St Aloysius College (Autonomous)

Mangaluru

Re-accredited by NAAC "A++" Grade

Course structure and syllabus of

B.Sc.

BIOCHEMISTRY

Under NEP Regulations, 2020
(2021-2023 Batch)

ಸಂತ ಅಲೋಶಿಯಸ್ ಕಾಲೇಜು
(ಸ್ವಾಯತ್ತ)
ಮಂಗಳೂರು– 575 003, ಕರ್ನಾಟಕ
www.staloysius.edu.in

ESTD : 1880

ST ALOYSIUS COLLEGE (AUTONOMOUS)
P.B. NO. 720, MANGALURU – 575 003, KARNATAKA, INDIA
Phone: +91- 0824-4117701, 4117702, 4117703, 4117704
Email: principal@staloysius.edu.in
aloysius.principal@gmail.com

Re-accredited by NAAC with 'A++' Grade with CGPA 3.67/4 (Cycle 4)
Recognised as Centre for Research Capacity Building under UGC-STRIDE Scheme
Recognised under DBT – BUILDER Scheme, Government of India
College with "STAR STATUS" Conferred by DBT, Government of India
Recognised by UGC as "College with Potential for Excellence"

Date: 21-02-2022

NOTIFICATION

Sub: Syllabus of **B.Sc. Biochemistry** under NEP Regulations, 2020.
(As per Mangalore University guidelines)

Ref: 1. Decision of the Academic Council meeting held on 18-12-2021 vide Agenda No: 6
2. Decision of the Academic Council meeting held on 09-07-2022 vide Agenda No: 14
3. Decision of the Academic Council meeting held on 25-02-2023 vide Agenda No. 12
4. Decision of the Academic Council meeting held on 02-09-2024 vide Agenda No. 3
5. Office Notification dated 21-02-2022
6. Office Notification dated 17-08-2022
7. Office Notification dated 30-03-2023
8. Office Notification dated 26-09-2023

Pursuant to the above, the Syllabus of **B.Sc. Biochemistry** under NEP Regulations, 2020 which was approved by the Academic Council at its meeting held on 18-12-2021, 09-07-2022, 25-02-2023 & 02-09-2024 is hereby notified for implementation with effect from the academic year **2021-22**.

PRINCIPAL

REGISTRAR

To:
1. The Chairman/Dean/HOD.
2. The Registrar Office.
3. Library

A meeting of the Board of Study in BIOCHEMISTRY (UG) was held on13-11-2021 at 9.30 am in Conference Room Aruppe block 408

Members present:

Internal Members:

1. Ms. Shameena.K.A**. {Chairperson , Department of Biochemistry (UG) }**
2. Ms. Valina Jenisha D'Almeida

External Members:

3. Vice Chancellor nominee – Dr Sarojini B.K, Professor and Chairperson, M.Sc Industrial Chemistry, Mangalore University, Mangalagangothri, Konaje- 574199
4. Subject Experts - Dr Cletus D' Souza, Adjunct Professor, Department of PG studies and Research in Biochemistry, St Aloysius College (Autonomous), Mangalore-575003
5. Ms. Usha B Rao, HOD, Biochemistry, Alva's College, Moodibidri-Karnataka.
6. Representative from industry-Dr Praveen M.K, Assistant Manager, Mol Bio Diagnostics private Ltd., Goa.
7. Student representative- Saumia Thomas Kampadukad , Reg no 192852.

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A meeting of the Board of Study in BIOCHEMISTRY (UG) was held on 24-06-2022

Members present:

Internal Members:

1. Ms. Shameena.K.A. **{Chairperson , Department of Biochemistry (UG) }**
2. Ms. Valina Jenisha D'Almeida

External Members:

3. Subject Experts - Dr Cletus D' Souza, Adjunct Professor, Department of PG studies and Research in Biochemistry, St Aloysius College (Autonomous), Mangalore-575003
4. Ms. Usha B Rao, HOD, Biochemistry, Alva's College, Moodibidri-Karnataka.
5. Representative from industry-Dr Praveen M.K, Assistant Manager, Mol Bio Diagnostics private Ltd., Goa.
6. Student representative- Saumia Thomas Kampadukad , Reg no 192852.

A meeting of the Board of Study in **BIOCHEMISTRY (UG)** was held on 10-02-2023 at 9.30 am in Conference Room of Admin block

Members present:

	Name	Category	Address	Mode of meeting
	Internal members			
1.	**Ms Shameena.K.A.**		**Chairperson, Department of Biochemistry**	**Offline**
2.	**Ms Valina D Almeida**			**Offline**
	External members			
3.	**Dr Bharathi Prakash**	Vice Chancellor Nominee	Head Department of Microbiology University College, Hampanakatte.	**Offline**
4.	**Prof Cletus D' Souza**	Subject expert	Adjunct Professor, Department of PG studies and Research in Biochemistry, St Aloysius College (Autonomous)	**Offline**
5.	**Dr Avinash Kudva K**	Subject expert	entific officer, M.Sc Biochemistry course, Mangalore University, Mangalagangothri	**Offline**
6.	**Dr Yogesh Kumar K**	Representative from industry	I-sens Biosensors India Pvt. Ltd, Haryana	**Online**
7.	**Samana Upadhyaya**	Meritorious Alumnus	Invitago GmbH Frankfurt am Main- Germany	**Online**
8.	**Zoya Sheikh**	Student Representative	Reg no 2121719	**Offline**

A meeting of the Board of Study in **BIOCHEMISTRY (UG)** was held on 10-08-2023 at 10.00 am by Virtual mode

Members present:

	Name	Category	Address	Mode of meeting
	Internal members			
1.	**Ms Shameena.K.A.**		**Chairperson, Department of Biochemistry**	**Offline**
2.	**Ms Valina D Almeida**			**Offline**
	External members			
3.	**Dr Bharathi Prakash**	Vice Chancellor Nominee	Head Department of Microbiology University College, Hampanakatte.	**Online**
4.	**Prof Cletus D' Souza**	Subject expert	Adjunct Professor, Department of PG studies and Research in Biochemistry, St Aloysius College (Autonomous)	**Offline**
5.	**Dr Avinash Kudva K**	Subject expert	entific officer, M.Sc Biochemistry course, Mangalore University, Mangalagangothri	**Online**
6.	**Dr Yogesh Kumar K**	Representative from industry	I-sens Biosensors India Pvt. Ltd, Haryana	**Online**
7.	**Samana Upadhyaya**	Meritorious Alumnus	Invitago GmbH Frankfurt am Main- Germany	**Online**
8.	**Zoya Sheikh**	Student Representative	Reg no 2121719	**Offline**

Preamble:

The learning outcomes are designed to help learners understand the objectives of studying B.Sc (Honour's) Biochemistry that is, to analyze, appreciate, understand the basic concepts of biomolecular processes and chemical reactions occurring in the living system. This course is fundamental to tackle many of the health related challenges facing society. Considering the rapid and far-reaching advances in biological sciences in 21st century, it is imperative to have curriculum incorporating these updated emerging concepts of biochemistry. The current pattern is designed to impart concept based learning with emphasis on hands-on training, skill development and research. Aimed at multi-faceted development of a student, the curriculum includes courses encompassing core courses, intra and inter discipline specific courses, skill and ability enhancement courses to impart in-depth knowledge in biochemistry complemented with varied subjects and skills. The course seeks to discover and nurture typical attributes of a competent science graduate such as; spirit of inquiry, critical thinking, problem solving, analytical reasoning, aptitude to research/industry and entrepreneurial instincts.

Programme Learning Outcome

The learning outcome-based curriculum is specific in terms of changes in cognitive and psychomotor behavior of students. Biochemistry Honors course is intended to provide a broad framework enabling students to acquire a skill set that helps them understand and appreciate the field of biochemistry. The structure or design of this framework shall ensure a high standard of the Honors degree in Biochemistry at national level. The programme specifications are intended as a reference point for prospective students, current students, academic in delivering the programme and realizing its objectives.

Keeping in pace with the developmental trends in Biochemistry and allied areas, it is expected that the students undertaking Biochemistry (Honors) course become conversant with the essence of Biochemistry and exhibit certain levels of learning outcomes as proposed below.

PROGRAMME OUTCOME (PO)

PO 1	To create interest in Biochemistry and appreciation for chemical basis ofbiological processes.
PO2	inculcate the spirit of inquiry and value of systematic study of a discipline. Provides general understanding of the related disciplines with a holistic knowledge generation in biological sciences.
PO3	provide an in-depth understanding of chemical reaction mechanisms in biological processes.
PO4	provide a flavor of historical developments of enzymes and their applications in research, diagnostics and various industries.
PO5	in proficiency in basic laboratory techniques and be able to apply the scientific method to the processes of experimentation, hypothesis testing, data interpretation and logical conclusions.
PO6	velop problem solving and analytical skills tHrsough case studies, research papers and hands-on-experience
PO7	appreciate biochemical mechanistic basis of physiological processes, metabolism under normal and pathological conditions importance and levels of metabolic regulations.
PO8	apply and effectively communicate scientific reasoning and data analysis in both written and oral forms. They will be able to communicate effectively with well-designed posters and slides in talks aimed at scientific audiences as well as the general public.
PO9	bridge the knowledge and skill gap between academic out and industryrequirements.
PO10	give students experience in conducting independent, hypothesis-driven, biologicalresearch, project planning and management
PO 11	provide skills to publish research findings, and awareness of IP rights,and scientific publication ethics and problems of plagiarism.
PO 12	prepare competent human resource with better knowledge, hands-on-experience and scientific attitude, at national and global levels for careers in research and development, academia and Pharma-, biotech- and agro-, and food processing industries.

Graduate Attributes:

Graduates with strong academic knowledge, discipline-specific and generic skills complemented with social responsibility are greatest asset of the country. The curriculum frame work under NEP for Biochemistry graduates aims to build the following attributes;

Disciplinary Knowledge:

- Ability to comprehend fundamental concepts of biology, chemistry and apply basic principles of chemistry to biological systems.
- Ability to relate various interrelated physiological and metabolic events.
- Ability to critically evaluate a problem and resolve to challenge blindly accepted concepts.
- Ability to think laterally and in an integrating manner and develop interdisciplinary.
- Good experimental and quantitative skills and awareness of laboratory safety.
- A general awareness of current developments at the forefront in biochemistry and allied subjects.
- Awareness of resources, and their conservation.

Communication Skills:

- Ability to speak and write clearly in English and local language.
- Ability to listen to and follow scientific viewpoints and engage with them.
- Ability to understand and articulate with clarity and critical thinking one's position.

Critical Thinking

- Ability to conceptualize critical readings of scientific texts in order to comprehend.
- Ability to place scientific statements and theme in contexts and also evaluate them in terms of generic conventions

Problem Solving:

- Ability to make careful observation of the situation and apply lateral thinking and analytical skills.

Analytical Reasoning:

- Ability to evaluate the strengths and weaknesses in scholarly texts spotting flaws in their arguments.
- Ability to use scientific evidences and experimental approach to substantiate one's argument in one's reading of scientific texts.

Research Skills:

- Ability to formulate hypothesis and research questions, and to identify and consult relevant sources to find answers.
- Ability to plan and write a research paper.

Team work and Time Management:

- Willingness to participate constructively in classroom discussions and contribute to group work.
- Ability to meet a deadline.

