ROYAL GLOBAL UNIVERSITY

GUWAHATI

ROYAL SCHOOL OF BIO - SCIENCES

(RSBSC)

Department of Biochemistry

Biochemistry Postgraduate Programme

For

M.Sc. Biochemistry

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Preamble

Over the past decades the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. The upgradation ofPostgraduate programmes will play an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution - a democratic, just, socially conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all. A holistic and multidisciplinary education would aim to develop all capacities of human beings -intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner. Such an education will help develop well-rounded individuals that possess. Such changes will further result in learning outcome based curriculum in order to maximize the benefits of the newly designed curriculum. The learning outcome based curriculum in general and in Biochemistry in particular will definitely help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. It is pertinent to mention here that the purpose of education is to develop an integrated personality of the individual and the educational system provides all knowledge and skills to the learner for this.

The template as developed has the provision of ensuring the integrated personality of the students in terms of providing opportunity for exposure to the students towards core courses, discipline specific courses, generic elective courses, ability enhancement courses and skill enhancement courses with special focus on technical, communication and subject specific skills through practical and other innovative transactional modes to develop their employability skills. The template of learning outcome based framework has categorically mentioned very well defined expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness and so on along with very specific learning course outcomes at the starting of each course. Therefore, this template on Learning Outcomes based Curriculum Framework (LOCF) for M.Sc. in Biochemistry Honours under The Assam Royal Global University will be more flexible, multi-disciplinary, holistic and will definitely be a landmark in the field of outcome based curriculum construction.

1. INTRODUCTION

1.1 About the Department:

1.1.1 Historical background of Department

The Department of Biochemistry, The Assam Royal Global University, was established in 2018 with about 10 students and a few faculty members. The dynamic and visionary contributions of several renowned biochemists and educationist earned the Department recognition for its teaching and research.

1.1.2 Department highlights in terms of its ranking, courses

The Department of Biochemistry is committed to expand and absorb the wide diversity of scientific disciplines associated with the study of reactions in living organisms. Our B.Sc., M.Sc., and Ph.D. programmes are multi-faceted and designed to empower post-graduate students and researchers with a holistic and comprehensive education across a wide range of subject areas, which would enable them to contribute effectively to basic and applied education and research in biochemistry.

1.1.3 About the programme

The discipline of Biochemistry is regarded as the Mother of all Biological Sciences disciplines because it unveils the chemical basis of life in all living organisms, including plants, animals, and microorganisms. Biochemistry has enormously contributed to improving the understanding of many metabolic processes across different life forms. This has helped in achieving massive improvements in the field of health sciences, agriculture and its many branches, drug designing, food technology, and also in environmental bioremediation.

Keeping in pace with the developmental trends in various subareas of Biochemistry, it is expected that the students undertaking Biochemistry (Honours) courses at the postgraduate level become conversant with the fundamentals of Biochemistry and at the same time at the end of the programme they exhibit certain levels of learning outcomes. Such learning outcomes like understandingdiscipline,criticalthinking, problem-solving,analyticalandscientificreasoning, research/industry-related skills, etc., will empower the students to develop their future careers withamuchbetterand more meaningfulorientation.Withthisbackground, LOCF-Biochemistrypostgraduate model curriculum has been developed, which includes 10 core theory papers, 12 department-specifictheorypapers, andcorrespondingpracticalpapers.Thecoursecontentsinclude fundamentals as well as upcoming developments in the discipline of Biochemistry and interfacial sciences.

1.1.4 About Post Graduate Attributes

In addition to academic rigor and training in subject-specific areas listed above, our students are also well trained in ethics, critical thinking, reasoning and analytical skills, effective communication, laboratory safety, sensitivity to environment and sustainable living.

1.1.5 About the process of course development involving various stakeholders at different stages.

The draft course contents are finalized by the Academic Council after extensive deliberations and discussions involving all faculty members in Board of Studies Meetings. Feedback from

students and alumni are obtained during their study periods. The draft courses are uploaded on the University website to invite comments and suggestions from various stakeholders and reviewed by the Council Prior to approval by the Departmental Council, Courses Committee of UG and PG in Biochemistry and then sent to two external experts in the subject area for their critical inputs and suggestions. The finalized course contents were then discussed in school Board of Studies and submitted for administrative approval by statutory bodies of RGU.

