PART V: Extension Activities:

Students shall be awarded a maximum of 1 Credit for Compulsory Extension Service. All the Students shall have to enroll for NSS /NCC/ NSO (Sports & Games) Rotract/ Youth Red Cross or any other Service Organizations in the College and shall have to put in compulsory minimum attendance of 40 hours which shall be duly certified by the Principal of the College before 31st March in a year. If a student lacks 40 hours attendance in the first year, he or she shall have to compensate the same during the subsequent years.

Those students who complete minimum attendance of 40 hours in one year will get 'half-a- credit and those who complete the attendance of 80 or more hours in Two Years will get 'one credit'. Literacy and Population Education and Field Work shall be compulsory components in the above extension service activities.

4.2.6. SCHEME OF EXAMINATIONS
SEMESTER - I

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
Part –I - Language Paper -I	3	25	75	100
Part –II - English Paper -I	3	25	75	100
Part-III Core Paper-I: Nutritional Biochemistry	5	25	75	100
Allied Paper- I	3	25	75	100
Part-IV * Basic Tamil/Adv. Tamil/ Non Major Elective -I: Medicinal Chemistry	2	25	75	100
Soft Skills –I	3	50	50	100

SEMESTER - II

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
Part –I – Language Paper -II	3	25	75	100
Part –II - English Paper –II	3	25	75	100
Part-III Core Paper -II: Cell Biology	5	25	75	100
Core Paper – III: Core Practical –I	4	40	60	100
Allied paper- II	3	25	75	100
Allied Practical –I &II	4	40	60	100
Part-IV * Basic Tamil/Adv. Tamil/ Non Major Elective -II: Human diseases and Preventive Aspects	2	25	75	100
Part-IV Soft Skills –II	3	50	50	100

* (a) Non-Tamil Students up to XII Std must studied “Basic Tamil” comprising of two course in degree level

(b) Tamil Students up to XII Std, taken Non-Tamil Language under Part-I at degree level, shall be taken “Advanced Tamil” comprising of two courses.

(c) Tamil Students up to XII Std and taken Tamil under Part-I Language at degree level, shall be choose “Non- major Electives” at degree level

SEMESTER - III

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
Part –I – Language Paper -III	3	25	75	100
Part –II – English Paper -III	3	25	75	100
Part-III Core paper-IV: Chemistry of Biomolecules I	5	25	75	100
Allied paper- III	3	25	75	100
Part-IV Soft Skills –III	3	50	50	100

SEMESTER – IV

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
Part –I - Language Paper -IV	3	25	75	100
Part –II - English Paper -IV	3	25	75	100
Part-III Core paper-V: Chemistry of Biomolecules- II	5	25	75	100
Core Paper VI : Core Practical II	4	40	60	100
Allied paper- IV	3	25	75	100
Allied Practical –III & IV	4	40	60	100
Part-IV- Environmental Studies	2	25	75	100
Soft Skills-IV	3	50	50	100

SEMESTER - V

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
Part-III Core Paper-VII: Enzymes	5	25	75	100
Core Paper -VIII: Metabolism	5	25	75	100
Core Paper-IX: Analytical Biochemistry	5	25	75	100
Core Elective Paper -I: Human Physiology	4	25	75	100
Part-IV- Value Education	2	25	75	100

SEMESTER -VI

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
Part-III Core Paper-X: Clinical Biochemistry	5	25	75	100
Core Paper -XI: Molecular Biology	5	25	75	100
Core Paper XII – Core Practical III	4	40	60	100
Core Paper XIII – Core Practical IV	4	40	60	100
Core Elective Paper II : Immunology	5	25	75	100
Core Elective Paper III: Biotechnology	4	25	75	100
Part-V Extension Activity	1			

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. INSTRUCTIONAL (TEACHING) HOURS

5.1. For First, Fourth Second, Third and semesters:

Course	B. Sc Biochemistry
Language	4 + 2 hours *
English	4 + 2 hours @
Core Course I	5hours Theory 3hours Practical
Core Course II	-
Allied Course	
NME Course	2 hours
Total	30 hours

* 2 hours for Part IV Basic Tamil/ Advanced Tamil/ Non-Major Elective Courses

@ 2 hours for Soft Skills Courses.

5.2. For Fifth and Six Semesters:

Course	B.Sc Biochemistry
Core Course (each)	6 hours
Elective Course (each)	5 hours

6. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTER

6.1 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.

6.2 Attendance: All Students must earn 75% and above of attendance for appearing for the University Examination. (Theory/Practical)

6.3 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.

6.4 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.

6.5 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.

6.6 Condonation of shortage of attendance for married women students: In respect of married women students undergoing UG 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.

6.7 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.

6.8 Transfer of Students and Credits: The strength of the credit 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.

6.8.1 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.

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

6.8.3 The transfer students are eligible for classification.

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

6.8.5 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.

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

7. EXAMINATION AND EVALUATION

7.1 Register for all subjects: Students shall be permitted to proceed from the First Semester up to Final Semester irrespective of their failure in any of the Semester Examination. For this purpose, Students shall register for all the arrear subjects of earlier semesters along with the current (subsequent) Semester Subjects.

7.2 Marks for Internal and End Semester Examinations for PART I, II, III, and IV

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

7.3 Procedure for Awarding Internal Marks

Course	Particulars	Marks
Theory Papers	Tests (2 out of 3)	10
	Attendance	05
	Seminars	05
	Assignments	05
	Total	25
Practical Papers	Attendance	05
	Test best 2 out of 3	30
	Record	05
	Total	40
Project	Internal Marks (best 2 out of 3 presentations)	20
	Viva-Voce	20
	Project Report	60
	Total	100

7.4 (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

7.4.1 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.

Question Paper Pattern for End Semester (University) Examination

SECTION – A			
10 questions out of 12 Questions	30 words	10 X 2	20 Marks
SECTION – B			
5 questions out of 7 Questions	200 words	5 X 5	25 Marks
SECTION – C			
3 questions out of 5 Questions	500 words	3 X 10	30 Marks
Total			75 Marks

7.6 PASSING MINIMUM

7.6.1 There shall be no passing minimum for Internal.

7.6.2 For external examination, passing minimum shall be 40% [Forty Percentage] of the maximum marks prescribed for the paper for each Paper/Practical/Project and Viva-Voce.

7.6.3 In the aggregate [External/Internal] the passing minimum shall be of 40%.

7.6.4 He/She shall be declared to have passed the whole examination, if he/she passes in

all the papers and practical wherever prescribed as per the scheme of the examinations by earning **140 CREDITS** in PartI, II, III, IV & V. He/she shall also fulfil the extension activities prescribed earning a minimum of 1 credit to qualify for the Degree.

7.7 INSTANT EXAMINATION: Instant Examinations is conducted for the students who appeared in the final semester examinations. Eligible criteria for appearing in the Instant Examinations are as follows:

7.7.1 Eligibility: A Student who is having arrear of only one theory paper in the current final semester examination of the UG Degree programme alone is eligible to appear for the Instant Examinations.

7.7.2 Non-eligibility for more than one arrear paper: A Student who is having more than one arrear paper at the time of publication of results is not eligible to appear for the Instant Examinations.

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

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

7.8 RETOTALLING, REVALUATION AND PHOTOCOPY OF THE ANSWER SCRIPTS:

7.8.1 Re-totalling: All UG Students who appeared for their Semester Examinations are eligible for applying for re-totalling of their answer scripts.

7.8.2 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.

7.8.3 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.

7.9 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

8. CLASSIFICATION OF SUCCESSFUL STUDENTS

8.1 PART I TAMIL / OTHER LANGUAGES; PART II ENGLISH AND PART III CORE SUBJECTS, ALLIED, ELECTIVES COURSES AND PROJECT:

Successful Students passing the Examinations for the Part I, Part II and Part III courses and securing the marks (a) 60 percent and above and (b) 50 percent and above but below 60 percent in the aggregate shall be declared to have passed the examination in the **FIRST and SECOND** class respectively; all other successful candidates shall be declared to have passed the examination in the **THIRD Class**.

9. **MARKS AND GRADES:** The following table shows the marks, grade points, letter grades and classification to indicate the performance of the Student:

RANGE OF MARKS	GRADEPOINTS	LETTERGRADE	DESCRIPTION
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
40-49	4.0-4.9	C	Satisfactory
00-39	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

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

GPA for a Semester: = $\sum iC_iG_i \div \sum iC_i$

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.

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.

9.2 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	
4.5 and above but below 5.0	C +	Third Class
4.0 and above but below 4.5	C	
0.0 and above but below 4.0	U	Re-appear

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

10. 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 6 are only eligible for Classification.

11. CONCESSIONS FOR DIFFERENTLY-ABLED STUDENTS

11.1 Dyslexia students: For students, who are mentally disabled, learning 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:

- i) Part I Foundation course Tamil or any other Language can be exempted.
- ii) One-third of the time of paper may be given as extra time in the examination.
- iii) Leniency in overlooking spelling mistakes, and
- iv) Amanuensis for all courses 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.

11.2 Hearing, Speaking Impaired & Mentally retarded: For students who are hearing and speaking impaired and who are mentally challenged, the following concessions shall be granted:

- i) One Language paper either Part I Foundation course Tamil or any other Language or Part II English or its equivalent can be exempted
- ii) Part IV Non-Major Elective (NME) or Basic Tamil or Advanced Tamil can be exempted.