Scientific Reasoning:

- Ability to analyze theories and beliefs, evaluate ideas and scientific strategies.
- Ability to formulate logical and convincing arguments.

Reflective Thinking:

- Ability to locate oneself and see the influence of location—regional, national, global—on critical thinking.

Self-Directing Learning:

- Ability to work independently in terms of organizing laboratory, and critically analyzing scientific literature.
- Ability to postulate hypothesis, questions and search for answers.

Digital Literacy:

- Ability to use digital resources, and apply various platforms to convey and explain concepts of Biochemistry.

Multicultural Competence:

- Ability to engage with and understand cultures of various nations and respect and transcend differences.

Moral and Ethical Values:

- Ability to interrogate one's own ethical values, and to be aware of ethical and environmental issues.
- Ability to read values inherited in society and criticism vis-a-vis, the environment, religion, spirituality and structures of power.

Leadership qualities:

- Ability to lead group discussions, to formulate questions related to scientific and social issues.

Life-long Learning:

- Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day business.

Job opportunities in Biochemistry Core Course

Exit After ONE Year: CERTIFICATE COURSE

Knowledge	Skill Acquired	Employability
Fundamental and principles of Biochemistry, atoms, acid and bases,metals. Biological significance of elements. Understanding of chemical bonding, Physical properties of molecules, chemistry of toxic chemicals. Colligative properties, Properties ofmatter and electro chemistry, redox reactions. Organometallic compounds and its applications. A general scientific spirit of inquiry	Numerical calculations, data generation and analysis, including the application of data transformations. Laboratory, safety and precautions, proficiency in preparation of laboratory reagents, use of glassware, Demonstration of basic oxidation and reduction reactions, primary and secondary standards. Handling basic instruments. Communication interpersonal and leadership skills, and ability enhancements complementing the core Biochemistry, Entrepreneurship	Small and medium size chemistry/ pharma basedlaboratories; as Jr. laboratory assistant assisting chemists/scientists. QC Assistants in Laboratories dealing with QC service. Toiletries, chemicals, perfumery, oil industries, distilleries/textiles/ pollution control units Entrepreneurship

Exit After **two** Year: **Diploma COURSE**

Knowledge	Skill Acquired	Employability
Basic chemistry of natural compounds, alkaloids, terpenes, heterocycliccompounds, drugs, stereochemistry, biological relevance of thesecompounds, outlines of Photochemistry and environmental chemistry. History ofBiochemistry, Comprehensive knowledge and hand-ontraining in laboratory techniques of biochemistry. Analytical instrumentationand methodology	Acquaintance with analytical techniques that will permit them to studythe biological system. Demonstrating skills offractionating organic compounds. Hands on experience of handling instruments and analysis of data. Improving personality traits, team work, organizing abilities. Communication skills	Assistants in Health care/ paramedical laboratories. Supervision and maintenance oflaboratories QC assistants in analytical laboratories dealing with biochemical/clinical/Food processing/pharma industrial settings. Marketing Entrepreneurial opportunities,Material safety datasheet maintenance, curation ofchemical/drug stores, chemical storekeeping

Exit After **three** Years: **B.Sc. degree**

After Four Years: **B.Sc. (Hons.)**

Knowledge	kill Acquired	Employability
Comprehensive knowledge ofbiomolecules: higher order structure s of proteins, nucleic acids and their functions. Bioenergetics, metabolism, enzyme kinetics, basic molecular biology, industrial microbiology, Immunology recombinant DNA technology. Understanding interrelatedphysiological and metabolic events. Overall knowledge of the avenues forresearch and higher academic achievements in the field of biochemistry and allied subjects.	Basic skills in clinical laboratory techniques, Immunology and molecular biological experimental skills. Demonstrate the overall ability to independently design experiment and analyse data. Basic statistical handling of data. Oral and written skills to convey scientific experimental results. Ability to understand research findings and disseminate to common public. Teaching skills	Scientific assistants in biotech based industries. Chemical /pharma/animal feeds/ scientific data mining, / Forensic science labs. Blood Banks, Public heath support staff, Clinical research, Drug discovery R&D, Medical coding, medical transcription, Medical content writingTeaching at secondary school level

Knowledge	Skill Acquired	Employability
Introduction to advanced concepts in Biochemistry; Molecular Biology, Recombinant DNA technology, Clinical Biochemistry/ Plant Biochemistry, Immunology, Nutrition and Dietetics, BiochemicalPharmacology, Research methodology, Intellectual property rights, Bioinformatics skills, data analysis, Pharmacogenomics, Introduction to Intellectual property rights. A strong theoretical and practical knowledge of clinical and molecular setting, core research exposure.	Skills to isolate, identify and assay the biomolecules. Conducting independent research as part of project work. Hand on training in modern techniques in molecular biology. R-DNA techniques Computation skills, Prism, graph pad, Excel, Scientific writing skills: general articles, research reviews, Debating on scientific inventions and social implications.	Research staff, Clinical Biochemist, Forensic science technician, Biomedical scientist Nutrition Dept. Pharma industry Clinical research industries, R&D divisions of Pharma industries Vaccine industry. Medical coding, Bioinformatics, Medica content writing, Patent examiner Toxicological asst. Medica Science Liaison officer Environmental science

B3-I. Curriculum and Credit Framework for Undergraduate Programme with two core subjects as majors (both with practicals) in the first three years, and choosing one of them for the 4th year.

Sem.	Discipline Specific Courses - Core (DSC), Elective (DSE) (Credits) (L+T+P)	Minor/ Multidisciplinary/ Open Elective (OE) Courses (Credits) (L+T+P)	Ability Enhancement Courses (AEC)(Credits) (L+T+P) (Languages)	Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship.		Total Credits
I	DSC-A1(4), A2(2) DSC-B1(4), B2(2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	**SEC-1**: Digital Fluency (2) (1+0+2)/ Env. Studies (3)	Health, Wellness & Yoga (2) (1+0+2)	25/26
II	DSC-A3(4), A4(2), DSC-B3(4), B4(2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Env. Studies (3)/ SEC-1: Digital Fluency (2)(1+0+2)	Sports/NCC/NSS/R&R(S&G) / Cultural (2) (0+0+4)	26/25
Students exiting the programme after securing 46 credits will be awarded UG Certificate in Disciplines A and B provided they secure 4 credits in work based vocational courses during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during the first year.						
III	DSC-A5(4), A6(2), DSC-B5(4), B6(2)	OE-3 (3)/ India and Indian Constitution (3)	L1-3(3), L2-3(3) (4 hrs. each)	**SEC-2**: AI/Financial Edu. & Inv. Aw. (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
IV	DSC-A7(4), A8(2), DSC-B7(4), B8(2)	India and Indian Constitution (3) / OE-3(3)	L1-4(3), L2-4(3) (4 hrs. each)	**SEC-3**: Financial Edu. & Inv. Aw. /AI (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
Students exiting the programme after securing 92 credits will be awarded UG Diploma in Disciplines A and B provided they secure additional 4 credits in skill based vocational courses offered during first- or second-year summer term.						
V	DSC-A9(4), A10(2), A11(4), A12(2);	DSC-B9(4), B10(2), B11(4), B12(2)		**SEC-4**: Cyber Security (2) (1+0+2)/Internship (2)		26
VI	DSC-A13(4), A14(2), A15(4), A16(2);	DSC-B13(4), B14(2), B15(4), B16(2)		**SEC-5**: Relevant SEC (2) (1+0+2)/ Internship (2)		26
Students exiting the programme after 3-years will be awarded UG Degree in Disciplines A and B as double majors upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed.						
	B.Sc. (Honours with Research) in Discipline A		B.Sc. (Honours) in Discipline A			
VII	DSC-A17(4), A18(2), A19(4), A20(2); Res. Methodology (4)	DSE-E1(3), Vocational-1(3) Res. Proposal formulation (2*)	DSC-A17(4), A18(2), A19(4), A20(2); Res. Methodology (4).	DSE-E1(3), Vocational-1(3).		22
VIII	DSC-A21(4).	DSE-E2(3), Vocational-2(3), Research Project (10+2*)	DSC-A21(4), A22(2), Internship/ Apprenticeship (4).	DSE-E2(3), E3(3) Vocational-2(3), 3(3).		22
Bachelor of Science Degree Honours with or without research, B.Sc. (Honours with Research) or B.Sc. (Honours) in Discipline A with Discipline B as Minor will be awarded upon securing 176 credits and satisfying the minimum credit requirements under each category of courses prescribed.						

Note: Only those students who secure 75% marks or CGPA of 7.5 and above in the first six semesters may choose to undertake research in the fourth year. Honours students not undertaking research have to do 3 to 4 Additional Courses/Entrepreneurship Courses and Internship/Apprenticeship for 12 credits.

Programme structure for the under-graduate programs in universities and colleges [subjects with practical's] **[With major Biochemistry]**

SEMESTER – I								
Group	**Course Code**	**Title of the Course**	**Instruction HOURS / week**	**Duration of Exam (HOURS)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Discipline Core Courses	G 510 DC 1.1	Chemical Foundations Of Biochemistry - I	04	2.5	40	60	100	4
	G 510 DC 2.1P	Volumetric analysis & Estimations – Practical-I	04	03	25	25	50	2
Open Elective Courses	G 510 OE 1.1	Biochemistry of cells	03	02	25	25	50	3
SEMESTER – II								
Group	**Course Code**	**Title of the Course**	**Instruction HOURS / week**	**Duration of Exam (HOURS)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Discipline Core Courses	G 510 DC 1.2	Chemical Foundations Of Biochemistry - II	04	2.5	40	60	100	4
	G 510 DC 2.2P	Qualitative and Quantitative Analysis – II	04	03	25	25	50	2
Open Elective Courses	G 510 OE 1.2	Proteins & Enzymes	03	02	25	25	50	3

SEMESTER – III								
Group	**Course Code**	**Title of the Course**	**Instruction HOURS / week**	**Duration of Exam (HOURS)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Discipline Core Courses	G 510 DC 1.3	Bio-Organic Chemistry	04	2.5	40	60	100	4
	G 510 DC 2.3P	Bioorganic Chemistry -III	04	03	25	25	50	2
Open Elective Courses	G 510 OE 1.3	Biochemical Techniques	03	02	25	25	50	3
SEMESTER – IV								
Group	**Course Code**	**Title of the Course**	**Instruction HOURS / week**	**Duration of Exam (HOURS)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Discipline Core Courses	G 510 DC 1.4	Analytical Biochemistry	04	2.5	40	60	100	4
	G 510 DC 2.4P	Analytical Biochemistry - IV	04	03	25	25	50	2
Open Elective Courses	G 510 OE 1.4	Plant Biochemistry	03	02	25	25	50	3

SEMESTER – V								
Group	**Course Code**	**Title of the Course**	**Instruction HOURS / week**	**Duration of Exam (HOURS)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Discipline Core Courses	G 510 DC 1.5	Biochemistry of Macromolecules	04	2.5	40	60	100	4
	G510 DC 2.5P	Qualitative Analysis of Macromolecules	04	03	25	25	50	2
	G 510 DC 3.5	Human Physiology and Enzymology	04	2.5	40	60	100	4
	G510 DC 4.5P	Human Physiology and Enzymology	04	03	25	25	50	2
SEMESTER – VI								
Group	**Course Code**	**Title of the Course**	**Instruction HOURS / week**	**Duration of Exam (HOURS)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Discipline Core Courses	G 510 DC 1.6	Bioenergetics and Metabolism	04	2.5	40	60	100	4
	G 510 DC 2.6P	Bioenergetics and Metabolism	04	03	25	25	50	2
	G 510 DC 3.6	Molecular Biology and Immunology	04	2.5	40	60	100	4
	G 510DC 4.6P	Molecular Biology and Immunology	04	03	25	25	50	2
	INTERNSHIP							

SEMESTER - I

COURSE TITLE : CHEMICAL FOUNDATIONS OF BIOCHEMISTRY – I	**COURSE CREDITS : 4**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA: 2.5 HOURS.**
Formative assessment marks: 40	**Summative assessment marks: 60**

Course Outcome:

This will inculcate confidence and clarity of mind in students to understand the chemistry of Biomolecules and Biological reactions.