2. Introduction to CBCS (Choice Based Credit System) Choice Based Credit System:

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enable the potential employers in assessing the performance of the candidates.

2.1 Approach to Curriculum Planning

While designing these frameworks, emphasis is given on the objectively measurable teaching-learning outcomes to ensure employability of the graduates. In line with recent trends in education section, these frameworks foster implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, MOOCs and other e-learning platforms. In addition, the framework pragmatic to the core; it is designed such a way to enable the learners implementing the concepts to address the real world problems. A major emphasis of these frameworks is that the curriculum focuses on issues pertinent to India and also of the west; for example, biodiversity and conservation of endemic and threatened species that are found in India, Indian climatological variables, Indian biodiversity and so on. Above all, these frameworks are holistic and aim to mould responsible Indian citizen who have adequate skills in reflective thinking, rational scepticism, scientific temper, digital literacy and so on such that they are equipped to fight immediate social issues apropos to Indian milieu, including corruption and inequity.

The fundamental premise underlying the learning outcomes-based approach to curriculum planning and development is that higher education qualifications such as a Master's Degree (Hons) programmes are earned and awarded on the basis of (a) demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and (b) academic standards expected of graduates of a programme of study.

Learning outcomes-based frameworks in any subject must specify what postgraduates completing a particular programme of study are (a) expected to know, (b) understand and (c) be able to do at the end of their programme of study. To this extent, LOCF in MSc Botany is committed to allowing for flexibility and innovation in (i) programme design and syllabi development by higher education institutions (HEIs), (ii) teaching-learning process, (iii) assessment of student learning levels, and (iv) periodic programme review within institutional parameters as well as LOCF guidelines, (v) generating framework(s) of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes. HEIs, on their turn, shall address to the situations of their students by identifying relevant and common outcomes and by developing such outcomes that not only match the specific needs of the students but also expands their outlook and values.

2.2 Definitions:

i. 'Academic Programme' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre
ii. 'Course' means a segment of a subject that is part of an Academic Programme
iii. 'Programme Structure' means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission
iv. 'Core Course' means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course
v. 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre
vi. 'Open Elective' means an elective course which is available for students of all programmes, including students of same department. Students of other Department will opt these courses subject to fulfilling of eligibility of criteria as laid down by the Department offering the course.
vii. 'Credit' means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course
viii. 'SGPA' means Semester Grade Point Average calculated for individual semester.
ix. 'CGPA' is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.

x. ‘Grand CGPA’ is calculated in the last year of the course by clubbing together of CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into %age marks is given in the Transcript.

2.3 Nature and Extent of Master’s Degree Programme in Biochemistry:

A student pursuing 2 years post-graduate programme in Biochemistry shall be awarded an appropriate Degree in that discipline on completion of 4th Semester if he/she secures 102 Credits. An illustration of credits requirements in relation to the type of award is illustrated below:

Sl. No.	**YEAR**	**Mandatory Credits to be secured for the Award**
1	**After successful completion of 1st Year**	**43**
2	**After successful completion of 2nd Year**	**60**

Master’s Degree is a well-recognized, structured, and specialized Post graduate level qualification in tertiary, collegiate education. The contents of this degree are determined in terms of knowledge, understanding, qualification, skills, and values that a student intends to acquire to look for professional avenues or move to higher education at the postgraduate level.

Master’s Degree programmes attract entrants from the graduate level or equivalent, often with subject knowledge that are directly relevant to the field of study/profession. Thus, MSc Course in Biochemistry aims to equip the students to qualify for joining a profession or to provide development opportunities in particular employment settings. Post Graduates are enabled to enter a variety of jobs or to continue academic study at a higher level.

3. Aims of Master’s degree (Honours) programme in Biochemistry:

The overall aims of Master’s degree (Hons) programme in Biochemistry are to:

1. Provide students with a platform to develop their interest in learning biochemistry; develop in-depth understanding of the working of biomolecules, key biochemical concepts, and equip students with appropriate technical and analytical skills to tackle issues and problems in the field of biochemistry.
2. Expose the students to a wide range of careers that combine biology, plants,and medicine.

3. Provide students with some work/research experience, via a research-based dissertation work in a research laboratory to further boost the career prospects.
3. Provide students with the knowledge and skill base that would enable them to undertake further studies in biochemistry and related areas and help develop a range of generic skills that are relevant to the needs of the biotech/pharma industry or the major research institutions, or for entrepreneurship.