11.3 Visually Challenged students:

- i) A scribe shall be arranged by the College and the scribe be paid as per the College decision.

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

12.1 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.)

12.2 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).

12.3 Students qualifying during the extended period shall not be eligible for **RANKING**.

Learning Outcomes-based Approach to Curricular Planning

Aims of B.Sc degree programme in Biochemistry:

The overall aims of B.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 laboratory training or a science project 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 graduate 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.

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 behavior 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 B.Sc degree programme in Biochemistry

Each graduate 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—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 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.** Comprehending fundamental concepts in Biochemistry to enhance knowledge in theoretical aspects.
- PSO-2.** Understanding and acquiring skills in performing laboratory experiments.
- PSO-3.** Inculcating research motivation among student community and boosting them to pursue higher studies in Biochemistry
- PSO-4.** Contribution to the betterment of the student community by inculcating sound knowledge in the clearance of competitive exams.
- PSO-5.** Facilitate the development of skills based on current trends in versatile fields by offering Job oriented certificate courses and Value-added courses.

B. Sc DEGREE COURSE IN BIOCHEMISTRY

SYLLABUS

(Effective from the academic year 2020 – 2021)

SEMESTER- I

CORE PAPER-I: NUTRITIONAL BIOCHEMISTRY

CREDITS – 5

TOTAL HOURS – 60

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

CO-1: Explore the role of food and nutrients in the maintenance of health and to understand about the calorific value of foods and nutrients, BMR and its determination.

CO-2: Know about the sources, daily requirements, biological functions and deficiency symptoms of various vitamins and minerals.

CO-3: Know about causes, biochemical manifestations and treatment of nutritional disorders such as Kwashiorkor and Marasmus (Under nutrition) and Obesity (over nutrition).

CO-4: Know about the physiological role and nutritional significance of carbohydrates, proteins, lipids and nutraceuticals.

CO-5: Understand the concepts of human rights and its applications.

Nutritional Biochemistry	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2			✓	✓	
Unit-3		✓			
Unit-4		✓			
Unit-5					✓

UNIT I

Basics of Food and Nutrition - Concepts of food and nutrition. Composition of food, Basic food groups- energy yielding, body building and functional foods. Units of energy. Calorific value of foods. Measurement of calories by bomb calorimeter. Energy requirement of man, Basal metabolic rate (BMR) - definition, determination of BMR and factors affecting BMR. Respiratory quotient (RQ) of nutrients and factors affecting the RQ. SDA - definition and biological significance.

UNIT II

Biological role of Macronutrients - Physiological role and nutritional significance of carbohydrates, lipids and proteins. Glycemic index of foods, Evaluation of proteins by nitrogen balance method - Biological value of proteins - Digestibility Coefficient, Biological Value, and Net Protein Utilization. Protein energy malnutrition- Kwashiorkor and Marasmus, Clinical manifestations and management. Obesity (elementary details).

UNIT III

Balanced Diet and Vitamins - Balanced diet, example of a low and high cost balanced diet – for children, adults and elderly people. Role of dietary fiber. Nutrient antioxidants and their sources. Role of nutraceuticals in health.

Vitamins - definition and types of vitamins. Sources, requirement, biological functions, deficiency symptoms of Water soluble vitamins - thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folic acid and cyanacobalamine and vitamin- C. Sources, requirement, biological functions, deficiency symptoms of Fat soluble vitamins - A, D, E and K. Hypervitaminosis.

UNIT IV

Minerals - sources, requirement, physiological functions, deficiency and toxicity of calcium, sodium, potassium, iron, magnesium, Chromium, cobalt, copper, manganese, molybdenum, selenium, iodine and Zinc.

UNIT V

Human rights – introduction- definition, scope and need for study of human rights and relations. Categories- civil and political rights, economic relations and social relations. Institutions : International and National- United Nations Human Rights Commission, State Human Rights Commission. International Convention on civil and political rights. International convention on economic and social rights. National Human Rights Act- National Commission for minorities, SC/ST and Women, Students activity- assignment, case study, term paper.

Books Recommended

1. Garrow, JS, James WPT and Ralph A (2000). Human nutrition and dietetics (10th ed) Churchill Livingstone
2. Andreas M. Papas (1998). Antioxidant Status, Diet, Nutrition, and Health (1st ed) CRC Press
3. M.Swaminathan (1995). Principles of Nutrition and Dietetics. Bappco
4. Margaret Mc Williams (2012). Food Fundamentals (10th ed), Prentice Hall
5. Tom Brody (1998). Nutritional Biochemistry (2nd ed), Academic Press, USA
6. Aravind Kumar (1999). Human rights and social movements, Anmol publishers.
7. Piarey Lal Mehta, Neena Verma, P I Mehta (1999). Human Rights Under the Indian Constitution. Deep & Deep Publications Pvt. Ltd.

NON – MAJOR ELECTIVE PAPER- I - MEDICINAL CHEMISTRY

CREDITS – 2

TOTAL HOURS – 30

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

CO-1: Understand the first aid methods, specimen collection and transportation.

CO-2: Explain about the roles of anti-inflammatory, antihypertensive and antiulcer drugs

CO-3: Explain the Causes, Symptoms and Treatment of Blood pressure, stroke, cirrhosis and AIDS.

CO-4: Explain the mechanism of action of streptomycin, tetracyclines, *Ofloxacin*. Chloroquine, Metronidazole and Lamivudine.

CO-5: Describe Common vernacular name, biological sources and chemical nature of chief constituents and common uses of indigenous medicinal plants.

Medicinal Chemistry	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓	✓		
Unit-3		✓	✓		
Unit-4				✓	
Unit-5					✓

UNIT I

First Aid and Safety - Treatment of Shock, Hemorrhage, Cuts and Wounds. Burns – Classification and first Aid. Specimen collection and processing (Blood, urine, feaces), anti-coagulant and preservatives for blood and urine. Transport of specimens. Blood transfusion.

UNIT II

Basic Drugs: Cardiac glycosides, Antihypertensive drugs, Antihyperlipidemics, Anti-inflammatory agents, Anti-asthmatic drugs and Antiulcer drugs - each two examples, uses and side effects.

UNIT III

Vital ailments and treatment: Vital ailments and treatment - Blood pressure (Hypertension and Hypotension), stroke, cirrhosis. AIDS - Causes, Symptoms and Treatment.

UNIT IV

Antimicrobial drugs: Mode of action and uses of streptomycin, tetracyclines, Ofloxacin. Cholroquine, Metronidazole and Lamivudine.

UNIT V

Phytoedicine: Traditional drugs : Common vernacular name, biological sources, chemical nature of chief constituents and common uses of indigenous medicinal plants: Amla, Brahmi, Tulsi, Turmeric, Aloe Vera and Neem

Reference Books

1. Applied Chemistry, Jayashree Ghosh - S. Chand and Company Ltd., 2006
2. Biochemistry, S. C. Rastogi - Tata McGraw Hill Publishing Co., 1993.
3. Medicinal Plants of India, Rasheeduz Zafar - CBS Publishers and Distributors, 2000.
4. Hawk's Physiological Chemistry, B. L. Oser - Tata-McGraw Hill Publishing Co. Ltd.
5. Practical Pharmaceutical Chemistry, A. H. Beckett and J. B. Stenlake - Vol. I - CBS Publishers and Distributors, 2000.

II SEMESTER

CORE PAPER – II - CELL BIOLOGY

CREDITS – 5

TOTAL HOURS – 60

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

CO-1: Explore the structural organization of prokaryotic and eukaryotic cell and to know about the classification of bacteria, virus and fungi.

CO-2: Know about the detailed information about the sub cellular organelles such as nucleus, mitochondria, endoplasmic reticulum, golgi complex, lysosome etc.,

CO-3: Explore the organization of cells in to tissues and role of various molecules in cell-cell adhesion and cell-matrix adhesion.

CO-4: Know about the details of cell division such as mitosis and meiosis and its importance.

CO-5: Know the about the organization of prokaryotic and eukaryotic genome, Cell cycle and Cancer.

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

UNIT I

Classification of living organisms - Cell theory, cell as basic unit of life. Classification of Viruses, Bacteria and Fungi. Structure and organization of prokaryotic and eukaryotic cells. Comparison between prokaryotic and eukaryotic cell. Comparison between plant and animal cells. Bacterial cell wall.

General structure of cytoskeleton - structure, composition and functions of microfilaments, microtubules and intermediate filaments.

UNIT II

Sub cellular organelles - The ultra structure of cell wall, nucleus, mitochondria, rough and smooth endoplasmic reticulum, Golgi apparatus, lysosome, ribosomes, peroxisome, chloroplast and glyoxisome and their function.

UNIT III

Membrane Transport - Biomembrane – structure, organization and basic functions, fluid mosaic model, Transport across cell membrane – uniport, symport and antiport. Passive and active transport, Ion channel and water channel. Intercellular junction – Tight junction and Gap junction.

UNIT IV

Types of Tissues - Organization of cells into tissue. Types of tissue. Cell – cell adhesion, cell matrix adhesion. Extracellular matrix– components and their biological role. Cancer- cause, types, symptoms and treatment, Tumor markers.