Course Outcomes /ProgramOutcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	X	X										
Critical thinking		X										
Subject clarity	X	X										X
Analytical Skill	X				X	X						

UNIT-I

SCOPE OF BIOCHEMISTRY & UNITS OF MEASUREMENT:- **14 HOURS**

What is Biochemistry, brief historical overview, future and scope of Biochemistry, applications of Biochemistry, chemical composition of living organisms. 1Hrs.

Units of measurement: CGS and SI system, units of length, mass, time, temperature and amount (Mole), derived units, (velocity, density, specific gravity, frequency, power, force, pressure, and energy) SI prefixes (milli, micro, nano, pico, femto, kilo, mega, giga, tera) 3Hrs.

Atoms, atomicity, element, compound, molecules, isotopes, isotope notation, A-Z notation, isobars,Natural abundance, atomic weight, average mass, molecular weight.. 4Hrs.

Avogadro`s number mole, mole concept, Dalton's concept, molarity, molality, percent composition of atoms. Concentration, molar solution, percent solution, ppm, equivalent weight, normality. 6 Hrs.

UNIT-II

ATOMIC STRUCTURE AND CHEMICAL BONDS:- **14 HOURS**

Structure of an atom, electrons and Quantum numbers, orbitals, shapes of orbitals, s, p, d, and f subshells, K, L, M, N, O, P, and Q shells. Illustration of Pauli`s exclusion principle, Aufbau principle, and Hund`s rule, electron configuration, octet rule. 6 Hrs.

Chemical bonding: formation of ionic bond, covalent bond (sigma and pi bonds), co-ordinate bond with examples. Hydrogen bonds, bonding in water molecule, Water as a fluid of life, special properties of water- (boiling point and melting point, surface tension, viscosity, high specific heat) bonding of water in ice and its significance. Weak forces of interaction, van der Waals interactions, London forces, dipole-dipole interactions, electrostatic interactions, and hydrophobic interactions. 8 Hrs.

UNIT-III

BUFFERS AND COLLIGATIVE PROPERTIES: - **14 HOURS**

Acids, bases, conjugated acids and bases. Arrhenius concept, Lewis concept, Lowry and Bronsted concepts.Strong and weak acids and bases. Strength of acids and bases. Ionic product of water, pH scale, Buffers, Henderson-Hasselbalch equation, buffers in blood-carbonic acid buffer. Titration curve of an amino acid. pK value, zwitterionic structure of aspartic acid isoelectric pH. 7Hrs.

Water as a solvent. Solutions and types-ionizable solutes, non- ionizable solutes (sugar & salt). Colligative properties and anomalous colligative properties of solutions, vapor pressure and its application in distillation, boiling point, freezing point, de-icing.

Osmotic pressure: Osmosis and osmotic pressure determination, reverse osmosis, isotonic, hypo and hypertonic solution and its effects on blood cells. Donnan membrane equilibrium. 7Hrs.

UNIT-IV

ELECTROCHEMISTRY AND REDOX REACTIONS:-

Electrochemistry: - electrochemical cells, electrode potential and its measurement, electrodes, half-cell reaction, standard electrodes-glass electrode 4 Hrs.

Laws of thermodynamics-I, II and III law. Concept of entropy and enthalpy, their relation, Gibb`s energy, free energy change. Oxidation and reduction- oxidation number and its significance redox reactions, redox potential, application of redox potential. 6 Hrs.

Chemical Kinetics: Rate of a reaction, Molecularity and order of a reaction. First and second order reaction, Half life of a first order reaction, Energy of activation. 4 Hrs.

REFERENCES:

Advanced Inorganic Chemistry: A comprehensive Text,1999, Cotton A and Geoffrey Wilkinson, 6th edition , Wiley publication

Inorganic Chemistry, 2014, Miessler GL , Paul Fischer PJ, and Tarr DA, 5th edition,Pearson Publication

Inorganic Chemistry, 2004, Catherine E and Sharpe AG, ACS publication

Inorganic Chemistry , 2015, Overton, Rourke , Weller , Armstrong and Hagerman,Oxford Press

Physical Chemistry: A molecular approach, 2019, Donald A, McQuarrie and Simon JD, Viva Books Publication.

Physical chemistry 2019, Atkins P, Paula JD, Keeler J , 11th edition , Oxford press.

SEMESTER-I PRACTICALS – I

COURSE TITLE: VOLUMETRIC ANALYSIS & ESTIMATIONS – PRACTICALS-I	**COURSE CREDITS: 2**
TOTAL CONTACT HOURS: 4 HOURS/ Week	**DURATION OF ESA : 03 Hrs**
FORMATIVE ASSESSMENT MARKS: 25	**SUMMATIVE ASSESSMENT MARKS: 25**

Course Outcome:

This course aims to familiarize students with the principles of analytical chemistry and basic analytical techniques such as volumetric analysis. Course objective is to provide experimental practice of quantitative volumetric analysis. Upon successful completion students should be able to make solutions of various molar, normal concentrations and determine the amount of a substance in a given sample.

EXPERIMENTS:

1. Concept of molarity, molality and normality. Calculation and preparation of molar solutions. (Problems to be given in exams). Calculation and preparation of normal solutions and percent solutions and dilute solutions.
2. Calibration of volumetric glassware's (Burette, pipette).
3. Preparation of standard sodium carbonate solution, standardization of HCl (Methyl orange) and estimation of NaOH in the given solution. (Methyl orange or phenolphthalein).
4. Preparation of buffer.
5. Estimation of amino acid Glycine by formal titration method
6. Titration curve for an amino acid and determination of pKa value.
7. Preparation of Isotonic, hypotonic & hypertonic solution.
8. Effect of Isotonic, Hypotonic & hypertonic solutions on RBC.
9. Redox reactions
10. Dialysis & Reverse Dialysis

REFERENCES:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Dr. O. P. Pandey, D. N. Bajpai, Dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.
4. Principles of Practical Chemistry- M. Viswanathan
5. Instrumental Methods of chemical Analysis B.K Sharma.
6. Experiments in Physical Chemistry R.C. Das and B. BeHrsa, Tata Mc Graw Hill
7. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House
8. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co.

SEMESTER -I

OPEN ELECTIVE

COURSE TITLE	**BIOCHEMISTRY OF CELLS**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**42**
DURATION OF ESA	**2.5**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:

- This open elective course offering to students of various streams gives knowledge about biomolecules in their cellular environment. Further, they will learn basic chemistry of amino acids, peptides, sugars, polysaccharides, nucleosides, nucleotides, nucleic acids, lipids, vitamins, coenzymes and metal ions.

UNIT - I

BIOMOLECULES IN THEIR CELLULAR ENVIRONMENT: 14 HOURS

The cellular basis of life. Cellular structures – prokaryotes and eukaryotes. Chemical principles in biomolecular structure. Major classes of biomolecules. Role of water.

Amino acids and peptides:

Structure of amino acids, classification of amino acids based on polarity, derivatives of amino acids and their biological role. Peptide bond, Properties of a peptide, biologically important peptides

UNIT - II

SUGARS AND POLYSACCHARIDES: 14 HOURS

Basic chemistry of sugars, optical activity. Disaccharides, trisaccharides and polysaccharides - their distribution and biological role.

Nucleosides, nucleotides and nucleic acids:

DNA structures and their importance, different types of RNA. Unusual DNA structures, other functions of nucleotides.

UNIT -III

LIPIDS: 14 HOURS

Different classes of lipids and their distribution, storage lipids, structural lipids in membranes, lipids as signal molecules, cofactors and pigments.

Vitamins, coenzymes and metal ions:

Occurrence and nutritional role. Coenzymes and their role in metabolism. Role of metal ions in biological system and theirsignificance - heme, porphyrins and cyanocobalamin.

REFERENCES:

1. Lehninger- Principles of Biochemistry-DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
2. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc.(2010).

SEMESTER – II

COURSE TITLE : CHEMICAL FOUNDATIONS OF BIOCHEMISTRY -II	**COURSE CREDITS: 4**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA : 02 Hrs**
FORMATIVE ASSESSMENT MARKS : 40	**SUMMATIVE ASSESSMENT MARKS : 60**

Course Outcome

These topics will enable students to understand the fundamentals of chemical processes in biological systems.

Course Outcomes /Program Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	X	X	X									
Critical thinking	X	X										
Subject clarity	X	X										X
Analytical Skill	X	X			X	X						

UNIT- I

CHEMICAL CATALYSIS:- **14 HOURS**

Homogeneous and Heterogeneous – Definition and examples. theories of catalysis, types- homogeneous, heterogeneous, Bio catalysis. Enzyme as catalyst. 4 Hrs.

Colloids: true solutions, classification of colloids (Examples: Fog, cloud, steam, smog, vehicle exhaust- PM, milk, jelly). 4 Hrs.

Protein as a colloidal solution. Ultra filtration, Brownian movements, electric properties, coagulation, salting in and salting out of protein. Emulsion, types, (Example Butter) micelles with lipids, emulsifiers. 6 Hrs.

UNIT- II

NOMENCLATURE OF ORGANIC COMPOUNDS: **14 HOURS**

Classification, naming- IUPAC nomenclature, compounds containing one and two functional groups. Stereochemistry, geometric isomerism-cis and trans (Example of fatty acids) 4 Hrs.

Structural Isomerism, conformation example glucose- enantiomers, epimer, anomer, mutarotation, chair and boat conformations. Optical isomerism, D and L plane polarized light and optical rotation d and l glucose. 5Hrs.

Nomenclature of racemic mixture, resolution. Fischer and Newmann projection formulae, molecule with one and two chiral and achiral centers. Priority rules; E and Z (CIP rules), R and S (alanine),D and L(Glucose) notations,. Role of stereochemistry in biological systems. 5 Hrs.

UNIT- III

INORGANIC CHEMISTRY: 14 HOURS

Coordination compounds–simple, double and complex salts-definition, differences with examples, IUPAC nomenclature. Werner's theory, ligands- uni, bi, and polydentate. Coordination number. 5Hrs.

Trace metals in biological systems: selenium, molybdenum, cobalt. Toxicity of heavy metals:

Lead, mercury, cadmium, arsenic. Bulk elements in biological systems (Na, K, Ca, Mg, Fe, Co, Zn and I). Structural role of calcium, zinc in enzymes. 7Hrs.

Reactive oxygen, oxygen and nitrogen free radicals. 2Hrs.