3.1 Program Learning Outcomes relating to MSc Biochemistry degree Programme in Biochemistry:

The student graduating with the Degree M.Sc. Biochemistry should be able to acquire

PO-1: Knowledge of Biochemistry

Upon completion of the program, students will demonstrate the ability to apply fundamental knowledge of Biomolecules, protein, biochemical techniques in the area of Biochemistry.

PO-2:Ability to solve Complex problems

Upon completion of the Biochemistry program, students will possess advanced skills in complex problem-solving, enabling them to address intricate challenges in biochemistry and allied sciences.

PO-3:Develop analytical and critical thinking

Students will exhibit advanced capabilities in analytical and critical thinking, allowing them to assess scientific data, conduct rigorous research, and evaluate complex biological issues with precision and insight.

PO-4:Develop the ability to create

Students will demonstrate innovative and creative thinking, fostering novel approaches to address biological challenges and contribute to advancements in biochemistry research and innovation.They will harness the ability to learn a system with its component, or process to meet desired need within realistic constraints.

PO-5:Develop effective communication skills

Students will possess strong communication skills, effectively conveying complex scientific concepts and findings to diverse audiences, fostering collaboration and promoting public awareness of biological issues.

PO-6:Develop research related skills

Upon completion of the Biochemistry program, students will possess the ability to use the

techniques, skills and modern professional tools necessary for professional practice and for research.

PO-7: Develop skills for Collaborative/Team Work

The students will exhibit strong collaboration skills, effectively working with multidisciplinary teams to address complex challenges and promote collective efforts towards biochemistry research and its application in human welfare.

PO-8: Develop Leadership qualities

Upon completion of Biochemistry program, students will demonstrate exceptional leadership qualities, inspiring and guiding teams in the field of biochemistry and allied sciences to foster innovation, conservation, and sustainable practices.

PO-9: Enable students to adopt to evolving digital and technological skills

Students will possess proficient digital and technological skills, utilizing cutting-edge tools and methodologies to enhance research, data analysis, and communication in the field of biochemistry, biotechnology, and bioinformatics, promoting advancements and efficiency in their work.

PO-10: Develop environmental awareness and develop suitable skills to address to problems

Upon completion of the program, students will display a heightened environmental awareness, incorporating ecological principles into their work, and taking proactive actions to promote sustainability and conservation efforts in the realm of biology.

3.2 Programme specific Learning Outcomes

PSO1: Ability to apply knowledge of Biochemistry to realize and explain notions and complexities of biological and allied sciences.
PSO2: Ability to comprehend the relationship of organisms at all levels: molecular, cellular, and organismal and students shall be able to conduct the clinical biochemistry, diagnostic biochemistry experiments as well as to analyze and interpret the results.

PSO3: Students shall be able to use the biochemical techniques, genetic engineering &biotechnology skills and modern pathological tools necessary for professional practice and conduct empirical studies for scientific research as well as to validate, analyze and interpret them.

3.3 Teaching Learning Process

Teaching and learning in this programme involve classroom lectures, Practical lab and tutorials.

It allows-

• The tutorials allow a closer interaction between the students and the teacher as each student gets individual attention.

• Written assignments and projects submitted by students

• the project-based learning

• Group discussion

• Home assignments

• Quizzes and class tests

• PPT presentations, Seminars, interactive sessions

• Diversity survey

• Co-curricular activity etc.

• Industrial Tour or Field visit

3.4 Assessment Methods

Methods	**Weightage**
Semester End Examination	70%
Internal Assessment	30%
Total	**100%**

Internal assessment is based on:

- 25%- Mid-semester Examination, Class test, Assignment, Project, Viva-voce, Seminar, etc.
- 5%- Attendance of the student.

4.Programme Specific Outcomes (PSOs):

PSO1: Ability to apply knowledge of Biochemistry to realize and explain notions and complexities of biological and allied sciences.
PSO2: Ability to comprehend the relationship of organisms at all levels: molecular, cellular, and organismal and students shall be able to conduct the clinical biochemistry, diagnostic biochemistry experiments as well as to analyze and interpret the results.

PSO3: Students shall be able to use the biochemical techniques, genetic engineering &biotechnology skills and modern pathological tools necessary for professional practice and

conduct empirical studies for scientific research as well as to validate, analyze and interpret them.