UNIT V

Cell division and Cellular genome - Organisation of prokaryotic and eukaryotic genome, chromosomes, types, structure and function. Sex determination in Humans. Cell division, mitosis, meiosis, their significance. Cell cycle – phases of cell cycle, Role of cyclins and CDKs in cell cycle. Cell death-Apoptosis.

Books recommended

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6th ed). John Wiley & Sons. Inc.
2. Bruce Alberts and Dennis Bray (2013). Essential Cell Biology, (4th ed), Garland Science.
3. De Robertis, E.D.P. and De Robertis, E.M.F. (2010). Cell and Molecular Biology. (8th ed). Lippincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. (5th ed). Sunderland, Mass. Sinauer Associates, Inc.

5. Wayne M. Baker (2008). The World of the Cell. (7th ed). Pearson Benjamin Cummings Publishing, San Francisco. Cell Biology
6. P.S.Verma and V.K.Agarwal (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology (14th ed), S.Chand and Company Ltd

CORE PAPER – III - CORE PRACTICAL – I

CREDITS – 4

TOTAL HOURS – 60

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

CO-1: Know about the quantitative determination of vitamin-C, oxalic acid, iron, glycine by titrimetric method.

CO-2: understand the procedure of isolation and estimation of starch from potato, Casein from milk, Hemoglobin from blood and albumin from egg white.

CO-3: Calculate the BMI of a person to assess normal class, underweight and obesity.

CO-4: Identify the structure of cells by microscopic method.

CO-5: Know about the various nutrients present in foods by food analysis.

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. Titrimetric procedures

1. Estimation of Glycine by Sorenson's formal titration.
2. Estimation of calcium from milk.
3. Estimation of iron.
4. Estimation of Vitamin C (Ascorbic acid) from lemon or citrus fruits or amla.

II. Group experiments

1. To make a temporary stained mount of onion peel to see the structure of cells under microscope
2. To make a temporary stained mount of onion root tip to show different stages of mitosis.
3. Determination of BMI
4. Food analysis – Determination of Moisture and ash content of food sample,
Test for carbohydrates, protein, fat & minerals (iron, calcium, phosphorus and chloride)

III. Biochemical Preparation

1. Preparation of starch from potatoes.
2. Preparation of casein from milk.
3. Preparation of albumin from eggs.
4. Extraction and estimation of total lipid content in the food sample/oil seeds.

Books recommended

1. Varley's practical clinical biochemistry, Alan. H. Gowen clock, 6th Edition, 1988, CBS publishers & distributors, India.
2. Practical manual of Biotechnology, Lab Manual, Dr.Ritu Mahajan, Dr.Jitender Sharma & Dr. R.K. Mahajan, 1st Edition, 2010, Vayu education of India, New Delhi.
3. Laboratory manual and Practical biochemistry, T.N.Pattabiraman, 4th Edition, 2010, All India Publisher's & Distributors limited, New Delhi.
4. Practical text book of biochemistry for MBBS students, D.M.Vasudevan, 1st Edition, 2007, Jaypee brothers, New Delhi.
5. An introduction to practical biochemistry, David. T. Plummer, 3rd Edition, 1998, Tata Mc.Grawhill education private limited, New Delhi.

NON –MAJOR ELECTIVE PAPER –II

HUMAN DISEASES AND PREVENTIVE ASPECTS

CREDITS – 2

TOTAL HOURS – 30

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

CO1: Explain infectious diseases, diseases in young children and prevention.

CO2: Describe causes, types, symptoms and treatment measures of cancer.

CO3: Explain causes, types and treatment for diabetes and Kidney stones.

CO4: Know the nutritional significance of lipids & it's diseases with treatment measures

CO5: Understand the causes, symptoms and management of liver diseases

Human Diseases and Preventive Aspects	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT I

Pathological diseases - Diseases – definition – Examples for bacterial, viral and fungal diseases. Endemic and epidemic diseases – causes and symptoms. Major diseases of young children with special reference to diarrhea, primary complex, whooping cough, Kwashiorkor and Marasmus and their preventive aspects.

UNIT II

Cancer and prevention - Cancer- differences between benign and malignant tumors. Growth characteristics of cancer cells. Metastasis, Agents causing cancer - physical, chemical, biological. Prevalence of cancer in India. Cancer therapy - surgery, radiation and chemotherapy. Cancer prevention.

UNIT III

Thyroid hormone disorders and prevention - Hypothyroidism and hyperthyroidism – Causes, aetiology, symptoms, diagnosis, treatment and prevention. Kidney stones – Causes, types, aetiology, symptoms, diagnosis, treatment and prevention.

UNIT IV

Cardiovascular diseases and prevention - Cardiovascular diseases- Role of dietary lipids. HDL and LDL as risk factors. Hyperlipidemia, Hypo lipidemia, Atherosclerosis, Myocardial infarction- pathogenesis, diagnosis, treatment and prevention.

UNIT V

Anemia and gall stones - Anemia – classification. Iron deficiency anemia and sickle cell anemia - causes, symptoms, diagnosis, treatment and prevention. Gall stones –types, pathogenesis, diagnosis, treatment and prevention.

Books recommended

1. M.N.Chatterjee and Rana Shinde (2007).Textbook of Medical Biochemistry (7th ed)
2. Ambika Shanmugam (2012). Fundamentals of Biochemistry for Medical Students (7th ed),
3. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (2014) (7th ed),
Saunders
4. A.Catherine Ross (2012) Modern nutrition in health and diseases (11th ed). Lippincott Williams and Wilkins
5. Michael.G.Wohl, Robert.S.Goodhart, Maurice E.Shils (1999). Modern nutrition in health and disease (9th ed), Lippincott Williams and Wilkins
6. R.Ananthanarayan and C.K.Jayarane Paniker (2009). Text book of Microbiology (8th ed), Universities press private (India) Limited.

III SEMESTER

CORE PAPER – IV - CHEMISTRY OF BIOMOLECULES- I

CREDITS – 5

TOTAL HOURS – 60

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

CO-1: Understand the basic component or biomolecules of living organisms

CO-2: Have knowledge on the structure/conformational freedom of biomolecules, e.g. Carbohydrates, amino acids and proteins.

CO-3: Understand and demonstrate how the structure of biomolecules determines their chemical properties and reactivity.

CO-4: Learn the classifications of carbohydrates and proteins

CO-5: Recognize the importance of the three dimensional shape of a protein and its function and the role of non-covalent bonds in maintaining the shape of a protein.

Chemistry of Biomolecules I	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2	✓	✓			✓
Unit-3		✓	✓		
Unit-4	✓			✓	
Unit-5					✓

UNIT I

Carbohydrates - Classification and biological significance, physical properties, stereo isomerism, optical isomerism and mutarotation. Configuration of aldo and keto trioses, tetroses, pentoses and hexoses. Reactions of monosaccharides due to the presence of hydroxyl, aldehyde and ketone groups. Structure and properties of reducing disaccharides (lactose & maltose), non-reducing disaccharide (sucrose). Identification of ketose, pentose, reducing and non - reducing sugars.

UNIT II

Polysaccharides - Occurrence, structure and functions of polysaccharides- starch, glycogen and cellulose. (structural elucidation is not needed). Structure and biological significance of mucopolysaccharides - hyaluronic acid, chondroitin sulphate and heparin. Composition and functions of inulin, agar, pectin, chitin, dextran, gum arabic and alginic acid. (structures are not necessary). Structure of bacterial cell wall polysaccharides (peptidoglycan and teichoic acid), blood group polysaccharides and glycoprotein.

UNIT III

Amino acids - Biological role. General structure of amino acids. 3- and 1-letter abbreviations. Classification of amino acids based on nature of R group (polar, non polar, acidic, basic, neutral). Modified amino acids in protein, non protein amino acids. Physical properties of amino acids, isoelectric point, titration curve (alanine, lysine, glutamic acid), optical activity. Chemical reactions due to carboxyl group, amino group and side chains. Colour reactions of amino acids.

UNIT IV

Proteins - Composition and biological importance of peptides. Examples of peptide hormones. Solid state peptide synthesis. Structure of oligopeptides like glutathione, vasopressin and oxytocin, Peptidases – exo and endo peptidases. Classification of proteins based on composition, solubility, and functions. Properties of proteins- salting in and salting out, denaturation and renaturation, UV absorption. Estimation of protein by Biuret, Folin's phenol and UV methods.

UNIT V

Protein Structure - Definition and biological significance of hydrogen bond, hydrophobic interactions and van der waals forces. Levels of organization of protein structure – primary structure – composition, peptide bond. Outline of protein sequencing, Secondary structure – α helix (egg albumin), β -pleated sheath (keratin), triple helix (collagen). Tertiary structure – forces

involved in maintenance of tertiary structure like hydrogen bond, hydrophobic interactions, van der waals force, disulphide linkage and ionic bonds with reference to myoglobin. Quaternary structure with reference to haemoglobin. Ramachandran plot.

Books Recommended:

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

IV - SEMESTER
CORE PAPER – V - CHEMISTRY OF BIOMOLECULES II

CREDITS – 5

TOTAL HOURS – 60

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

CO-1: Understand the basic component or biomolecules of living organisms

CO-2: Have knowledge of the structure/conformational freedom of biomolecules, e.g. lipids and nucleic acids.

CO-3: Compare and contrast saturated, mono-unsaturated, and poly-unsaturated fatty acids.

CO-4: Understand the types and structure of DNA and RNA

CO-5: Study about heterocyclic compounds and porpyrins.