UNIT- IV

ORGANOMETALLIC COMPOUNDS: 14 HOURS

Metal atom linked organic compounds.

Para chloro mercury benzoate- structure, uses. Methyl mercury toxicity 2Hrs.

Porphyrins: definition, classification. Important metalloporphyrins occurring in nature; structure and their biological importance. 2Hrs.

(Hemoglobin, cytochrome, chlorophyll, myoglobin, vitamin B12 iron-sulphur clusters with suitable Examples and their role in biological systems). 10Hrs.

REFERENCES:-

1. Physical Chemistry 2006, Peter Atkins. 8th edition, W.H. Freeman and Company
2. Inorganic Chemistry: Principles of structure and Reactivity, 2006, Huheey JE, Keiter EA, Keiter RL , Pearson Education India
3. Stereochemistry: Conformation and Mechanism, 2009, Kalsi PS, New Age InternationalPublications
4. Introduction to Stereochemistry 2012, Kurt Mislow, Dover Publications
5. A text book of Organic Chemistry 2016, Raj K Bansal, 6th edition, New Age InternationalPublications
6. Advanced Inorganic Chemistry 1999, Cotton et al , 6th edition, A Wiley – International
7. Principles of physical Chemistry by Puri, Sharma and Pathania.
8. Physical Chemistry by R. L. Madan, G. D. Tuli. S. Chand and Co.
9. A Text Book of Physical Chemistry by K. L. Kapoor. Vol. 2. Mc. Millan Publisher, IndiaLtd.
10. Advanced Organic Chemistry by Bahl and Bahl

SEMESTER - II PRACTICALS - II

COURSE TITLE: QUALITATIVE AND QUANTITATVE ANALYSIS – PRACTICALS – II	**COURSE CREDITS: 2**
TOTAL CONTACT HOURS: 4 HOURS/Week	**DURATION OF ESA : 03**
FORMATIVE ASSESSMENT MARKS : 25	**SUMMATIVE ASSESSMENTMARKS : 25**

Course Outcome:

The Course Objective is to provide experimental practice of quantitative and qualitative analysis. Also it provides training in physical chemistry laboratory techniques. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

EXPERIMENTS:

1. Salting in and salting out of milk.
2. Estimation of calcium in Ragi
3. Estimation of Fe in Edible leaves
4. Reactive Oxygen species
5. Verification of Beer's Law. Estimation of unknown concentration of a biomolecule by using colorimeter
6. Partition Coefficient of Amino Acid (Phenylalanine/ Glycine) in n-octane: water system
7. Oxidation and reduction of cytochrome
8. Calibration of pH meter and determination of pH of aerated soft drinks.
9. Lab safety measures.

REFERENCES:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Dr. O. P. Pandey, D. N. Bajpai, dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.,
4. Principles of Practical Chemistry- M. Viswanathan
5. Instrumental Methods of chemical Analysis B.K Sharma.
6. Experiments in Physical Chemistry R.C. Das and B. BeHrsa, Tata Mc Graw Hill
7. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House
8. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co
9. Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
10. General Chemistry experiment – Anil J Elias (University press)

SEMESTER – II

OPEN ELECTIVE

COURSE TITLE	**PROTEINS AND ENZYMES**
COURSE CREDITS	**02**
TOTAL CONTACT HOURS	**42**
DURATION OF ESA	**2.5**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**50**

Course Outcome:

- Proteins: The course aims to introduce proteins and their importance to modern Biochemistry, highlighting their structural features and unique characteristics that help them participate in every physiological process in life.
- Enzymes: The objective of this course is to integrate the practical aspects of enzymology with the kinetic theories to provide a mechanistic over view of enzyme activity and regulation in the cell.
- To prepare students to confidently and competently work with enzyme systems in both Academia and industry.

UNIT - I

Classification of amino acids based on structure, Zwitterion structure, Isoelectric point, pKa. Properties of peptide bonds. Classification of proteins based on structure and functions. Overviewof Primary, Secondary, Tertiary and Quaternary structures of proteins. Structure of myoglobin and hemoglobin, Ramachandran plot, Helices, sheets and turns.

Determination of N-terminalamino acid (by DNFB and Edman method), and C- terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Overview on proteinfolding.

14 HOURS

UNIT – II

Introduction of Biocatalysts, Nomenclature and classification of enzymes, enzyme specificity, Active site and its models, fundamentals of enzyme assay. Enzyme Kinetics: Order of reactions, Michalis – Menten equation for Uni-Substrate reaction (derivation not necessary), significance of Km and Vmax. Enzyme inhibition: Over view on Reversible and irreversible inhibition Regulation of enzyme activity: Allosterism and cooperativity, feedback inhibition. Outline of Mechanism of enzyme action: Acid – base catalysis, covalent catalysis,. Mechanism of Chymotrypsin. Applications of enzymes.

14 HOURS

UNIT – III

Separation and characterization of Proteins and enzymes: Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization, Ion exchange chromatography, molecular sieve chromatography, affinity chromatography, Native and SDS – PAGE electrophoresis.

14 HOURS

REFERENCES

1. Lehninger Principles of Biochemistry, 6th Edition , David L Nelson, 2017
2. Fundamentals of Biochemistry, 4th Edition , Donald Voet and Judith Voet , 2015
3. Biochemistry Jeremy Berg , Lubert Stryer and John Tymoczko, Gregory Gatto, 2019
4. Protein Purification. Principles and Practice. Robert K Scopes, Springer, ISBN 978-1-4737-2333-5

SEMESTER - III

COURSE TITLE : BIO-ORGANIC CHEMISTRY	**COURSE CREDITS : 4**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA: 02.5 HOURS.**
Formative assessment marks: 40	**Summative assessment marks: 60**

Course Outcome:

These topics will enable students to understand the fundamentals of organic chemistry pertinent to their importance in understanding biochemical reactions.

Course outcomes /Programoutcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	X	X	X	X								
Critical thinking		X										
Subject clarity	X	X				X	X	X		X		X
Analytical skill	X				X	X	X	X	X			X

UNIT-I

REACTION MECHANISMS AND HYDROCARBONS **14 HOURS**

Introduction, meaning of the term, kinetic and non-kinetic. Fundamental aspects: Homo and heterolytic cleavage. Classification of organic reactions (substitution, addition, elimination, and re- arrangement), with two examples for each. Reactive intermediates-examples of free radicals, carbo cations and carbanions, free radicals, carbenes, nucleophiles and electrophiles.

06 Hrs

Aromatic compounds - Aromaticity, criteria for aromaticity, anti-aromatic, and non-aromatic compounds with examples, Polycyclic benzenoid hydrocarbons , their structure and role

Heterocyclic compounds

Biological occurrence -Structural formula and importance of Furan, Pyrrole, Thiopene, Pyridine, Pyran, Thiazole, Pyrimidine, Purine, Indole, Imidazole, Quinoline and Isoquinoline.

05 Hrs

UNIT -II

MECHANISM OF SUBSTITUTION, ELIMINATION, AND ADDITION REACTIONS

14 HOURS

Examples of Electrophilic substitution (nitration of Benzene), example of S_N1(from DNA synthesis) and S_N2 (S-Adenosyl Methionine methyl transferase) reactions , Stereochemistry (Retention of configuration and inversion of configuration).Addition and elimination reactions (Examples), 1,2 and 1,4 addition reactions. Addition of oxygen to C=C in fatty acids. 6 hours

Alcohols

Monohydric, Dihydric, Trihydric alcohols with examples. Primary, secondary and tertiary alcohols reactions: oxidation and reduction. Distinguishing test.

Function of phenols and phenolics (in plants) 3hours

Amines

Classification, properties, Amino functional group - Basicity of amines acylation. Reaction with HNO_2 and Schiff's base formation. Distinguishing reactions of primary, secondary and tertiary -amines. 5hours

UNIT -III

MECHANISM OF ELECTROPHILIC SUBSTITUTION REACTIONS 14 HOURS

Coenzymes- introduction, structure**,** Role of Coenzymes in reaction mechanism. 1 Hr

Water soluble Vitamins- definition, sources, structures of thiamine, riboflavin, niacin, pyridoxine, biotin. The reaction of the coenzymes- thiamine pyrophosphate and its role in decarboxylation. Vit B_2 (FAD) role in redox reactions with suitable examples. Biotin its role in carboxylation reaction.

10 hours

Mechanism of antioxidant activity of vitamin C and vitamin E

Antivitamins- sources and effects of avidin, Dicumarol & Antinutrition factors – Canavanin, Hypoglycin A

4 hours

UNIT- IV

BIO-ORGANIC COMPOUNDS 14 HOURS

Introduction to Bioorganic chemistry

Terpenes: Definition, Isoprene rule, classification, isolation, structure and biological importance of menthol, camphor, farnesol, phytol, lanosterol, lycopene and dolichols. 4hours.

Steroids: Basic ring structure in steroids. Structure and biological importance of cholesterol, phytosterols, ergosterol, cortisol, β-estradiol, testosterone, and aldosterone. Bile acids (Mono, Di & Tri cholic acids). 4hours

Alkaloids: Definition, classification based on their structure and biological functions, Isolation of alkaloids, structure and physiological action of morphine, nicotine and atropine. 4hours.

Food Adulteration

Natural toxicants (Lathyrus sativus) and adulterants (Butter yellow, Lead chromate & malachite green) 2hours

REFERENCES

1. Textbook of Organic Chemistry 22nd Edition S. Chand Publishers 2019.
2. Organic Chemistry. Vol. I Fundamental Principles. I. L. Finar. 6th Edn. ELBS, 2002
3. Organic Mechanisms, Peter Sykes, Longman, 1977
4. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Edn. Prentice Hall, India, 2018
5. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn.Macmillan Publications 2012
6. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Edn.Karen C. Timberlake, Benjamin Cummings, 1999
7. Reaction Mechanisms at a Glance, ed. M. Moloney, Blackwell Science 2000.

SEMESTER-III

PRACTICALS – 3

COURSE TITLE: BIOORGANIC CHEMISTRY -3	**COURSE CREDITS: 2**
TOTAL CONTACT HOURS: 4 HOURS/ Week	**DURATION OF ESA : 03 Hrs**
FORMATIVE ASSESSMENT MARKS: 25	**SUMMATIVE ASSESSMENT MARKS: 25**

Course Outcome:

This course aims to familiarize students with the principles of organic chemistry and basic qualitative analysis of organic compounds. Course objective is to provide experimental practice of preparation of organic compounds and extraction of biologically important compounds.

EXPERIMENTS:

1. Estimation of Cholesterol by Zak's method.
2. Estimation of Vitamin C by titration method/ colorimetric method
3. Estimation of Flavones by colorimetric method
4. Estimation of Vitamin E
5. Qualitative analysis of food adulterants
6. Estimation of Phenolics
7. Extraction of casein from milk
8. Extraction of starch from potatoes
9. Extraction of caffeine from tea leaves

REFERENCES:

1. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani, A. Chhikara 2009
2. Textbook of Practical Organic Chemistry Including Qualitative OrganicAnalysis by Arthur Israel Vogel 2003
3. Comprehensive practical organic chemistry- preparation and quantitative analysis. V. K. Ahluwalia and Renu Aggarwal 2004

SEMESTER - III

OPEN ELECTIVE

COURSE TITLE : BIOCHEMICAL TECHNIQUES	**COURSE CREDITS: 3**
TOTAL CONTACT HOURS: 42	**DURATION OF ESA : 2.5 Hrs**
FORMATIVE ASSESSMENT MARKS : 40	**SUMMATIVE ASSESSMENT MARKS : 60**

Course Outcome:

These topics will enable students to develop competence in handling various chromatographic, electrophoretic and isotopic techniques and apply them in isolating and characterizing different biological molecules.