5.Programme Structure:

The Master of Science in Botany programme is a two-year coursedivided into four semesters. A student is required to complete 103 credits for completion of the course and the award degree.

SCHEME OF EVALUATION

I. Theory Papers (T):	**II. Practical Papers (P):**	**III. Combined Theory & Practical Papers (TP):**
Continuous Evaluation: 15% (Assignment, Class Test, Seminar, Quiz : Any Three) Mid-term examination: 10% Attendance: 5% End Term Examination: 70%	Continuous Evaluation: 25% (Skill Test, lab copy, viva, lab involvement: Any Three) Attendance: 5% End term examination: 70 %	Continuous Evaluation: 15% (Assignment. Class Test, Seminar, Lab Experiment, Copy and Viva: Any Three) Mid-term examination: 10% Attendance: 5% End term examination: 70 %

SCHEME AND COURSE STRUCTURE FOR CHOICE-BASED CREDIT SYSTEM IN M.Sc. HONOURS BIOCHEMISTRY

1st semester								2nd semester							
Sl. No.	Subject Code	Names of subjects	L	T	P	C	TCP	Sl. No.	Subject Code	Names of subjects	L	T	P	C	TCP
Core Subjects (please use rows as required)								Core Subjects (please use rows as required)							
1	BCH154 C101	Chemistry of Biomolecules	3	1	0	4	4	1	BCH154 C201	Enzymology	3	1	0	4	4
2	BCH154 C102	Cell Biology	3	1	0	4	4	2	BCH154 C202	Molecular Biology	3	1	0	4	4
3	BCH154 C103	Bioenergetics &Metabolism	3	1	0	4	4	3	BCH154 C203	Immunology	3	1	0	4	4
4	BCH154 C114	Practical I	0	0	3	3	6	4	BCH154 C214	Practical II	0	0	3	3	6
Ability Enhancement Compulsory Course (AECC)*								Ability Enhancement Compulsory Course (AECC)*							
5	CEN984 A101	Communicative English – I				1	1	5	CEN984 A201	Communicative English – II				1	1
6	BHS984 A103	Behavioural Science - I				1	1	6	BHS984 A203	Behavioural Science - II				1	1
								Ability Enhancement Elective Course (AEEC) (Skill Based):							
								7		AEEC/SE C/-1*				2	2
Elective: Discipline-Specific D.S.E.								Elective: Discipline-Specific D.S.E.							
7	BCH154 D101	DSE – 1	3	1		4	4	8	BCH154 D201	DSE – 2	3			3	3
Total:21								Total:22							
3rd semester								4th semester							

Sl. No.	Subject Code	Names of subjects	L	T	P	C	TCP	Sl. No.	Subject Code	Names of subjects	L	T	P	C	TCP
Core Subjects (please use rows as required)								**Core Subjects (please use rows as required)**							
1	BCH154 C301	Advanced Enzymology	2	1	0	3	3	1	BCH154 C401	Microbiology	2	1	0	3	3
2	BCH154 C302	Clinical Biochemistry	2	1	0	3	3	2	BCH154 C402	Membrane Biology	2	1	0	3	3
3	BCH154 C313	Practical III	0	0	3	3	6	3	BCH154 C413	Practical IV	0	0	3	3	6
Ability Enhancement Compulsory Course (AECC)*								**Ability Enhancement Compulsory Course (AECC)***							
4	CEN984 A301	Comm. Eng.				1	1	4	CEN984 A401	Comm. Eng.				1	1
Ability Enhancement Elective Course (AEEC) (Skill Based):															
5		AEEC/SE C/-2*				2	2								
Elective: Discipline-Specific D.S.E.								**Elective: Discipline-Specific D.S.E.**							
6	BCH154 D301	DSE – 3	3	1		4	4	5	BCH154 D401	DSE - 6	3	1		4	4
7	BCH154 D302	DSE – 4	3	1		4	4	6	BCH154 D402	DSE - 7	3	1		4	4
8	BCH154 D303	DSE – 5	3	1		4	4	7	BCH154 D403	DSE - 8	3	1		4	4
Project Dissertation								**Project Dissertation**							
9	BCH154 C324	Minor				5	10	9	BCH154 C424	Major				9	18
Total:29								**Total:31**							