Chemistry of Biomolecules II	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2	✓	✓			
Unit-3			✓	✓	
Unit-4	✓	✓			
Unit-5					✓

UNIT I

Lipids - Chemical nature, biological functions and classification of lipids. Fatty acids – definition, classification – saturated, unsaturated, hydroxy and cyclic fatty acids, nomenclature, structure and properties of fatty acids. Simple and mixed triglycerides – structure and general properties, Isolation of fats (Folch method) and identification. Characterization of fats – iodine value, saponification value, acid number, acetyl number, Polensky number, Reichert-Meissl number.

UNIT II

Sterols - Structure of cyclopentanoperhydro phenanthrene nucleus. Animal sterol: cholesterol - properties and functions. Plant sterol: stigmasterol – Functions, Ergosterol: Functions. Lipoproteins: general structure, classification: chylomicrons, VLDL, LDL, IDL, HDL – composition and biological roles. Classification, structure, properties and biological functions of glycolipids, phospholipids and sphingolipids.

UNIT III

Nucleic acids - Structure of purine and pyrimidine bases, nucleosides and nucleotides and their biological importance. Types of DNA : A, B, C, Z DNA, structure and biological significance, superhelicity. Isolation, purification, identification and estimation of DNA. Properties of DNA – hypochromic and hyperchromic effect, melting temperature, viscosity. Denaturation and annealing.

UNIT IV

Ribonucleic acids - Isolation, purification, identification and estimation of RNA. Salient features of prokaryotic and eukaryotic RNA. RNA as a genetic material. Types of RNA: mRNA, tRNA, rRNA, hnRNA, snRNA- location and role. Secondary and tertiary structure of tRNA. Action of nucleases of pancreas, spleen and venom on RNA.

UNIT V

Heterocyclic Compounds - Heterocyclic rings of biological importance - pyridine, pyrrole, quinoline, pteridine, thiazole, imidazole, indole with examples. Porphyrins: Porphyrin nucleus and classification of prophyrins, important metalloporphyrins occurring in nature, Chemical nature and significance of bile salts and bile pigments.

Books Recommended

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6th ed), W.H. Freeman.
2. Voet.D and Voet. J.G (2010) Biochemistry (4th ed), John Wiley and Sons, Inc.

3. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.
4. Zubay G.L (1999). Biochemistry (4th ed), Mc Graw-Hill.
5. Lubert Stryer (2010). Biochemistry (7th ed), W.H.Freeman
6. Satyanarayan,U (2014). Biochemistry (4th ed), Arunabha Sen Books and Allied (P) Ltd, Kolkata.

CORE PAPER VI - CORE PRACTICAL – II

CREDITS – 4

TOTAL HOURS – 60

On Completion of the course, students are able to understand

CO -1: Safety measures in laboratory, handling and care of instruments.

CO -2: Determination of saponification, Iodine and acid value of oil using titrimetric methods.

CO- 3: Qualitative analysis of carbohydrates, amino acids and proteins.

CO- 4: Quantitative estimation of biomolecules carbohydrates, proteins, amino acids.

CO -5: Quantitative estimation of Nucleic acids DNA and RNA.

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		✓	✓		✓

I. Titrimetric methods

1. Determination of saponification value of an edible oil.
2. Determination of acid number of an edible oil.
3. Determination of iodine value of an edible oil.

II. Qualitative analysis

1. Analysis of simple sugars- glucose, fructose, galactose, xylose, sucrose, lactose, maltose and starch.
2. Analysis of amino acids - tyrosine, tryptophan, arginine, cysteine and histidine
3. Tests for protein- Solubility, Biurette, Xanthoproteic, Million's tests. Denaturation by heat, pH change. Precipitation by heavy metals and by acidic reagents.

III. Colorimetry

1. Estimation of Protein by Biuret method.
2. Estimation of inorganic phosphorus by Fiske and Subbarow method.
3. Estimation of amino acids by Folins method.
4. Estimation of DNA by Indole method
5. Estimation of RNA by Orcinol method
6. Estimation of carbohydrate by Anthrone method

Books recommended

1. Varley's practical clinical biochemistry, Alan. H. Gowen clock, 6th Edition, 1988, CBS publishers & distributors, India.
2. Practical manual of Biotechnology, Lab Manual, Dr.Ritu Mahajan, Dr.Jitender Sharma & Dr. R.K. Mahajan, 1st Edition, 2010, Vayu education of India, New Delhi.
3. Laboratory manual and Practical biochemistry, T.N.Pattabiraman, 4th Edition, 2010, All India Publisher's & Distributors limited, New Delhi.
4. Practical text book of biochemistry for MBBS students, D.M.Vasudevan, 1st Edition, 2007, Jaypee brothers, New Delhi.
5. An introduction to practical biochemistry, David. T. Plummer, 3rd Edition, 1998, Tata Mc.Grawhill education private limited, New Delhi.

V SEMESTER

CORE PAPER – VII – ENZYMES

CREDITS – 5

TOTAL HOURS – 60

CO-1: To gain knowledge about Enzymes, chemical nature and general properties of enzymes.

CO-2: To learn mechanism of enzymatic reactions and kinetics.

CO-3: To understand about isolation, homogenization and separation procedures of enzymes using various biochemical techniques.

CO -4: To recognize Enzyme, coenzymes and their role in biological processes in the body and industrial applications of Immobilized Enzymes.

CO-5: To understand on Enzyme Inhibition, types and mechanism of Inhibition.

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

UNIT I

Introduction - Enzymes - definition and chemical nature of enzymes. General properties; Nomenclature and classification, enzymes as catalysts - Activation energy. Enzyme specificity- Active site. Lock and key hypothesis and Induced fit theory, Allosteric site. Regulatory enzymes- allosteric enzymes with reference to ATcase. Isoenzymes with reference to LDH and CK – types and functions.

UNIT II

Isolation & Purification of Enzymes - Methods of isolation of enzymes: Homogenisation techniques, intracellular localization of enzymes; isolation of intracellular enzymes; separation

procedure based on molecular size - dialysis, ultrafiltration, molecular exclusion chromatography. Methods based on solubility – isoelectric precipitation, Salting in and salting out. Methods based on electric charge – electrophoresis, Ion exchange chromatography.

UNIT III

Coenzymes - action and functions of TPP, PLP, NAD / NADP, FMN, FAD, coenzyme A, lipoic acid and Biotin. Multienzyme complexes. Metallo enzymes and metal activated enzyme. Industrial uses of enzymes – food and pharmaceutical industries. Biosensors – principle, types and applications. Immobilized enzymes - methods of immobilization and applications.

UNIT IV

Enzyme Kinetics - Rate of enzyme catalyzed reaction, Derivation of Michaelis - Menten equation. Lineweaver Burk plot and Eadie Hofstee plot. Factors affecting enzyme activity - pH, temperature, activators, cofactors, concentration of enzyme and substrate.

UNIT V

Enzyme inhibition – reversible and irreversible inhibition – types of reversible inhibitors: competitive, non competitive , uncompetitive inhibitors. (Derivation not required). Mechanism of enzyme activity, covalent catalysis. Mechanism of action of chymotrypsin.

Books recommended

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6th 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 (29th ed), McGraw-Hill Medical
4. Trevor Palmer (1995). Understanding Enzymes (4th ed), Ellis Horwood Ltd

CORE PAPER VIII – METABOLISM

CREDITS – 5

TOTAL HOURS – 60

On Successful completion of course, students will be able to

CO-1: Gain knowledge about anabolism and catabolism.

CO-2: Obtain knowledge on carbohydrate, lipid and Protein metabolism help to understand the conversion of simple nutrients after absorption into energy and cell macromolecules.

CO-3: Provide information on conversion of toxic ammonia into Urea through Urea cycle.

CO-4: Understand about Electron Transport Chain and Oxidative Phosphorylation

CO-5: Learn about Purine and Pyrimidine biosynthesis and catabolism.

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

UNIT I

Biological Oxidation - Introduction to intermediary metabolism, the basic metabolic pathways, anabolic, catabolic and amphibolic pathways. High energy compounds – definition, structure and free energy of hydrolysis of high energy compounds. Lippman ATP cycle. Biological oxidation – Redox reactions. Electron transport in mitochondria – components of electron transport chain, energetics and inhibitors of electron transport. Oxidative phosphorylation – mechanism of Chemi-Osmotic theory. Inhibitors of oxidative phosphorylation – uncouplers and ionophores. Substrate level phosphorylation.

UNIT II

Metabolism of carbohydrates - Glycolysis, Pyruvate oxidation, Citric acid cycle-reactions, inhibitors, energetics, Glyoxalate cycle, Gluconeogenesis, Cori cycle, anaplerotic reactions and HMP shunt pathway. Glycogenolysis, glycogenesis and regulation of glycogen metabolism.

UNIT III

Metabolism of lipids - Biosynthesis and degradation of saturated fatty acids, triglycerides, phospholipids (lecithin). Biosynthesis of cholesterol and ketone bodies.

UNIT IV

Metabolism of amino acids - Oxidative deamination – role of dehydrogenases and oxidases. Non-oxidative deamination – role of pyridoxal phosphate with reference to serine and cysteine, Decarboxylation, Transamination reaction – mechanism of Schiff's base formation and transpeptidation, Ammonia detoxification – urea cycle – compartmentation and enzymes of urea cycle.