UNIT I

CHROMATOGRAPHY **14 HOURS**

General Principles of Chromatography and applications of - Adsorption Chromatography, Paper chromatography, Rf value, Principle and applications of TLC, Ion exchange chromatography, Affinity chromatography, Gel filtration chromatography, Gas liquid chromatography, HPLC

UNIT II

14 HOURS

ELECTROPHORESIS –Introduction, Principles of Electrophoresis, Types- Paper and Zone electrophoresis, Basic principles of agarose electrophoresis, SDS-PAGE, 2D - electrophoresis

UNIT III

SPECTROSCOPY- Introduction, principle and application of Spectrophotometer, UV-spectroscopy, X- ray diffraction, Fluorimeter, principle of IR, NMR, Mass Spectroscopy, its application.

14 HOURS

SEMESTER -IV

COURSE TITLE : ANALYTICAL BIOCHEMISTRY	**COURSE CREDITS : 4**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA: 2.5 HOURS.**
Formative assessment marks: 40	**Summative assessment marks: 60**

Course Outcome:

These topics will enable students to develop competence in handling various chromatographic, electrophoretic and isotopic techniques and apply them in isolating and characterizing different biological molecules.

Course outcomes /Program outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	X	X	X	X								
Critical thinking		X				X						
Subject clarity	X	X						X				X
Analytical skill				X	X	X	X	X	X	X	X	X

UNIT-I

BIOLOGICAL SAMPLE PREPARATIONAND FRACTIONATION 14 HOURS

Introduction and objectives of bioanalysis. Occurrence of proteins and polysaccharides in nature. Extraction of proteins and polysaccharides from tissues and cells. Extraction of phytochemicals from plants.

4hours

CENTRIFUGATION

Introduction, principles of centrifugation, relative centrifugal field(RCF). Types of centrifugations- Preparative and analytical. Differential, density gradient, ultra-centrifugation. Basic instrumentation; types of rotors. Laboratory centrifuge, Analytical Centrifuges- Sedimentation coefficient, maintenance of instrument.

10hours

UNIT- I I

CHROMATOGRAPHY 14 HOURS

General principles and historical developments in chromatography. Classification based

on the types of separation (adsorption, partition,ion exchange and affinity).Paper chromatography - ascending, descending and circular, 2-Dchromatography, Rf values. TLC. Gel-filtration, ion exchange and affinity-chromatography. Advanced chromatography- GLC, HPLC, FPLC and UPL

UNIT III

ELECTROPHORETIC AND RADIO ISOTOPIC METHODS 14 HOURS

Electrophoresis: General principle of electrophoresis, Types- paper, agarose, polyacrylamide, polymerization of acrylamide, methodology and applications of native PAGE and SDS- PAGE, 2-D electrophoresis, Staining of proteins post electrophoresis. Isoelectric focusing. Principle and applications of immuno electrophoresis. 10 hours

Radioisotopic methods: Radioisotopes and heavy Isotopes

Types of radioactive decay- α, β, γ radiations. Half-life period. Detection of radioactivity – GM counter and liquid scintillation counters (only principle and working) Applications of radioisotopes – ^{3}H, ^{14}C, ^{131}I, ^{60}Co and ^{32}P. Biological effects of radiations, safety measure in handling radio isotopes. 4hours

UNIT IV

SPECTROSCOPIC METHODS OF BIO-ANALYSIS 14 HOURS

Spectroscopic methods: Electromagnetic spectrum. Beer-Lambert's law and its limitations. Principle, design, application of Colorimeter and UV-Vis spectrophotometer. Determination of molar absorption coefficient of molecules. Working principle and application of flame photometer and fluorimeter. Principle and application of IR, Raman, ESR and NMR spectroscopy, MRI.

SEMESTER-IV

PRACTICALS – 4

COURSE TITLE: ANALYTICAL BIOCHEMISTRY-4	**COURSE CREDITS: 2**
TOTAL CONTACT HOURS: 4 HOURS/ Week	**DURATION OF ESA : 03 Hrs**
FORMATIVE ASSESSMENT MARKS: 25	**SUMMATIVE ASSESSMENT MARKS: 25**

Course Outcome: This course aims to provide experimental practice of analytical techniques in Biochemistry. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

- Sourcing and handling biological samples.
- Develop skill and proficiency in basic techniques
- Centrifugation
- Chromatography
- Electrophoresis and
- Spectroscopy

EXPERIMENTS

1. Identification of amino acids by circular chromatography.
2. Ascending (amino acids) and descending (carbohydrates) chromatography
3. Demonstration of separation of plant pigments by column chromatography
4. Separation of Leaf pigments by Thin Layer Chromatography
5. Demonstration of Agarose gel electrophoresis
6. Demonstration of SDS PAGE
7. Estimation of DNA by diphenylamine method
8. Isolation of chloroplast by centrifugation.
9. Recording the absorption spectrum of Riboflavin
10. Estimation of Na and K ions by flame photometer

SEMESTER-IV OPEN ELECTIVE

COURSE TITLE : **PLANT BIOCHEMISTRY**	COURSE CREDITS: 3
TOTAL CONTACT HOURS: 42	DURATION OF ESA : 2.5 Hrs
FORMATIVE ASSESSMENT MARKS : 25	SUMMATIVE ASSESSMENT MARKS : 60

Course outcomes:

These topics will enable the students to

- Understand the plant cell, photosynthesis, transporters, and important primarymetabolites.
- Illustrate plant growth regulators, plant's responses to various biotic and abiotic stresses.
- Explain about plant secondary metabolites and their functional importance.

UNIT I 14 HOURS

Plant cell- structure and molecular components: Cytoskeleton- an overview. Plant celldivision, cell cycle.

An overview of photosynthesis: C3, C4 plants and crussulacean acid metabolism (CAM); photorespiration; Phytochromes.

Plant cell membranes and membrane transport: Introduction to plant cell membranes and membrane constituents. Organization of transport systems across plant membranes; Different types of pumps operate at plant cell and organelle membranes; classification and importance of H^+-ATPases. Ion channels-properties and significance; Aquaporins and water transport.

Important Primary metabolites of plants: Cellulose, starch, sucrose, oligosaccharides; fructans, gums, mucilages, poly unsaturated fatty acids, lignin, suberin, surface waxes, sulfides and sweet proteins.

UNIT II 14 HOURS

Plant growth regulators: Auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids, polyamines, jasmonic acid, salicylic acid

Brief history of plant tissue culture, Principle, Laboratory requirements and general techniques involved in micro propagation techniques (Equipments, Media-types, preparation, explants, and sterilization techniques)

UNIT III 14 HOURS

Plant secondary metabolites (Natural products):

Introduction; secondary metabolites (natural productions) definition; classification of plant secondary metabolites (natural products).

Alkaloids: Classification of alkaloids; Contribution of amino acids for alkaloid biosynthesis; Isolation, purification and characterization of alkaloids. (S)-Seticuline-the chemical chameleon.

Phenolics: Classification of phenolic compounds; Classification of flavonoids; Classification of anthocyanins; Isolation, purification and characterization of phenolics.

Terpenoids: Classification of terpenoids, biogenic isoprene rule; volatile compounds; plantgrowth regulator terpenoids – saponins. Isolation, purification, and characterization of terpenoids

REFERENCES:

1. Lehninger's Principles of Biochemistry - Nelson & Cox. CBS Publishers & Distributors,2013
2. Principles of Biochemistry - Moran, Horton, Scrimgeour, Perry.Pearson, 5thEdition , 2011
3. Plant Biochemistry - P.M. Dey & J.B. Harborne. Hart Court Asia Pvt Ltd. 1997
4. Plant Biochemistry and Molecular Biology - P. Lea & Richard C Leegood., John Wiley &Sons. 1999
5. Introduction to Plant Biochemistry - Goodwin and Mercer. CBS Publisher and Distributors.2005
6. Biochemistry and Molecular Biology of Plants - Buchanan, Greussem and Jones. AmericanSociety of Plant Physiologists. 2000
7. Natural Products from plants. Peter B. Kaufman, Leland J. Cseke, Sara Warber, James A.Duke, Harry L. Brielmann, CRC Press, Boca Raton 1999.
8. Natural Products Targeting Clinically Relevant Enzymes. Paula B. Andrade, PatriciaValentao David M. Pereira. Wiley-VCH Verlag GmbH & Co 2017
9. Plant Cell Tissue and Organ Culture: Fundamental Methods - O.L. Gamborg & G.C. PhillipsNarosa Publishers, New Delhi, 1995.
10. Kant R. Sweet proteins – Potential replacement for artificial low calorie sweeteners.Nutrition J. 2005; 4:5 doi:10.1186/1475-2891-4-5.

SEMESTER -V (a)

COURSE TITLE : BIOCHEMISTRY OF MACROMOLECULES	COURSE CREDITS : 04
TOTAL CONTACT HOURS: 60	DURATION OF ESA: 2.5 HOURS.
Formative assessment marks: 40	Summative assessment marks: 60

Course Outcome:

The course provides fundamental insights on the types of macromolecules; and unique structuralfeatures, chemical properties and biological importance of each.

Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	x	x	x	x								
Critical thinking		x								x		x
Subject clarity	x	x					x					x
Analytical Skill	x				x	x				x		

UNIT I :

CARBOHYDRATES **15 HOURS**

Definition, empirical formulae, classification, biological importance.

Monosaccharides: Configuration relationship of D-aldoses, D-ketoses. General properties of aldoses and ketoses. Oxidation, reduction, condensation – phenyl hydrazine, addition – HCN. Stereochemistry of monosaccharides, (+) and (-), D and L, epimers, anomers, and diastereoisomers. Elucidation of open chain structure of glucose, mutarotation. Structure of galactose, mannose, ribose and fructose. Structure and biological importance of deoxy sugars and sugar acids.

Disaccharides: Establishment of structures of Sucrose and Lactose, Biological Importance and structure of Isomaltose, Trehalose and Maltose.

Polysaccharides: Partial structure, occurrence and importance of Starch, Glycogen, Inulin, Cellulose, Chitin, and Pectin.

UNIT II

LIPIDS **15 HOURS**

Classification and biological role, fatty acids – nomenclature of saturated and unsaturated fatty acids.

Acylglycerols: Mono, di and triacylglycerols. Saponification, saponification value, iodine value, acid value and significance. Rancidity, hydrolysis.

Phosphoglycerides: Structure of lecithin (phosphatidyl choline), cephalins, phosphatidyl inositol, plasmalogens, and cardiolipin. Biological role of phosphoglycerides.

Sphingolipids: Structure and importance of sphingomyelin.

Glycerosphingolipids: Importance of gangliosides and cerebrosides.

UNIT III :

AMINO ACIDS AND PROTEINS **15 HOURS**

Amino acids: Structure and classification of amino acids based on polarity. Reactions of the amino groups with HNO_2, $LiAlH_4$. Ninhydrin, Phenyl isothiocyante, DANSYL Chloride, Fluro dinitro benzene. Reaction of carboxyl group – Hydrazine. Zwitterionic properties. pKa values, D & L notation.