DISCIPLINE SPECIFIC ELECTIVE

SEMESTER 1ST	SEMESTER 2ND	SEMESTER III	SEMESTER VI
Anyone to be selected.	**Anyone to be selected**	**Any three to be selected**	**Any three to be selected**
Bioanalytical technique	Genetics for biologics	Neurobiochemistry	Biochemistryof Common Disorders
Plant Biochemistry	Environmental Science	Research methodology	Genetic engineering
		Nutritional Biochemistry	General Pharmacology
		Biostatistics and bioinformatics	Molecular Endocrinology

1ST SEMESTER SYLLABUS

PAPER I: CHEMISTRY OF BIOMOLECULES
SUBJECT CODE: BCH154C101
CREDIT UNITS: L-T-P-C = 3-1-0-4
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
The course is designed to introduce the analytical aspect of biochemistry and educate students about the various bioorganic and biochemical reactions and formulations.	1. Students will recall the core knowledge base in the theory and practice of modern Biochemistry and Biophysics. 2. Students will understand the mechanism of different Biochemical and Biophysical reactions 3. Students will be able to analyze the coordination necessary in biochemical functioning, like in the case of hemoglobin 4. Students will be able to analyze the biochemistry of micro nutrients	Powerpoint presentations; Teaching using chalk and board; Oral discussion sessions in the Class	Oral questions will be asked in the class. Problems will be assigned to test student's Analytical ability. Class tests will be conducted for internal Assessment.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Basics of Carbohydrate:**Stereochemistry,chirality, R.S. designation; chemistry and properties of water; pH and indicators; acid-base concept; mono- di- and poly-protic acids; buffer solutions and their action; reactive reaction intermediates (carbocation, carbanion, carbenecarbyne, and free radicals); dielectric constant; surface tension; viscosity; dipole moment. Classifications of Carbohydrates:Monosaccharides, Disaccharides, and Polysaccharides: Structural and functional concepts. Mutarotation of sugars. Key Reactions of Carbohydrates.	**16**
II	**Lipids:**Building blocks of lipids- fatty acids, glycerol, ceramide. Storage lipids- triacyl glycerol and waxes. Structural lipids in membranes– glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Importance of Cholesterol.	**14**
III	**Structure and properties of Nucleic acids:**Basic concepts of	**16**

	Nucleotides and nucleosides. Structure of DNA: DNA double helix;Forces stabilizing the double helical structure, Tm and Cot curve for denaturation and renaturation of DNA. DNA as genetic material. RNA: Different types of RNA, biological functions of mRNA, rRNA and tRNA.	
IV	**Amino Acids and Proteins:**Structure, properties, and classification of amino acids; titration curves; peptide bond & Ramachandran plot; Important reactions of amino acids. Levels of protein structure; globular, membrane & fibrous proteins; interactions stabilizing proteins; supersecondary& domain structure; protein targeting; protein folding, misfolding& aggregation; molecular chaperones; unstructured proteins; protein dynamics; naturally occurring peptides.Structural and functional aspects of haemoglobin and myoglobin: Oxygen binding property, oxy- and deoxy- forms, Relaxed and tense (R &T) configurations. Iron Containing Non-hemeMetalloproteins: transferrin and ferritin.	**18**
Total	**64**	**64**

Text Books:

1. Branden, C.I. and Tooze, J. (2009) Introduction to Protein Structure. Second Edition, C.R.C. Press.
2. Finkelstein, A.V. and Ptitsyn, O.B. (2016) Protein Physics: A course of lectures. Second Edition, Academic Press Publications.
3. Almeida, P. (2016) Proteins Concepts in Biochemistry. Garland Science Publishers.
4. Nelson D.L. and Cox M.M. (2017) Lehninger's Principles of Biochemistry, Seventh Edition, Freeman & Co, New York.
5. Atkins P.W. (2017) the Elements of Physical Chemistry.Seventh Edition, Oxford Univ. Press.
6. Finar I. L. (2012) Organic Chemistry, Pearsons.
7. Morrison R.T. and Boyd R.N. (2009) Organic Chemistry, Seventh Edition, Pearsons.
8. Stryer L. (2015) Biochemistry, Eight Editions. W.H. Freeman.
9. Voet, D. and Voet, J.G. (2011) Biochemistry. Fourth Edition, John Wiley & Sons.