UNIT V

Metabolism of nucleic acid - Introduction, fate of dietary nucleic acids, Biosynthesis of purine nucleotides – *Denovo* synthesis and salvage pathways, catabolism of purines, regulation of purine biosynthesis. Biosynthesis of pyrimidine nucleotides - *Denovo* synthesis and salvage pathways, Catabolism of pyrimidines, regulation of pyrimidine synthesis.

Books Recommended

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6th ed) W.H. Freeman.
2. Voet.D and Voet. J.G (2010). Biochemistry (4th ed), John Wiley & Sons, Inc.
3. Lubert Stryer (2010). Biochemistry (7th ed), W.H.Freeman.
4. Denise R Ferrier (2013). Biochemistry (Lippincott's Illustrated Reviews), (6th ed), Lippincott Williams and Wilkins.
5. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012). Harper's Illustrated Biochemistry (29th ed), McGraw-Hill Medical.

CORE PAPER – IX - ANALYTICAL BIOCHEMISTRY

CREDITS – 5

TOTAL HOURS - 60

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

CO-1: Understand about pH, its importance in the body and its determination by glass electrode.

To know about the working principle and applications of oxygen electrode.

CO-2: Explore about the principle, procedure and applications of different chromatographic techniques and electrophoretic techniques for the separation and identification of biomolecules.

CO-3: Know the Separation and purification of proteins and nucleic acids by Centrifugation, Chromatography and Electrophoresis techniques.

CO-4: Understand the principle, instrumentation and applications of colorimetry and UV spectroscopy techniques.

CO-5: Recognize the principle, instrumentation and applications of spectrofluorimetry and flame photometry techniques for the determination of vitamins, enzyme activity and minerals.

Analytical Biochemistry	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2			✓		
Unit-3		✓	✓		
Unit-4		✓	✓		
Unit-5				✓	✓

UNIT I

Biophysical Techniques - Definition of Molality, Molarity, Normality, Osmolarity, Definition of pH, pOH, determination of pH- Glass electrode, Isoelectric pH, Zwitter ion, buffers, Henderson–Hasselbalch equation, Tonicity, Donnon membrane equilibrium and application.

Buffers in body fluids, Red blood cells and tissues. Measurement of oxygen consumption - the Clark oxygen electrode

UNIT II

Centrifugation - Principle of Centrifugation. Centrifugal force, centripetal force, sedimentation rate, Svedberg constant. Types of centrifuges. Types of rotors – fixed angle, vertical, swinging bucket, zonal, elutriator rotors. Preparative centrifugation – differential centrifugation – fractionation of subcellular organelles. Density gradient centrifugation – gradient preparation, separation and recovery of sample. Ratezonal centrifugation and Isopycnic centrifugation. Analytical centrifugation.

UNIT III

Chromatography - General principles of chromatography – partition and adsorption chromatography. Paper chromatography – principle, sample application, development – ascending, descending and radial, detection of amino acids and sugars. Thin layer chromatography – principle, instrumentation and applications (separation of alkaloids). Column chromatography – principle, factors affecting resolution. Basic principles and applications of affinity chromatography. High Performance Liquid Chromatography (HPLC) - principle, instrumentation and applications. Molecular sieve chromatography – principle, instrumentation and applications

UNIT IV

Electrophoresis - General principle of electrophoresis, factors affecting migration rate – electrical potential, nature of the sample, nature of buffer, nature of the supporting medium. Tiselius moving boundary electrophoresis. Principle, procedure and application of paper, cellulose acetate, agarose and starch gel electrophoresis. Principle and applications of SDS-PAGE and Immuno electrophoresis.

UNIT V

Spectroscopy - Basic principles of electromagnetic radiation, energy, wavelength, wave number and frequency. Absorption and emission spectrum. Beer Lambert law – UV and Visible range. Colorimetry and UV Spectrophotometry- principle, instrumentation and applications.

Spectrofluorimetry- principle, instrumentation and applications with reference to riboflavin.
Flame photometry – atomic absorption and emission - principle, instrumentation and applications with reference to sodium and potassium analysis.

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 (2nd ed), Prentice Hall
5. Kaloch Rajan (2011). Analytical techniques in Biochemistry and Molecular Biology, Springer

CORE ELECTIVE PAPER –I - HUMAN PHYSIOLOGY

CREDITS – 5

TOTAL HOURS – 60

CO-1: To understand different physiological systems and their functions

CO-2: To be able to analyze the status of different systems.

CO-3: To categorize different components according to their nature.

CO-4: To describe the mechanism and process of different physiological events.

CO-5: To draw and prepare charts about different human organ systems.

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

UNIT I

Digestive and excretory systems - Structure of digestive system, digestion and absorption of carbohydrates, lipids and proteins. Mechanism of HCl formation in stomach, role of various enzymes and hormones involved in digestive process and defecation. Excretory system – structure and function of kidney, structure of a nephron, mechanism of urine formation.

UNIT II

Circulatory system - Composition of blood - cells, plasma, serum and lymph. ABO blood grouping. Blood clotting - Bleeding and clotting time. Mechanism of blood clotting. - basic anatomy of heart. Systemic, pulmonary and portal circulation. Heartbeat, cardiac cycle, electrocardiogram and pacemaker.

UNIT III

Nervous and muscular system - Brain - ventricles, spinal cord, central and autonomous nervous system - sympathetic and parasympathetic nervous system. Structure of a neuron, synaptic transmission. Reflex action and neurotransmitters. Muscular system- types of muscles, structure and composition of skeletal muscle, structure of a myofibril, mechanism of muscle contraction.

UNIT IV

Respiratory system - Composition of air. Partial pressure of oxygen and carbon dioxide. Structure of lungs and alveoli. Gaseous exchange of oxygen and carbon dioxide in the lungs and tissues. Role of kidney and lungs in maintaining the pH of blood.

UNIT V

Endocrine system - Classification of hormones, endocrine glands and their secretions. Insulin, thyroxine and growth hormone -structure and functions. Steroid hormones. Corticosteroids- sex hormones – testosterone and estrogen - menstrual cycle.

Books recommended

1. Stuart Ira Fox (2011). Human Physiology. (12th ed), McGraw Hill Publications.
2. Sembulingam (2016). Essentials of Medical Physiology (7th ed). Jaypee Brothers Medical Publishers
3. John E. Hall (2010). Guyton and Hall Textbook of Medical Physiology (12th ed), Saunders
4. Best and Taylor (1990). Medical Physiology (12th ed), Lippincott Williams and Wilkins
5. Walter F. Boron, Emile L. Boulpaep (2012). Medical Physiology (2nd ed), Saunders
6. Anne Waugh (2010). Ross and Wilson Anatomy and Physiology in Health and Illness. Elsevier

VI - SEMESTER

CORE PAPER-X - CLINICAL BIOCHEMISTRY

CREDITS – 5

TOTAL HOURS – 60

On Successful completion of course, students will be able to

CO-1: Understand the pathology, diagnosis and treatment of metabolic disorder Diabetes Mellitus.

CO-2: Obtain information about Inborn Errors of Carbohydrate metabolism

CO-3: Learn the diagnostic procedures for the assessment of liver diseases through Liver function tests.

CO-4: Explain Renal function Tests that provide information regarding diagnostic procedures of kidney diseases.

CO-5: Gain knowledge about clinical symptoms, diagnosis and treatment of various diseases through Clinical enzymology.

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

UNIT I

Disorders of Carbohydrate metabolism - Scope of clinical biochemistry. Blood glucose homeostasis, hormonal regulation of blood glucose, Abnormalities in glucose metabolism: Diabetes mellitus - types, causes, biochemical manifestations, diagnosis and treatment. Inborn errors of carbohydrate metabolism - Galactosemia, fructosuria and Glycogen storage diseases.

UNIT II

Disorders of lipid metabolism - Normal levels of cholesterol, triglycerides, phospholipids, free fatty acids and lipoprotein in blood. Abnormal levels of these lipids in diseases, Atherosclerosis,

hyper and hypo lipoproteinemias. Inborn errors of Lipid metabolism- Niemann-Pick disease, Gaucher's and Tay-Sach's disease.

UNIT III

Liver function tests - Bile pigment metabolism. Tests based on bile pigment metabolism, Carbohydrate metabolism, plasma proteins and lipids, detoxification and excretory functions of liver. Jaundice -classification, biochemical changes and differential diagnosis for jaundice.

UNIT IV

Renal function tests - Normal and abnormal constituents in urine. Kidney function tests - Inulin, urea and creatinine clearance tests. Concentration and dilution tests. Phenol red test. Levels of plasma protein and its significance related to kidney function. Proteinuria. Inborn errors of amino acid metabolism-Phenyl ketonuria, Alkaptonuria, Tyrosinemia, cystinuria

UNIT V

Clinical enzymology - Definition of functional and non-functional plasma enzymes. Isozymes and diagnostic tests. Enzyme patterns in acute pancreatitis, liver damage, bone disorder, malignancy, myocardial infarction and muscle wasting.

Books Recommended

1. Thomas M.Devlin (2014). Textbook of Biochemistry with Clinical Correlations (7th ed), John Wiley and Sons.
2. Montgomery R, Conway TW, Spector AA (1996). Biochemistry: A Case-Oriented Approach (6th ed), Mosby Publishers, USA.
3. Tietz (2014). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7th 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 (7th ed).