Peptides: Peptide bond, structure and biological importance of glutathione, Valinomycin. Synthetic peptides- polyglutamic acid, polylysine.

Proteins: Classification of proteins based on solubility, structure and functions with examples. Forces that stabilise the structure of proteins, Primary structure of proteins, methods of determining N- and C- terminal aminoacids, amino acid composition, sequencing by Edman's degradation method. Secondary Structure – α helix. β-sheet, β-bend. Tertiary and quaternary structures- hemoglobin, denaturation and renaturation of proteins. Anfinsen's experiment.

UNIT IV :

NUCLEIC ACIDS **15 HOURS**

Nucleic acids: Composition of DNA and RNA. Nucleosides and Nucleotides. Other functions of nucleotides – source of energy, component of coenzyme and second messengers. Chargaff's rule. Watson and Crick model of DNA. Nucleic acid chemistry- UV absorption, Effect of alkali and acid on DNA, Chemical reactions of RNA and DNA. Melting of DNA (Tm). Types of RNA (mRNA, tRNA and rRNA), Secondary structures of tRNA – clover leaf model.

REFERENCES

1. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4th Edition, John Wiley and Sons Inc, 2012
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
3. Biochemistry- the chemical reactions of living cells, David E Metzler, 2nd Edition, Elsevier Academic Press,
4. Fundamentals of Biochemistry, Jain, J.L, S.Chand publication 6th Edition, 2005.
5. Biochemistry, Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Freeman and company, 7th Edition, 2010.
6. Harper's Illustrated Biochemistry, Victor W Rodwell, et.al,31st edition, McGraw Hill Education Lange ® 2018.
7. Biochemistry , Lubert Stryer 5th edition 2015

SEMESTER V (a)

PRACTICAL

COURSE TITLE	**QUALITATIVE ANALYSIS OF MACROMOLECULES**
COURSE CREDITS	**02**
CONTACT HOURS	**4 HOURS/WEEK**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course Outcome:

The practical course will enable the students to learn the principles of reactions pertaining to different macromolecules. They will be able to qualitatively identify the presence of specific macromolecules or amino acids when provided with solution of a mixture of biomolecules.

EXPERIMENTS

QUALITATIVE ANALYSIS OF BIOMOLECULES

1. Carbohydrate – Glucose, Fructose, Lactose, Maltose and Sucrose.
2. Amino acids -Tryptophan, tyrosine or cysteine
3. Proteins –. Albumin or casein
4. Lipids- solubility, acrolein test, Salkowski test, Lieberman-Burchard test.
5. Extraction of phosphatides from egg yolk
6. Nucleic acids by diphenylamine test, orcinol test

QUANTITATIVE ANALYSIS OF BIOMOLECULES

7.Estimation of glucose by Folin Wu method, GOD/POD method.

8.Determination of iodine value of fat/oil

9.Isolation of RNA from Yeast cells

10.Estimation of RNA by Orcinol method

REFERENCES:

1. Practical Biochemistry, Geetha Damodaran, Jaypee, 2011
2. Biochemical methods, S. Sadasivam , A. Manickam, 3rd Edition, New Age International Pvt Ltd, 2007
3. An Introduction to Practical Biochemistry, David Plummer , 3rd edition 2017
4. Laboratory manual in Biochemistry , J. Jayaraman 2011

SEMESTER- V (b)

COURSE TITLE	**HUMAN PHYSIOLOGY AND ENZYMOLOGY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**56**
DURATION OF ESA	**2.5 hours**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:

- Describe cell structure and functions, how cells form and divide, and how they differentiate and specialize.
- Students will be able to describe the cyclical events of cell division and types of cell divisions. Student's knowledge with regard to the process of cell death and cell aging will enhance to its core.
- Physiology involves the study of how living systems function, from the molecular and cellular level to the system level, and emphasizes an integrative approach to studying the biological functions of the human body.
- Enzymology topics will enable students to describe structure, functions and the mechanism of action of enzymes. Learning kinetics of enzyme catalyzed reactions and enzyme inhibitions and regulatory process, Enzyme activity, Enzyme Units, Specific activity.

Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	x	x	x									
Critical thinking		x										
Subject clarity	x	x									x	
Analytical Skill	x				x	x						

Part-A Human Physiology

UNIT I: **14 Hours**

Basic body plan in humans & Location of organs.

Nervous System: Brief outline of nervous system, Neurons – types, structure of multipolar neuron, mechanism of nerve impulse transmission- along axon, across synapse. Action potential & resting potential. Neurotransmitters – Excitatory & Inhibitory with examples.

Respiratory system: Anatomy, structure and functions of lungs, mechanism of respiration (pulmonary ventilation), gas exchange mechanism, biochemical events in the transport of gases & factors affecting, role of lungs in acid-base balance. Hypoxia, emphysema.

Cardio-vascular system: Structure and functions of heart. Blood vessels – types. Overview & functions: Cardiac cycle, cardiac output, regulation of CVS, blood pressure, heart rate, ECG. Body fluids – blood (composition, structure & functions of blood cells), blood clotting mechanism, Lymph and CSF.

Bone and Cartilage: Structure and types of bone and cartilage. Long bone – Composition, structure, growth & remodeling, factors affecting.

UNIT -II

14 Hours

Digestive System and GIT: Anatomy of GIT and accessory organs, Digestion, absorption & transport of carbohydrates, lipids and proteins. Role of various enzymes involved in digestive process.

Hepatic System: Structure of a liver lobule. Role of liver in metabolic, storage and detoxification.

Excretory System: Brief outline of excretory system, formation of urine – Glomerular filtration, tubular reabsorption & secretions. Role of kidney in acid-base balance. Regulation of kidney function.

Endocrine System: Brief outline of various endocrine glands and their secretions. Dynamic balance and regulation of hormonal secretions. Classification of hormones based on structure and site of production. Physiological role of hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads. Regulation of their secretion. Membrane receptors and secondary messengers (cAMP, DAG, IP3, G- protein).

Part-B: ENZYMOLOGY

UNIT III: **14 hours**

Introduction to enzymes:

Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme, IUBMB classification of enzymes with examples. International Units of enzyme activity, specific activity.

Monomeric and oligomeric enzymes- Monomeric enzymes, multifunctional enzymes, oligomeric enzymes and multi- enzyme complexes, isoenzymes- lactate dehydrogenase.

Features of enzyme catalysis:

Catalysis, reaction rates and thermodynamics of reaction. Activation energy and transition state theory, catalytic power and specificity of enzymes (concept of active site), Theories of enzyme catalysis- Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

UNIT IV: **14 hours**

Enzyme kinetics of single substrate reactions:

Michaelis-Menten equation, equilibrium constant – mono substrate reactions, relationship between initial velocity and substrate concentration, Factors affecting the rate of chemical reactions - enzyme concentration, substrate concentration- pH, temperature and metal ions. Line weaver- Burk plot. Determination of Vmax & Km from L-B plot and their significance, Kcat and turnover number.

Enzyme inhibition:

Reversible inhibition- competitive, uncompetitive, non-competitive with graphical representations using L-B plots, Evaluation of Km and Vmax in presence of inhibitor mixed and substrate. Irreversible inhibition- Suicide inhibition - antibiotics as inhibitors- penicillin.

REFERENCES:

1) Chatterjee C C, Human physiology, Medical allied Agency. New Delhi 2020
2) Gerard J Tortora, Bryan H Derrickson. Principles of anatomy and physiology, 13th edition, John Wiley & Sons 2000
3) Gyton and Hall, Textbook of medical physiology, 10th edition, Elsevier Health Sciences 2015
4) Textbook of Human Physiology, A.K. Jain, APC Publishers, New Delhi, 9th edition 2020
5) Textbook of Human Physiology, Anthony C. Rose and William T. Wilson, Elsevier, 11th edition 2016
6) Bruce Alberts, Hopkin, Johnson Morgan, Raff, Roberts, and Walter, Essential Cell Biology, 5th edition, W.W. Norton & Company, 2019
7) Textbook of Enzymology, Trevor Palmer, Springer, 1st edition 2001
8) Fundamentals of Enzymology, Nicholas C. Price and Lewis Stevens, Oxford University Press, 4th edition 2017

SEMESTER V(b)
PRACTICAL

COURSE TITLE	**HUMAN PHYSIOLOGY AND ENZYMOLOGY**
COURSE CREDITS	**02**
CONTACT HOURS	**4 HOURS/WEEK**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course Outcome:
At completion of this course, it is expected that the students will be able to : Determining the blood grouping and other physiological parameters, Identify of microscopical features of various types of cells and tissues: Understand the anatomy & Physiology of various systems and Learn the enzymatic activity and reactions.

EXPERIMENTS:

1. Determination of ABO blood grouping
2. Determination of Rh factor of blood
3. Estimation of hemoglobin content in blood By Sahl's method
4. Determination of blood pressure using sphygmomanometer
5. Understanding principle, working & handling of simple microscope
6. Simple Staining of bacteria
7. Gram staining
8. Staining of Human blood cells
9. Demonstration of pure culture techniques – Streak, pour plate and serial dilution
10. Qualitative analysis of salivary amylase activity
11. Determination of activity of salivary amylase by DNS method
12. Determination of specific activity of salivary amylase.

REFERENCES

1. Essentials of Medical Physiology , K. Sembulingam and P. Sembulingam. Jaypee brothers medical publishers, New Delhi., 2019

2. Text book of Medical Physiology- C,Guyton and John.E. Hall. Miamisburg, OH, U.S.A, 12th edition 2011

3. Textbook of Practical Physiology , C.L. Ghai, Jaypee brother's medical publishers, New Delhi, 10th edition 2022

4. A Hand book of practical Microbiology, R. Saravanan , D. Dhachinamoorthi , CH. MM. Prasada Rao , 2019

SEMESTER VI (a)

COURSE TITLE	BIOENERGETICS AND METABOLISM
COURSE CREDITS	04
TOTAL CONTACT HOURS	56
DURATION OF ESA	2.5
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course Outcome:

At the end of the course the students will be able to:

- Understand the concepts of metabolism, characteristics of metabolic pathways and strategies used to study these pathways.
- Gain a detailed knowledge of various catabolic and anabolic pathways and its regulation
- Systematically learn the breakdown and synthesis of amino acids and nucleotides in humans and recognize its relevance with respect to nutrition and human diseases
- Acknowledge the role of inhibitors of nucleotide metabolism which are potentially being used as chemotherapeutic drugs
- Comprehend how the amino acid and nucleotide metabolism are integrated with carbohydrate and lipid metabolism

Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude		x		x				x				
Critical thinking		x		x		x				x		
Subject clarity	x	x				x	x					x
Analytical Skill	x				x	x				x		

UNIT-I

14 Hours

Bioenergetics: Laws of thermodynamics, free energy change, equilibrium constant

Photosynthesis-Ultra structure of Chloroplast, photosynthetic pigments**,** photoreaction & Calvin cycle in brief review, cytochrome, phytochrome & Bacterial photosynthesis.

Mitochondrial electron transport: Electron transport chain & oxidative phosphorylation- structure of mitochondria, sequence of electron carriers, flow chart of transport of electrons from reducing potential to O_2. inhibitors of ETC, oxidative phosphorylation, uncouplers of oxidative phosphorylation, ATP synthase-structure, Hypothesis of ATP synthesis – Binding change mechanism.