Reference:

1. Principles of physical chemistry- Puri,Sharma
2. Baxevanis A.D. And Ouellette B.F.F. (2001) Bioinformatics, Second edition, Wiley Interscience.
3. Mount D.W. (2004) Bioinformatics: Sequence and Genome Analysis, Second Edition. CSHL Press.
4. Lesk A.M. (2013) Introduction to Bioinformatics.Fourth Edition. Oxford University Press.
5. Grohima M.M. (2010) Protein Bioinformatics. Elsevier Publications.
6. Ghosh Z. and Mallick B. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

PAPER II: CELL BIOLOGY
SUBJECT CODE: BCH154C102
CREDIT UNITS: L-T-P-C = 3-1-0-4
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
The course entails to educate the student about the basic biology and physiology of a cell, and important structural and functional properties	1. Students will recall the core knowledge of different structural and functional properties of a cell 2. Students will understand the role of compartmentalization and the importance of cell biology in biochemistry. 3. Students will apply these principals to current biological questions of today. 4. Students will analyze how cells grow, divide, and die and the importance of these processes. 5. Students will determine how its dysregulation leads to cancer and other diseases.	Chalk and board teachings, power point presentations, and video presentations on the step by step process of mitosis and meiosis will be shown, chronology of molecular events in various processes will be shown as flowchart.	Discussions, oral Questioning and analytical questions will be given to students. Internal exams and seminars will be conducted

Detailed Syllabus:-

Modules	Course content	Periods
I	**Basic concepts of cell biology:** Evolution of cells, cell architecture, structural organization of prokaryotic and eukaryotic cells. Structure and functions of different cell organelles: nucleus, mitochondria, chloroplast, rough and smooth endoplasmic reticulum, Golgi apparatus, lysosomes, and peroxisomes. Cytoskeleton: actin, microfilaments, intermediate filaments, and microtubules. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions, and plasmodesmata. Subcellular fractionation and Svedberg unit.	**18**
II	**Chromosomal organization, cell cycle and cell division:** Definition of a gene, chromosomal organization of gene; Types of chromosomes: autosomes, sex chromosomes; Karyotyping; Chromatin, Histones and Nucelosomes;Heterochromatin and euchromatin;Structural chromosomal abnormalities: Chromosome ploidy, Polyploidy and aneuploidy. Cell cycle and its regulation; cell cycle checkpoints Events of mitosis and cytokinesis; Events of	**14**

	meiosis, Regulation of cell division.	
III	**Intracellular trafficking and its importance in cell function:** Overview of vesicle-mediated transport pathways - exocytosis, endocytosis, and retrograde transport; Vesicle formation and cargo selection: adaptins, clathrin, and cargo receptors. Role of small GTPases (Rab, Rho etc.) in vesicle targeting and fusion; Protein sorting in the trans-Golgi network and endosomes; SNARE proteins and membrane fusion: v-SNAREs, t-SNAREs, and NSF-SNAP complex;Specificity in vesicle targeting and membrane fusion.	**16**
IV	**Signal Transduction pathways for cellular growth, development and death**: Types of cell signaling: autocrine, paracrine, and endocrine signaling; Cell surface receptors and intracellular receptors ; Mechanisms of ligand binding, receptor activation, and conformational changes. Introduction to second messengers like cAMP and calcium; Role of second messengers in signal transduction; Activation of G Protein-Coupled Receptors (GPCRs) and receptor tyrosine kinase (RTKs); signaling pathways Ras-MAPK, PI3K/Akt/mToR, JAK-STAT pathway. Mechanism of cell death pathways: Apoptosis, Necrosis, Pyroptosis, and Ferroptosis.The physiological importance of Autophagy and senescence.	**16**
Total	**64**	**64**

Text Books:

1. Molecular Biology of the Cell, 6th Edition. Bruce Alberts, Dennis Bray, JulianLewis,
2. Martin Raff, Keith Roberts, and James D Watson. Publisher New York: GarlandScience.
3. The Cell: A Molecular Approach, 7th Edition, by Geoffrey M. Cooper and RobertE. Hausman, published by ASMPress.
4. *Lehninger Principles of Biochemistry*, Nelson, D.L., Cox, M.M., WH Freeman and Company, New York, U.S.A. 7th edition, 2017
5. Molecular Cell Biology; Lodish et al., 8thEdn. W.H. Freeman and Co. (2012).
6. Biochemistry 8th Edn. Jeremy M. Berg, John L. Tymoczko, LubertStryer.
7. Victor Rodwell, David Bender, P. Anthony Weil, Peter Kennelly. *Harpers Illustrated Biochemistry* 31th Edition,2018