CORE PAPER – XI- MOLECULAR BIOLOGY

CREDITS – 5

TOTAL HOURS – 60

After the completion of this course, the student will be able to

CO1: Understand the basic concepts of genetic information and the general principles of gene organization and expression

CO2: Understand the synthesis of DNA and Post replication processing.

CO3: Understand the synthesis of RNA and post transcriptional modifications

CO4: Understand the synthesis of protein and its post translational modifications

CO5: Describe the molecular mechanisms behind DNA damage and repair

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

UNIT I

Basic concepts of Genome - DNA as the unit of inheritance. Griffith, Avery, McLeod, McCarthy, Hershey and Chase experiments and their significance. Definition of gene, organization of gene and non-coding sequence in prokaryotes, mitochondrial DNA, plasmid DNA. Viral genome- bacteriophages (M13 and Φ X174), animal virus (influenza virus), plant virus (TMV).

UNIT II

Replication - Prokaryotic replication- model of replication - semiconservative mode of replication- replication forks, semi-discontinuous replication, Okazaki fragments. Bacteriophages M13 and Φ X174 replication, rolling circle model of replication. Enzymology of replication- role

of DNA polymerases I, II, III, gyrase, topoisomerases, helicase, ligases and SSB proteins. Theta replication in *E.Coli* - initiation events at Ori C, elongation events on the replication fork and termination - fidelity of replication - inhibition of replication.

UNIT III

Transcription - Transcription- prokaryotic RNA polymerases - role of sigma factor. TATA box, promoter, closed and open promoter complexes- initiation, elongation and termination of transcription, post transcriptional modifications in prokaryotes (tRNA and rRNA). Inhibitors of transcription.

UNIT IV

Translation - Genetic code - characteristics of genetic code - Wobble hypothesis - protein biosynthesis - activation of amino acids, initiation, elongation and termination of translation in prokaryotes. Inhibitors of protein biosynthesis.

UNIT V

DNA Damage & Repair - DNA damage, Mutation - types of mutation with examples, causes- physical and chemical agents, site - specific mutagenesis and mutational hot spots. DNA repair by direct reversal of damage, photoreactivation, excision repair-base excision, nucleotide excision and mismatch, recombination repair, SOS repair in prokaryotes.

Books recommended

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6th ed), John Wiley and Sons. Inc.
2. Bruce Alberts and Dennis Bray (2013). Essential Cell Biology (4th ed), Garland Science.
3. De Robertis, E.D.P. and De Robertis, E.M.F. (2010). Cell and Molecular Biology (8th ed), Lippincott Williams and Wilkins, Philadelphia.
4. James.D.Watson (2013). Molecular Biology of the Gene (7th ed), Benjamin Cummings.
5. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach (5th ed), Sunderland, Mass. Sinauer Associates, Inc.
6. David Freifelder (1992). Essentials of Molecular Biology (2nd ed), Jones and Bartlett Pub.

CORE PAPER – XII - CORE PRACTICAL III

CREDITS – 4

TOTAL HOURS – 60

CO1: To understand the collection and preservation of biological specimens

CO2: To determine the activity of Salivary amylase.

CO3: Separation and identification of aminoacids and sugars by Radial Paper chromatography & thin Layer chromatography.

CO4: To analyse qualitatively the normal and abnormal constituents of Urine

CO5: To estimate the amount of urea and creatinine in Urine.

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. Collection and preservation of urine sample.
2. Qualitative analysis of normal constituents of urine such as urea, creatinine, phosphorus, calcium and abnormal constituents such as calcium, sugar, protein, amino acid, ketone bodies and bile pigments with clinical significance.
3. Quantitative Analysis of Urine
 - a. Urea
 - b. Uric acid
 - c. Creatinine
4. Paper chromatography: Separation and detection of amino acids and simple sugars
5. Thin layer chromatography: Separation and detection of amino acids
6. Assay of activity of salivary amylase
7. Effect of pH and substrate concentration on activity of salivary amylase

Books recommended

1. Varley's practical clinical biochemistry, Alan. H. Gowen clock, 6th Edition, 1988, CBS publishers & distributors, India.
2. Practical manual of Biotechnology, Lab Manual, Dr.Ritu Mahajan, Dr.Jitender Sharma & Dr. R.K. Mahajan, 1st Edition, 2010, Vayu education of India, New Delhi.
3. Laboratory manual and Practical biochemistry, T.N.Pattabiraman, 4th Edition, 2010, All India Publisher's & Distributors limited, New Delhi.
4. Practical text book of biochemistry for MBBS students, D.M.Vasudevan, 1st Edition, 2007, Jaypee brothers, New Delhi.
5. An introduction to practical biochemistry, David. T. Plummer, 3rd Edition, 1998, Tata Mc.Grawhill education private limited, New Delhi.

CORE PAPER – XIII - CORE PRACTICAL – IV

CREDITS – 4

TOTAL HOURS – 60

After the completion of this course, the student will be able to

CO1: Understand the Basic concepts and principles of Clinical Biochemistry, detail on the various biological specimens including the process of collection, preservation and storage.

CO2: Analyze blood for RBC, WBC, TC/DC, ESR and hemoglobin by performing hematological assays

CO3: Acquire knowledge in the quantitative estimation of biomolecules, and correlating the laboratory test results with common diseases or conditions.

CO4: Determine blood urea and creatinine which acts as renal indices

CO5: Explain the nature and function of various enzymes, normal levels and elevated levels in various diseases.

Core Practical - IV	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. Collection and preservation of blood sample

2. Haematological studies

- a. RBC counting
- b. Total and differential count of white blood cells
- c. Packed cell volume
- d. Erythrocyte sedimentation rate
- e. Blood clotting time
- f. Blood grouping

3. Quantitative estimation in blood

- a. Haemoglobin
- b. Glucose
- c. Cholesterol
- d. Urea
- e. Creatinine
- f. Protein by Lowry's method.

4. Enzyme assay

- a. AST
- b. ALT
- c. Alkaline phosphatase

Books recommended

1. Varley's practical clinical biochemistry, Alan. H. Gowen clock, 6th Edition, 1988, CBS publishers & distributors, India.
2. Practical manual of Biotechnology, Lab Manual, Dr.Ritu Mahajan, Dr.Jitender Sharma & Dr. R.K. Mahajan, 1st Edition, 2010, Vayu education of India, New Delhi.
3. Laboratory manual and Practical biochemistry, T.N.Pattabiraman, 4th Edition, 2010, All India Publisher's & Distributors limited, New Delhi.
4. Practical text book of biochemistry for MBBS students, D.M.Vasudevan, 1st Edition, 2007, Jaypee brothers, New Delhi.
5. An introduction to practical biochemistry, David. T. Plummer, 3rd Edition, 1998, Tata Mc.Grawhill education private limited, New Delhi.

CORE ELECTIVE PAPER – II - IMMUNOLOGY

CREDITS – 5

TOTAL HOURS – 60

After the completion of this course, the student will be able to

CO-1: To understand different immunological components

CO-2: To be able to analyze the role of organs and cells for immunity.

CO-3: To categorize different components according to their nature.

CO-4: To describe the structure and functions of antibodies.

CO-5: To draw and prepare charts about different defense mechanisms.

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

UNIT I

Cells of immune system - Hematopoiesis, Pluripotent stem cells, Lymphoid progenitor lineage – T – Lymphocytes, B – Lymphocytes, NK cells and K- cells, Myeloid progenitor lineage – Neutrophil, Eosinophil, Basophil, Platelets, Erythrocytes, Monocytes, Macrophages, Antigen presenting cell – Dendritic cells.

UNIT II

Organs and tissues of immune system - Primary lymphoid organs – Bone marrow, Thymus; Secondary lymphoid organs – Spleen, Lymph node; Tertiary lymphoid organs – Mucosal associated lymphoid tissue (MALT), Cutaneous associated lymphoid tissue (CALT), Evolutionary comparisons of lymphoid organs.

UNIT III

Antigens - Antigenicity, Factors affecting antigenicity – Foreignness, Molecular size, Chemical composition, heterogeneity, Chemical nature, Susceptible to antigen processing, genotype, dosage and route; Adjuvants, Haptens, and Epitopes. Complement Pathways – Classical, Alternate and Lectin pathways.

UNIT IV

Immunoglobulins - Immunoglobulin genes, Basic structure of immunoglobulins, Different types of immunoglobulins – Isotypes, Allotypes and Idiotypes, Structure and functions of Immunoglobulins – Ig M, Ig G, Ig A, Ig E and Ig D and Characteristics of Immunoglobulins.

UNIT V

Immunity - Types of Immunity; Innate immunity – Components of innate immunity, phagocytic barrier, inflammatory barrier, physiological barrier, Adaptive immunity – Antigenic specificity, Immunologic memory, Immune diversity, self / non-self-recognition, Cell mediated immunity and Humoral immunity. Vaccines – Types of vaccines.

Books recommended

1. Kuby's Immunology - Janis Kuby, Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, 4th Edition, 2000, W.H. Freeman. (Unit I to V)
2. Roitt's Essential Immunology - Ivan Roitt and Peter Delves, 10th Edition, 2001, Wiley (Unit I to V)
3. Basic immunology - Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, 4th Edition, 2012, Elsevier Health Sciences.
4. Immunobiology - Janeway CA, Travers P, Walport M, and Shlomchik M, 6th edition, 2001, Garland Publishing, New York.
5. Immunology: An Introduction - Tizard, I.R., 4th edition, 1995. Saunders College Publishing, New York.
6. Immunology: Introductory text book – Nandini Shetty, 1st Edition, 2005, New Age International.