UNIT-II

14 Hours

Metabolism: Anabolism and catabolism, compartmentalization of **metabolic pathways.**

Metabolism of Carbohydrates: Reactions and energetics of glycolysis, entry of fructose, galactose, mannose and lactose into glycolytic pathway. Fates of pyruvate - conversion of pyruvate to lactate, alcohol and acetyl CoA. Cori's cycle.

Reactions and energetics of TCA cycle, amphibolic and integrating roles of TCA cycle. Anaplerotic reactions. Regulatory steps of glycolysis and TCA cycle, Gluconeogenesis and glycogenolysis. Pentose phosphate pathway and its significance.

UNIT-III

Metabolism of Lipids **14 Hours** **14 Hours**

Hydrolysis of triacylglycerols, transport of fatty acids into mitochondria, Beta-oxidation of even numbered saturated fatty acids, Energetics of β-oxidation. Biosynthesis of even number saturated fatty acids (Scheme only). Significance & source of Ketone bodies and ketosis. Outline of Cholesterol biosynthesis & regulation.

UNIT-IV

Metabolism of Amino acids **14 Hours**

General reactions of amino acid metabolism- transamination, oxidative deamination & decarboxylation, Urea cycle, flow chart of degradation & biosynthesis of amino acids, glucogenic & ketogenic amino acids.

Nucleic Acid metabolism: Degradation of nucleic acids, action of nucleases- DNase I and II, RNase and phosphodiesterases. De novo biosynthetic pathways of purine and pyrimidine nucleotides. Conversion of ribonucleotides to deoxy ribonucleotides. Catabolism of purines and pyrimidines. Salvage pathways.

REFERENCES

1.Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4th Edition, John Wiley and Sons Inc, 2012

2. Lehninger- Principles of Biochemistry; DLNelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012

3.Biochemistry- the chemical reactions of living cells, David E Metzler, 2nd Edition, Elsevier Academic Press

4. Fundamentals of Biochemistry, Jain, J.L, S.Chand publication 6th Edition, 2005.

5.Biochemistry, Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Freeman and company, 7th Edition, 2010.

6.Harper's Illustrated Biochemistry, Victor W Rodwell, et.al,31st edition, McGraw Hill Education Lange ® 2018.

SEMESTER VI- PRACTICAL

COURSE TITLE	BIOENERGETICS AND METABOLISM
COURSE CREDITS	02
CONTACT HOURS	4 HOURS/WEEK
DURATION OF ESA	03
FORMATIVE ASSESSMENT MARKS	25
SUMMATIVE ASSESSMENT MARKS	25

Course Outcome:

- The practical course will enable the students to learn the estimation of blood substances which tell how well the organs/kidneys are functioning, Blood urea nitrogen is a measure of how well the kidneys are working.
- Learning the structural levels of Nucleic acids.

I :Experiments

1. Estimation of Pyruvate by DNPH method
2. Estimation of Urea
3. Estimation of Uricacid
4. Estimation of RNA by orcinol method
5. Estimation of creatinine
6. Estimation of amino acid by Ninhydrin method

II :Report:

Visit to scientific/research institute – Tour report.

OR

Submission of assignment on recent trends in Biochemistry

REFERENCES:

1. Practical Biochemistry, Geetha Damodaran, Jaypee, 2011
2. Biochemical methods, S. Sadasivam , A. Manickam, 3rd Edition, New Age International Pvt Ltd, 2007
3. An Introduction to Practical Biochemistry, David Plummer , 3rd edition 2017
4. Laboratory manual in Biochemistry , J. Jayaraman 2011

SEMESTER VI

COURSE TITLE	**MOLECULAR BIOLOGY AND IMMUNOLOGY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**56**
DURATION OF ESA	**2.5**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

Will be able to explain:

- the concept of immunology, concepts of antigen and antibody
- the immune system cells , Discuss active immunity and passive immunity
- the cellular immune mechanism

Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Aptitude		x		x								
Critical thinking		x				x						
Subject clarity	x	x				x	x		x	x	x	x
Analytical Skill	x				x	x				x		

UNIT I

Introduction and DNA Replication **14 Hours**

History: Identification of DNA as genetic material- Experiments of Griffith, Hershey and Chase: Overview of structure of DNA.

Introduction to Molecular Biology: Chromosomal organization in prokaryotes and Eukaryotes; Gene and gene concept: cistron, muton, and recon. Central dogma of molecular biology and its modification,

Replication: Types of replication -Conservative, semi conservative and dispersive: Evidence for semi conservative replication- Messelson and Stahl experiment: Mechanism of semi conservative replication- Steps involved in replication, Enzymes and proteins involved in replication, outline of DNA replication in eukaryotes.

DNA damage-Mutation: Concept of mutation, Mutagens – chemical and physical, Molecular basis of mutation: spontaneous and induced mutations, effect of HNO_2, alkylating agents, intercalating agents and UV-radiation. Point mutations: Concept of missense, nonsense and frame shift mutations.

UNIT II

Transcription and Translation Regulation of gene expression 14Hours

Transcription: Types of RNA, RNA polymerases, promoters, enhancers, silencers, role of sigma factor, Structure of mRNA in prokaryotes, Mechanism- initiation, elongation and termination

(Rho- dependent and independent), Overview of eukaryotic transcription, post transcriptional processing: capping, splicing and poly adenylation.

Genetic code: characteristics of genetic code, wobble hypothesis.

Translation: Mechanism of translation - amino acid activation, charging of tRNA, initiation, elongation, and termination; Post-translational modification; Inhibition of protein synthesis by antibiotics. Outline of translation in eukaryotes.

Regulation of Gene expression

General aspects of regulation, transcriptional regulation - inducible and repressible system, Operon concepts - lactose , tryptophan operons, Regulation of translation. Brief account of Eukaryotic gene expression.

UNIT III

Over view and Nature of Antigen and Antibody 14Hours

Organs of the immune system: Anatomy and functions of lymphoid tissues, Cellular components of the immune system - Hematopoiesis, stem cells, granulocytes- Neutrophil, eosinophil, basophil and Mast cell, Mononuclear cells- Lymphocytes, Monocytes, Macrophages, NK cells and Dendritic cells.

Antigen: Concept of antigenic determinants and immunogens, factors that influence immunogenicity, Classes of antigen, Epitopes, Haptens.

Antibody: Molecular Structure - general features, light and heavychains, Hyper-variable and constant regions, Different isotypes and subtypes of immunoglobulins, Allotypes and idiotypes.

UNIT IV

Innate immunity **14 Hours**

Anatomical and physiological barriers, Soluble factors, Inflammation-characteristics, initiation of the inflammatory response, Chemotaxis, Phagocytosis, Acute inflammatory response, Role of innate immunity. Cytokines, Complement system.

Adaptive immunity

MHC molecules: genes, different classes, structure and function, Antigen processing and presentation: Endogenous and exogenous pathways.

Humoral Immunity – B cell receptors (BCR), B-Cell maturation, Activation, Differentiation, generation of plasma cells and memory B cells.

Cell-mediated immunity: Structural organization of T cell-receptors, T-cell maturation, Activation, Differentiation, Proliferation, B cell – T cell interaction, The germinal center reactions.

Transplantation: Types of transplants, Graft rejection, process of graft rejection-sensitization and effector stage, role of immunosuppressive agents in clinical situation.

REFERENCES:

1. Cox, Michael M. Lehninger Principles of Biochemistry. Freeman, 2013.
2. Lubert Stryer. Biochemistry, 5th edition , 2006
3. Owen, Judith A., Jenni Punt, and Sharon A. Stranford. Kuby immunology. New York: WH Freeman, 2013.
4. Delves, Peter J., Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt. & Roitt's essential immunology. Vol. 20. John Wiley & Sons, 2011.
5. Molecular Biology - David Friefelder, Narosa Publication- house Pvt. Ltd. New Delhi,2020
6. A Textbook of Biochemistry: Molecular and Clinical Aspects S. Nagini . 2nd edition .Sci Tech Publ., Chennai, 2007
7. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4th Edition, John Wiley and Sons Inc, 2012
8. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
9. Biochemistry , Lubert Stryer , W.H Freeman and Company Limited

SEMESTER VI

PRACTICAL

COURSE TITLE	**MOLECLAR BIOLOGY AND IMMUNOLOGY**
COURSE CREDITS	**02**
CONTACT HOURS	**4 HOURS/WEEK**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course Outcome:

The practical course will enable the students to learn the principles of reactions pertaining to nucleic acids. They will be able to isolate and quantitate DNA and RNA from different sources and characterization.

The practical course will enable the students to learn

- Identifying blood groups and types
- Competently perform serological diagnosis
- Analyze components of human sera by performing electrophoresis experiments.

Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude		x		x								
Critical thinking		x				x						
Subject clarity	x	x				x	x		X	x	x	x
Analytical Skill	x				x	x				x		

EXPERIMENTS: MOLECULAR BIOLOGY

1) Isolation of DNA from banana/endosperm of coconut/ bacteria / any other source
2) Isolation of RNA from spinach leaves/any other source
3) Purity check by UV spectrophotometer (DNA and RNA ratio)
4) Agarose gel electrophoresis of nucleic acids
5) DNA analysis by Restriction endonucleases
6) PCR

I. EXPERIMENTS: IMMUNOLOGY

1. Double immune Diffusion Test
2. Radial immune diffusion test
3. Antibiotic Sensi
4. WIDAL test
5. Dot ELISA
6. Differential leucocyte count
7. Preparation of Erythrocyte Ghost cell

REFERENCES :

1) Molecular Biology: A Laboratory Manual by by Ashwani Kumar S.K. Gakhar, Monika Miglani, 2019
2) Wilson And Walkers Principles And Techniques of Biochemistry And Molecular Biology 8th ed (Sae) by Hofmann, 1983
3) Laboratory Manual of Microbiology, Biochemistry and Molecular Biology by J. Saxena, M. Baunthiyal, I. Ravi , 2015
4) Biochemical methods, S. Sadasivam , A. Manickam, 3rd Edition, New Age International Pvt Ltd, 2007
5) An Introduction to Practical Biochemistry, David Plummer , 3rd edition 2017
6) Laboratory manual in Biochemistry , J. Jayaraman 2011
7) A handbook of practical and clinical immunology , 2017 G.P Talwar and S.K Gupta
8) Practical Immunology ,2000, Frank C Hey, Publisher: John Wiley and Sons Ltd
9) An Introduction to Practical Biochemistry, David Plummer , 3rd edition 2017
10) Laboratory manual in Biochemistry , J. Jayaraman 2011.