Reference:

1. Lipid Biochemistry; 5th Edn. Michael I. Gurr, John L. Harwood and Keith N. Frayn, Blackwell Science (2002).
2. Principles of Human Physiology; 6th Edn. Cindy L. Stanfield Pearson,(2011).
3. Biochemistry Ed. Donald Voet& Judith G. Voet, 4thEdn. John Wiley & Sons, Inc. (2012).
4. Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill,(1986)

PAPER III: BIOENERGETICS AND METABOLISM
SUBJECT CODE: BCH154C103
CREDIT UNITS: L-T-P-C = 3-1-0-4
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
The objective of the course is to introduce the	1. Students will remember the thermodynamic parameters associated with the metabolism of biological	Chalk and board teachings,	Discussions,oral Questioning and

students with fundamental concepts of energy production and metabolism of the biological macromolecules	macromolecules. 2. Students will understand the role of different metabolic enzymes in biological catalysis 3. Student will define biochemical functions and integrated metabolism in different tissues 4. Students will analyze the key regulatory points in metabolic pathways 5. Students will explain molecular mechanisms underlying major inherited diseases of metabolism	power point presentations	analytical questions involving calculations of bioenergetics will be given to students. Internal exams and seminars will be conducted.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Bioenergetics:** Energy transformation, Laws of thermodynamics, Biological oxidations, oxygenases, hydroxylases, dehydrogenases, and energy transducing membranes. Gibbs energy, free energy changes, and redox potentials, phosphate potential, ion electrochemicalpotentials,proton electrochemical potential, membrane potentials, photons energy interconversions. Ion transport across energy-transducingmembranes. The influxandeffluxmechanisms.Proton circuit and electrochemical gradient, the transport andDistribution of actions, anions, and ionophores. Uniport, antiport, and symport mechanisms, shuttle systems. The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron-sulfur proteins, cytochromes, and their characterization.	18
II	**Intermediary metabolism:** Approaches for studying metabolism. Carbohydrates: Glycolysis, citric acid cycle, its function in energy generation and biosynthesis of energy-rich bonds,pentose phosphate pathway, anditsregulation.Alternate pathways of carbohydrate metabolism. Gluconeogenesis, interconversions of sugars. Biosynthesis of glycogen, starch, and oligosaccharides. Regulation of blood glucose homeostasis. Hormonal regulation of carbohydratemetabolism.	14
III	**Lipids metabolism:**Lipids Fatty acid biosynthesis: Acetyl CoA carboxylase, Fatty acid synthase, desaturase, and elongase.	16

	Fatty acid oxidationand its regulation. Lipid Biosynthesis: Biosynthesis of triacylglycerols, phosphoglycerides, and sphingolipids,Biosyntheticpathwaysforterpenes,steroids, and prostaglandins. Ketone bodies: Formation and utilization. Metabolism of Circulating lipids: chylomicrons, LDL, HDL, and VLDL. Free fatty acids. Lipid levels in pathological conditions.	
IV	**Metabolism of amino acids and nucleotides:**Amino Acids biosynthesis and degradation. Urea cycleanditsregulation,Nucleicacidsbiosynthesisorpurines and pyrimidines Degradation of purines and pyrimidines. Regulation of purine and pyrimidine biosynthesis Structure and regulation of ribonucleotide reductase. Biosynthesis of ribonucleotides, deoxyribonucleotides, and polynucleotides. Inhibitors of nucleic acidbiosynthesis	16
Total	**64**	**64**

Text Books:

1. *Lehninger Principles of Biochemistry*, Nelson, D.L., Cox, M.M., WH Freeman and Company, New York, U.S.A. 7th edition, 2017
2. Harper's Illustrated Biochemistry; 31thEdn. Robert K. Murray, Daryl K. Granner,Victor
3. W. Rodwell, the McGraw-Hill (2018).
4. Biochemistry by Donald Voet and Judith Voet, John Wiley and Sons NY. 4thedtn, 2012.