CORE ELECTIVE-III – BIOTECHNOLOGY

CREDITS – 5

TOTAL HOURS – 60

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

CO-1: Understand the basic concepts of rDNA technology and restriction enzymes.

CO-2: Understand DNA library construction, gene transfer methods, screening of clones and hybridization

CO-3: Understand basics of animal cell culture, transfection methods and microinjection.

CO-4: Explain the basics of plant tissue culture, viral vectors, transgenic plants and applications.

CO-5: Describe types of fermentation, design of fermenter, commercial production of fuels, microbial enzymes, antibiotics and vitamins.

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

UNIT I

rDNA Technology - Scope and importance of biotechnology. Recombinant DNA technology- Definition, restriction endonucleases - types, role, recognition sequences, cleavage pattern, modification of cuts ends, vectors- plasmid, cosmid, phage and construction maps of PBR322, λ bacteriophage. Enzymes used in rDNA technology - DNA ligases, Alkaline phosphatase, polynucleotide kinase, linkers, homopolymer tailing and end labeling

UNIT II

Gene Transfer Methods - Steps in genetic engineering - Construction of genomic library. Synthesis of cDNA Construction of cDNA library. Gene transfer methods- transformation, conjugation, transduction, microinjection and electroporation. Selection - selectable markers,

selection of recombinants by blue-white selection method (chromogenic substrate) and screening of clones - colony hybridization, screening with antibodies. PCR – Principle and applications.

UNIT III

Animal cell culture - Introduction to basic tissue culture techniques; chemically defined and serum free media, disaggregation of animal tissue, establishment of cell line. Transfection methods- calcium phosphate precipitation, DEAE - dextran mediated transfection. Transgenic mice - retroviral transfer and stem cell mediated transfer, applications. Embryonic stem cell - definition, ES cell culture to produce differentiated cells. Microinjection and applications.

UNIT IV

Plant tissue culture - basic requirements for culture, MS medium, callus culture. protoplast culture – Protoplast Preparation and culture. Vectors – Ti plasmid . Viral vectors- TMV, CaMV and their applications. Transgenic plants – Agrobacterium mediated gene transfer. Applications of transgenic plants -Pesticide resistant Plants and herbicide resistant plants.

UNIT V

Basics of Fermentation – Design of fermenter, Types (Solid state and Sub merged fermentation), concepts of Upstream and Downstream processing, Production and applications of ethanol, Lactic acid, streptomycin, Riboflavin, Biogas.

Books Recommended

1. David Freifelder (1992). Essentials of Molecular Biology (2nd ed), Jones & Bartlett Pub.
2. Click B.R. and Pasternark J.J (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. (4th 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 (3rd ed), W.H.Freeman and Co.
4. Satyanarayana U (2008). Biotechnology, Books and Allied (P) Ltd.
5. Casida L (2007). Industrial Microbiology, New Age International.
6. Reed G (2004). Prescott and Dunn's Industrial Microbiology, CBS Publishers and Distributors.

ALLIED PAPERS FOR OTHER BRANCHES

ALLIED BIOCHEMISTRY – PAPER –I

CREDITS – 3

TOTAL HOURS – 60

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

CO-1: Understand the basic component or biomolecules of living organisms. Have knowledge of the structure/conformational freedom of biomolecules of carbohydrates. Learn the classifications of carbohydrates

CO-2: Understand and demonstrate how the structure of biomolecules determines their chemical properties and reactivity.

CO-3: Learn the molecular structures of 20 amino acids, differentiating essential and non-essential amino acids, biologically important modified amino acids and their functions.

CO-4: Recognize the structural levels of organization of proteins, 3D structure of proteins, its functions and denaturation.\

CO-5: Study about heterocyclic compounds and porpyrins.

Allied Biochemistry-I	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT I

Carbohydrates - Monosaccharides and Disaccharides: Definition and classification of carbohydrates, linear and cyclic forms (Haworth projection) for glucose, fructose, mannose and

disaccharides (maltose, lactose, sucrose). Physical properties – Stereoisomerism, Optical isomerism, mutarotation. Chemical properties of sugar.

UNIT II

Carbohydrates – Polysaccharides: Occurrence and Properties - Polysaccharides (Starch, Glycogen, Cellulose, Chitin, Pectin) and Mucopolysaccharides - Hyaluronic acid, heparin, Chondroitin sulphate, Dermatan sulphate.

UNIT III

Amino acids - Amino acids, various classifications, amphoteric nature, isoelectric point. Reactions of carboxyl and amino groups.

UNIT IV

Proteins - Proteins- classification - biological functions, physical properties - ampholytes, isoionic point, salting in and salting out, denaturation, nature of peptide bond. Secondary structure, α -helix and β -pleated sheet, tertiary structure, various forces involved - quaternary structure. Deamination, transamination and urea cycle.

UNIT V

Heterocyclic Compounds - Heterocyclic rings of biological importance - pyridine, pyrrole, pteridine, thiazole, imidazole and indole with examples. Porphyrins: Porphyrin nucleus and classification of porphyrins, important metalloporphyrins occurring in nature, Chemical nature and significance of bile salts and bile pigments.

Books Recommended

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6th ed) W.H. Freeman.
2. Voet.D & Voet. J.G (2010). Biochemistry, (4th ed), John Wiley & Sons, Inc.
3. Lubert Stryer (2010). Biochemistry (7th ed), W.H.Freeman.
4. Satyanarayan,U (2014). Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata.
5. Jain J.L (2007). Fundamentals of Biochemistry, S.Chand publishers.

ALLIED BIOCHEMISTRY – PAPER –II

CREDITS – 3

TOTAL HOURS – 60

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

CO-1: Understand the basic component or biomolecules of living organisms. Have knowledge of the structure/conformational freedom of biomolecules. Understand and demonstrate how the structure of biomolecules determines their chemical properties and reactivity.

CO-2: To understand the types and structure of DNA and RNA.

CO-3: Learning kinetics of enzyme catalysed reactions and enzyme inhibitions and regulatory process, Enzyme activity, Enzyme Units, Specific activity.

CO-4: To know the sources, biological functions and deficiencies of vitamins.

CO-5: To know the sources, biological functions and deficiencies of Minerals.

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

UNIT I

Lipids - Fats - function, classification, simple lipids, fatty acids (saturated and unsaturated), compound lipids, derived lipids, properties- saponification, rancidity, reduction, oxidation, halogenation. Functions of phospholipids, Cholesterol – biological importance, chemical properties.

UNIT II

Nucleic acids - Purine and pyrimidine bases, nucleosides, nucleotides, polynucleotides, DNA structure, various types, properties- absorbance, effect of temperature. Different types of RNA structure and function, Genetic code.

UNIT III

Enzymes - definition, units of enzyme activity, enzyme nomenclature, specificity, isoenzymes, factors affecting enzyme activity- substrate concentration, pH, temperature. Michaelis and Menten equation. Lineweaver- Burk plot, Enzyme inhibition, competitive, uncompetitive and non competitive inhibition

UNIT IV

Vitamins - definition and types of vitamins. Sources, requirement, biological functions, deficiency symptoms of water soluble vitamins, B1, B2, B3, B6, B12 and Vitamin-C.

Sources, requirement, biological functions, deficiency symptoms of fat soluble vitamins - A, D, E and K- Deficiency diseases.

UNIT V

Minerals - sources, requirement, physiological functions, deficiency and toxicity of calcium, sodium, potassium, iron, magnesium, copper, manganese, selenium, iodine and zinc.

Books Recommended

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry (6th ed) W.H. Freeman.
2. Voet.D & Voet. J.G (2010). Biochemistry, (4th ed), John Wiley & Sons, Inc.
3. Lubert Stryer (2010). Biochemistry, (7th ed), W.H.Freeman
4. Satyanarayan,U (2014). Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata.
5. Jain J.L (2007). Fundamentals of Biochemistry,S.Chand publishers

ALLIED BIOCHEMISTRY PRACTICALS

FOR PAPERS I & II

CREDITS – 4

TOTAL HOURS – 60

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

CO-1: Estimate the ascorbic acid and glycine by titration method.

CO-2: acquire knowledge in the Identification of carbohydrate using qualitative tests

CO-3: acquire knowledge in the Identification of amino acids using qualitative tests

CO-4: Colorimetric estimation of protein and phosphorous.

CO-5: Preparation of starch from potatoes and casein from milk.

Allied Biochemistry Practicals	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (Competitive Exams)	PSO-5 (Employment)
CO-1		✓			
CO-2		✓		✓	✓
CO-3		✓			
CO-4		✓	✓	✓	✓
CO-5		✓	✓	✓	✓

1. Volumetric analysis

- Estimation of ascorbic acid using 2, 6 – dichlorophenol indophenol as link solution.
- Estimation of Glycine by formal titration.

2. Qualitative analysis

- Qualitative analysis of carbohydrates- glucose, fructose, galactose, lactose, maltose and sucrose.
- Qualitative analysis of amino acids – arginine, cysteine, tryptophan and tyrosine.