RATIO OF WEIGHTAGE (MARKS) BETWEEN INTERNAL & END SEMESTER EXAMINATIONS FOR THEORY: 60:40

INTERNAL ASSESSMENT FOR THEORY (40 MARKS)

Components:	**Marks**
Continuous Internal Assessment (Two internal tests 10 x 2)	**20 marks**
Assignment	**05 marks**
Attendance/Regularity	**05 marks**
Surprise test/ Open book exam/ Unit wise test (Objective/MCQ)/Seminar/Micro teaching	**05 marks**
Group Project work/ MOOC course/ Poster or Paper presentation	**05 marks**

PRACTICUM	**Total Maximum Marks: 50**
INTERNAL ASSESSMENT + END SEMESTER PRACTICAL EXAM	
25 Marks + 25 Marks	

Internal Assessment for Practical (50 Marks) converted to 25 marks	
Components:	**Marks**
Continuous Internal Assessment of all practical experiments	**15 marks**
Model practical examination	**20 marks**
Maintenance of Record	**05 marks**
Viva	**05 marks**
Attendance	**05 marks**

Question paper Pattern for Practical Examination
(Same scheme to be followed for all VI Semesters)
End semester Practical exam

Time: 3 hrs	Total marks: 25
Major Experiment	10 marks
Minor Experiment	06 marks
Procedure writing	04 marks
Record	05 marks

B.Sc. HONOURS

SEMESTER I & VI

MODEL QUESTION PAPER

BIOCHEMISTRY

TIME: 2.5 hrs MAX. MARKS: 60

NOTE: ALL SECTIONS ARE COMPULSORY

SECTION – A

1. **Answer any FIVE of the following questions** **5 x 2 = 10**

a.

b.

c.

d.

e.

f.

g.

SECTION – B

Answer any FOUR of the following questions **5 x 4 = 20**

2.

3.

4.

5.

6.

7.

SECTION – C

Answer any three of the following questions **3 x 10= 30**

8. (6+4)

9. (6+4)

10. (6+4)

11. (5+5)

12.. (5+5)

B.Sc SEMESTER III & IV MODEL QUESTION PAPER

BIOCHEMISTRY

OPEN ELECTIVE

TIME: 2.5 hrs **MAX. MARKS: 60**

NOTE : ALL SECTIONS ARE COMPULSORY

SECTION – A

1. Answer any FIVE of the following 10 x 2 = 20

a.

b.

c.

d.

e.

f.

g.

h.

i.

j.

k.

l.

SECTION – B

Answer any EIGHT of the following 8 x 5 = 40

2.

3.

4.

5.

6.

7.

8.

9.

10.

****

INTERNSHIPS under UGC regulation, 2023.

INTERNSHIP GUIDELINES

NEP 2020 has devised transformative initiatives in the field of higher education. The skills required for developing employability ingenuities are fostered by introducing internship as an important component in the curriculum.

Internship is provided in two modes-

i. Internship for enhancing the employability
ii. Internship for developing the research aptitude

As per the UGC Guidelines for "**Implementation of Internship/Research Internship for Undergraduate Students**" our institution has structured the internship course under the following categories-

i. Internship for enhancing the employability

The interns may pursue their internships in varied industries perse and go beyond the clusters prescribed by the central, state, micro and local governments. An indicative list is provided by UGC which comprises of –

1. Trade and Agriculture Area
2. Economy & Banking Financial Services and Insurance Area
3. Logistics, Automotive & Capital Goods Area
4. Fast Moving Consumer Goods & Retail Area
5. Information Technology/Information Technology enabled Services & Electronics Area
6. Handcraft, Art, Design & Music Area
7. Healthcare & Life Science Area
8. Sports, Wellness and Physical Education Area
9. Tourism & Hospitality Area
10. Digitisation & Emerging Technologies (Internet of Things/Artificial Intelligence/Machine Learning/Deep Learning/Augmented Reality/Virtual Reality, etc.) Area
11. Humanitarian, Public Policy and Legal Service Area
12. Communication Area
13. Education Area
14. Sustainable development Area
15. Environment Area

16. Commerce, Medium and Small-Scale Industries Area and other areas approved by the statutory bodies of the institution from time to time.

ii. Internship for developing the research aptitude

Building of the research aptitude is a formative way to uncover facts and present the outcomes in an organised manner. Research internship aims at providing hands-on training to work on research tools, techniques, methodologies, equipment, policy framework and various other aspects in pursuing quality research.

The research interns can apply in research institute, research lab, national or internationally reputed organizations, research labs, working with faculty, mentors from distinguished fields.

INTERNSHIP STRUCTURE

- Internship is organised, executed and monitored by the Research & Development Cell (RDC) of the institution.
- Since the internship is time bound, a research supervisor is assigned to the interns for sharing expertise and follow up of their Internship Progress.
- Orientation sessions and interaction faculty-wise was initiated.
- A Nodal Officer was appointed along with four block-wise coordinators to harness the possibilities and effectively implement internship at department level.
- Internship Report Format is drafted for maintaining the uniformity in reporting ethos.
- The Nodal Officer is in charge of corresponding with the Internship Providing Organization (IPO) is any organization, HEI, philanthropy, farmer, government organization, R&D institutions, research labs, artisans, enterprises, institution/person of eminence, cooperatives, corporates providing an opportunity to the student for Internship during the programme.
- The Nodal Officers along with the block coordinators must be approached in case of any issues and will be responsible for any official registration, enrollment and upkeep of the internship programme and the students.
- Internship Supervisors/ Mentors are appointed and a lot of students are assigned to them who inturn are responsible to ensure the authenticity of the internship certificate provided and monitor the hours of the work undertaken by the interns.

- Students may apply for Internship Programme through the Nodal Officer or Online Internship Apps such as Internshala, Go Intern and so on to avail the Internship Offers.
- It is preferred to undertake internship in physical mode. Digital Mode or Group Internships are an option.
- Internship Reports must be endorsed by the Internship Supervisor/ Mentor.

ACADEMIC CREDENTIALS

- The internship as a course is mandatory for the under-graduate level fetching 2 credits each.
- For an internship, one credit of Internship means two-hour engagement per week.
- 60 – 90 Hours is mandatory to be undertaken by every student who is interning in any of the modes mentioned above.
- Hands-on training/ Orientation is mandatory before commencement of the internship/research internship programme.

EVALUATION

Report writing (15-20 pages)- Format will be sent to the Internship Mentors/ Project Guides	20 Marks
Powerpoint Presentation	10 Marks
Viva Voce (One to One)	10 marks
External Assessment (Internship)/ External Evaluation (Project Report)	10 Marks
Total	**50 Marks**
Number of Hours	**60 hours (Internship)**

EVALUATION AND ASSESSMENT COMPRISES OF-

i. Activity logbook and evaluation report of Internship Supervisor
ii. Format of presentation and the quality of the intern's report
iii. Acquisition of skill sets by the intern
iv. Originality and any innovative contribution
v. Significance of research outcomes
vi. Attendance

ANNEXURE

FORMAT OF THE INTERNSHIP REPORT

ST ALOYSIUS COLLEGE ( )MOUS) MANGALURU

INTERNSHIP REPORT FORMAT

1. Title Page (1 page)

- Student Name, Class, Register Number, Name of the College
- Name of the Company
- Internship Dates (Duration – Date of commencement –Date of completion)
- Certificate from Dean/Head of Department **(1 page)**
- Declaration by the Student **(1 page)**
- Certificate from the Internship Mentor **(1 page)**
- Company Certificate with Official Logo and Authorized Signature **(1 page)**

REFER SAMPLE 1 to SAMPLE 6 ANNEXED TO THIS FORMAT (Page No. 3 - Page No. 6)

2. Table of Contents (1 page)

- Keep it in Tabular Form
- Serial Number, Particulars and Page Number (three columns)

3. Acknowledgements *(*1 page)

(Mention how they helped you and what you learnt from each person)

4. Brief Profile of the Company/entity (2 pages)

- History- Vision- Mission of the Company
- Regular Business Activities (Broad/Specific)
- Intern's role in Overall Work Scheme

5. Tasks Assigned (1 page)

- Mention in points the various tasks assigned

6. Learning Objectives (1 page)

(Example: three objectives are mentioned- any other objective kindly mention)

- Mention the following learning objectives-
  - ✓ To pursue internship in a company or an institution which gives opportunity to explore and nurture our skills.
  - ✓ To undertake experiential learning to improvise the technical and social skills.
  - ✓ To build curriculum vitae and strengthen the work experiences.
  - ✓ Any other (kindly specify)

7. Responsibilities including Job Description (7 pages)

- Internship Position in the Company (Example: Database Management Assist as Designation)
- Day Wise Report (Mention- Date, Time, Venue, Staff In-charge Name and Designation, Detailed report on daily basis)
- Mention Specific Tasks, Skills you learnt and experiences that developed you professionally.
- Mention even the talks, seminars attended, training sessions attended.
- Attach the relevant documents and certificates and evidential documents.

8. Skills and Experiences (Learning Outcomes) (1 page)

- Specific skills developed relate it to educational experiences and your career goal.
- Professional traits acquired.

9. Conclusion (1 page)

- Potentialities for future internships
- Helping the organization in better understanding of the need and interest of interns.

10. Annexure

- Attach relevant documents, certificates and photographs

Principal 22-01-2023 **Registrar**

SAMPLE 1

Title page

ST ALOYSIUS COLLEGE (AUTONOMOUS) MANGALURU

Internship Report on ---------- (area of work)

at ---------- (name of the company, place)

Submitted to St Aloysius College (Autonomous), Mangaluru in partial fulfillment of the requirements for the award of the

Degree of Bachelor of ……jh ……

B. ……..

By

(Name of the Student)

(Class and Register No)

Under the guidance of

Name and address of Internal Guide

2023 – 2024

SAMPLE 2

Certificate from the Dean/HOD

FACULTY OF ……..

ST ALOYSIUS COLLEGE (AUTONOMOUS)

LIGHT HOUSE HILL ROAD, MANGALORE – 575 003

CERTIFICATE

This is to certify that Mr./Ms …….. bearing Register number…….. has successfully completed his/her internship on ……..…….. (area of work) at ……..(name of the company and place).

This internship report is prepared after having undergone internship for the period as stipulated by the College and is submitted to St Aloysius College (Autonomous) Mangaluru, in partial fulfilment of the requirements for the award of the Degree of Bachelor of …….. during the year 2023-24.

Date: Signature with name and Designation

Place: Seal

SAMPLE 3

Declaration by the student

DECLARATION

This is to certify that this internship report has been prepared by me after undergoing internship from……..to……..(duration) at ……..…..(name of the company and place). This report is my original work and is being submitted for the partial fulfilment of the requirements of the award of the Degree of ……..…..

This report has not been submitted earlier to this College or any other Universities/Institutions for the fulfilment of the requirements of the course of the study.

Date: Signature

Name of the student

Place: Register No

SAMPLE 4

Certificate from Internship Mentor

CERTIFICATE

This is to certify that …….. (Name of the student), Register Number……., of ……., has successfully completed his/her internship on…… (area of work) at …… (name of the company and place), in partial fulfilment of the requirements for the Degree of ……. The internship report has been prepared by him/her under my guidance and supervision. I further certify that no part of this report has been submitted for the award of any degree, diploma, fellowship or such other similar title.

Name and Designation of the Internship Mentor:

Date:

Place: Signature

(Internship Mentor)

SAMPLE 5

Certificate of Performance from the company in its letter head

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr/Ms …….. (name of the student), …….. (Reg No), student of B.Com at St Aloysius College (Autonomous) Mangaluru, has done his / her internship in our company on …….. ……., (area of work), for the purpose of partial requirements for the award of the Degree of Bachelor of Commerce. He /She has completed the internship from our company for the period from …….. to ……. (date of internship).

During his/her tenure of the internship his/her conduct and character was good.

Signature

Name and Designation

Company seal

Date:

Place:

****