3. Quantitative analysis: (demonstration)

a. Colorimetric estimation of protein by Biuret method.

b. Colorimetric estimation of phosphorus.

4. Biochemical preparations

a. Preparation of casein from milk.

b. Preparation of starch from potato.

Books recommended

1. Varley's practical clinical biochemistry, Alan. H. Gowen clock, 6th Edition, 1988, CBS publishers & distributors, India.
2. Laboratory manual and Practical biochemistry, T.N.Pattabiraman, 4th Edition, 2010, All India Publisher's & Distributors limited, New Delhi.
3. Practical text book of biochemistry for MBBS students, D.M.Vasudevan, 1st Edition, 2007, Jaypee brothers, New Delhi.
4. An introduction to practical biochemistry, David. T. Plummer, 3rd Edition, 1998, Tata Mc.Grawhill education private limited, New Delhi.

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)

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

4.2 SCHEME OF EXAMINATIONS

SEMESTER - I

Course Components/Title of the paper	Credits	MARKS		
		CIA	EXT	TOTAL
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
Theory Papers	Tests (2 out of 3)	10
	Attendance	05
	Seminars	05
	Assignments	05
	Total	25
Practical Papers	Attendance	05
	Test best 2 out of 3	30
	Record	05
	Total	40
Project	Internal Marks (best 2 out of 3 presentations)	20
	Viva-Voce	20
	Project Report	60
	Total	100

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

Below 60% = 0 marks,

60 % to 75% = 3 marks,

75 % to 90% = 4 marks

Above 90%= 5 marks

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

By Internal and External Examiners

6.5.1 Improvement of Internal Assessment Marks.

- (a) Should have cleared end-semester University examination with more than 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:

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

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

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

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.**

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 key 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 (6th ed), W.H. Freeman.
2. Voet.D & Voet. J.G (2010). Biochemistry (4th ed), John Wiley & Sons, Inc.
3. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.
4. Zubay G.L (1999). Biochemistry (4th ed), Mc Graw-Hill.
5. Lubert Stryer (2010). Biochemistry (7th ed), W.H.Freeman.
6. Satyanarayan,U (2014). Biochemistry (4th 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,(2nd ed), Prentice Hall
5. Kaloch Rajan (2011). Analytical techniques in Biochemistry and Molecular Biology, Springer
6. Segel I.H (1976). Biochemical Calculations (2nd 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 O₂ and CO₂ 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 (7th ed), Pearson Benjamin Cummings Publishing, San Francisco.
2. P.S.Verma and V.K.Agarwal. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology (14th ed), S.Chand and Company Ltd
3. John E. Hall (2010). Guyton and Hall Textbook of Medical Physiology (12th ed), Saunders
4. Best and Taylor (1990). Medical Physiology (12th ed), Lippincott Williams and Wilkins
5. Walter F. Boron , Emile L. Boulpaep (2012). Medical Physiology (2nd 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 α -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 α -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 8th 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⁺, 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 cellulose. 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 (6th 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 (29th ed), McGraw-Hill Medical.
4. Trevor Palmer (1995). Understanding Enzymes (4th ed), Ellis Horwood Ltd.
5. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.
6. Zubay G.L (1999). Biochemistry (4th 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 (6th 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 (29th ed), McGraw-Hill Medical.
4. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.
5. Zubay G.L (1999) Biochemistry (4th ed), Mc Grew-Hill.
6. Ferrier DR (2013). Lippincott's Illustrated Reviews Biochemistry (6th ed), Ippincott Williams & Wilkins
7. M.N.Chatterjee and Rana Shinde (2007). Textbook of Medical Biochemistry (7th 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 (α , β & ω oxidation) Oxidation of fatty acids with odd and even numbered carbon atoms. Regulation of β oxidation. Ketogenesis and its regulation. Biosynthesis of fatty acid – saturated and unsaturated, chain elongation, regulation.

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, α -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 (6th 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 (29th ed), McGraw-Hill Medical.
4. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.
5. Zubay G.L (1999). Biochemistry (4th ed), Mc Grew-Hill.
6. Ferrier DR (2013). Lippincott's Illustrated Reviews Biochemistry (6th 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 (3rd 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 (6th 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 (3rd 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 (6th 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 (6th 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 (29th ed), McGraw-Hill Medical.
4. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.
5. Zubay G.L (1999). Biochemistry (4th ed), Mc Grew-Hill.
6. Ferrier DR (2013). Lippincott's Illustrated Reviews Biochemistry (6th ed), Ippincott Williams & Wilkins.
7. Devlin RM (1983). Plant Physiology (4th ed), PWS publishers.
8. Taiz L, Zeiger E (2010). Plant Physiology (5th 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 – C₃ and C₄ 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, 2nd ed. Publisher: I K International. ISBN-10: 8188237116, ISBN- 978047 0714218
2. Taiz and Zeiger, Plant Physiology, 5th edition, Sinauer Associates Inc. ISBN-13: 978- 0878938667, ISBN-10:0878938664
3. Caroline Bowsher, Martin Steer, Alyson Tobin (2008), Plant Biochemistry, Garland science ISBN 978-0-8153-4121-5.
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 λ 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 (2nd ed), Jones & Bartlett Pub
2. Click B.R. and Pasternark J.J (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. (4th 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 (3rd ed), W.H.Freeman & Co
4. Satyanarayana U (2008). Biotechnology, Books & Allied (P) Ltd.
5. Brown TA, (2010). Gene Cloning and DNA Analysis (6th ed), Wiley-Blackwell
6. Green MR and Sambrook J (2012). Molecular Cloning: A Lab Manual(4th ed), Cold Spring Harbor Laboratory Press
7. Sandy B. Primrose and Richard M. Twyman (2002). Principles of Gene Manipulation(6th 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.

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

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, γ -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 (7th ed). John Wiley & Sons
2. Montgomery R, Conway TW, Spector AA (1996). Biochemistry: A Case-Oriented Approach (6th ed), Mosby Publishers, USA.
3. Tietz (2014). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7th 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 (7th 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, 7th 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, 5th Edition, W. H. Freeman, 2004 (Unit III and Unit IV)
3. Principles of Genetics - Robert H. Tamarin, 7th Edition, 2002, Tata McGraw-Hill Education. (Unit II and Unit V)
4. The Cell A Molecular Approach - Cooper and Hausman, 4th Edition, 2007, ASM Press. (Unit I).

6. Principles of Biochemistry – Donald, Voet, Judith G., Pratt, Charlotte W. Voet, 3rd 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 (2nd ed), Prestographik, Vellore, India.
3. Warren,J, Gregory,E, Grant,R (2004). Statistical Methods in Bioinformatics (1st ed), Springer.
4. Milton,J.S.(1992). Statistical methods in the Biological and Health Sciences (2nd ed), 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 (2nd 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.

Genomics & Proteomics	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			✓
Unit-3			✓		
Unit-4				✓	✓
Unit-5					✓

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 (2nd ed), Jones & Bartlett Pub
2. Click B.R. and Pasternark J.J (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. (4th 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 (3rd ed), W.H.Freeman & Co
4. Satyanarayana U (2008). Biotechnology, Books & Allied (P) Ltd.
5. Brown TA, (2010). Gene Cloning and DNA Analysis (6th ed), Wiley-Blackwell
6. Green MR and Sambrook J (2012). Molecular Cloning: A Lab Manual(4th ed), Cold Spring Harbor Laboratory Press
7. Sandy B. Primrose and Richard M. Twyman (2002). Principles of Gene Manipulation(6th ed), Wiley-Blackwell.
8. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6th 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

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

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 (10th ed), Saunders.
2. Wilson JD and Foster DW (1998). Williams Textbook of Endocrinology (9th ed), Saunders.
3. Laycock J and Lee J (1979). Essential Endocrinology (1st ed), Oxford University Press.
4. Tietz (2014). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7th 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 (7th ed). John Wiley and Sons.
2. Montgomery R, Conway TW, Spector AA (1996). Biochemistry: A Case-Oriented Approach (6th ed), Mosby Publishers, USA.
3. Tietz (2014). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7th 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 (7th 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, 6th Edition, 1988, CRC Press. (Antioxidant status).
2. Tietz Fundamentals of Clinical chemistry – Carl A. Burtis, Edward R. Ashwood, Barbara Border, Norbert W. Tietz, 5th Edition, 2001, Palme yayıncılık. (Immunological studies).
3. Principles and Techniques of Biochemistry and Molecular Biology– Keith Wilson and John Walker, 5th Edition, 2010, Cambridge University Press. (Immunological studies).
4. Principles of Instrumental analysis – Skoog, Holler, Nieman, 5th Edition, 1998, Saunders College Publishing. (Immunological studies).
5. Manual for Medical Laboratory Technology - S Ramakrishnan, KN Sulochana, 1st 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, Ca²⁺/ calmodulin - dependent protein kinases, Structure and regulation of phosphatases, I,2A,2B,PP2A.

Books Recommended

1. John Hancock (2010). Cell signalling (3rd 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, 4th Edition, 2000, W.H. Freeman. (Unit I)
2. Roitt's Essential Immunology - Ivan Roitt and Peter Delves, 10th 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, 7th Edition, 2011, Elsevier Health Sciences. (Unit IV)
5. Immunology: Introductory text book – Nandini Shetty, 1st Edition, 2005, New Age International.(Unit V)

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