Reference:

1. Berg, J. M., Tymoczko, J. L. and Stryer. *Biochemistry*,, W.H Freemanand Co., 9thEdition, 2019.
2. Buchanan, B., Gruissem, W. and Jones, R.,*BiochemistryandMolecularBiologyofPlants*, 2ndEdn, American Society of Plant Biologists,U.S.A.
3. Fundamentals of Biochemistry by J.L.Jain, Nitin Jain and Sunjay Jain, S.ChandGroup.

PAPER IV: PRACTICAL I

SUBJECT CODE: BCH154C114
CREDIT UNITS: L-T-P-C = 0-0-3-3
STUDENT'S SCHEME OF EVALUATION: PRACTICAL (P)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
The objective of the course is to introduce the students with fundamental concepts of energy production and metabolism of the biological macromolecules	1. Students will remember the thermodynamic parameters associated with the metabolism of biological macromolecules. 2. Students will understand the role of different metabolic enzymes in biological catalysis 3. Student will define biochemical functions and integrated metabolism in different tissues 4. Students will analyze the key regulatory points in metabolic pathways 5. Students will explain molecular mechanisms underlying major inherited diseases of metabolism	Chalk and board teachings, video presentations of the methology, calculations guidance, conversion of moles, molar, mg, g, L etc, weighing, handling equipments and hands on practicals	Discussions, oral Questioning and analytical questions will be given to students. Students' hands on' learning will be regularly monitored

Detailed Syllabus:-

Modules	Course content	Periods
I	1. Preparation of buffer using Henderson-Hasselbach equation and determination of its buffering capacity by acid and alkali. 2. Estimation of serum inorganic phosphate. 3. Formal titration of amino acids.	**24**
II	1. Estimation of D.N.A. using diphenylamine. 2. Estimation of R.N.A. usingorcinol.	**24**

	3. Determination of free proline.	
III	1. Estimation of Carbohydrate by Anthronemethods. 2. Estimation of protein by Lowry's method. 3. Microscopic examination ofurine. 4. Microscopic examination and chemical analyses ofblood.	**24**
IV	1. Separation of amino acid mixtures by paper chromatography. 2. Separation of lipids by T.L.C. 3. Molecular docking study of protein and drugs using M.G.L. tools.	**24**
Total		**96**

Text books:

1. Practical Biochemistry – 3rdEdn. DavidPlummer.
2. Introductory Practical Biochemistry – S.K.Sawhney and Randhir Singh.

Reference book:

1. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. C.B.S.Publishers.
2. Practical Clinical Biochemistry: Methods and Interpretation, 4th edn. RanjnaChawla, Jaypee Brothers Medical Publishers.
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N.Pattabhiraman, Gajanna Publishers.

2ND SEMESTER SYLLABUS

PAPER I: ENZYMOLOGY
SUBJECT CODE: BCH154C201
CREDIT UNITS: L-T-P-C = 3-1-0-4
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To introduce the students to enzyme types, mechanisms and regulation.	Students will learn about 1. Students will learn about Different enzyme classifications, various aspects of action mechanism of enzyme, role of metals in enzyme action, organization of enzymes in cells and enzyme mechanisms and regulation. 2. Students will understand the basis of enzyme classification, role of various	Chalk and board teachings, powerpoint presentations	Discussions, oral Questioning and analytical questions will be given to students. Internal exams and seminars

	factors in enzyme activity, role of amino acids in enzyme actions and the role of cellular conditions in enzyme regulation. 3. Students will be able to analyse the role of different amino acids and cofactors in enzyme reactions. 4. Student will be able to evaluate the important amino acids in enzyme reactions		will be conducted

Detailed Syllabus:-

Modules	Course content	Periods
I	**Introduction to enzymes:** Enzyme nomenclature and classification, Isozymes; Ribozymes; Zymogens; Abzymes; Structure and General properties of enzymes; Active site and Specificity of enzyme; Enzyme substrate complex. Induced fit theory. Mechanism of enzyme action, Factors affecting enzyme activity; Isozymes; Coenzymes, Metalloenzymes; membrane bound enzymes; Multienzyme complexes. Thermodynamics and Equilibrium; Enzyme activity; Specific activity and Units; Classification and nomenclature of enzymes.Enzyme assays: Types, Continuous and discontinuous assays.	16
II	**Enzyme kinetics:** Kinetics of enzyme action - Concept of E.S. complex, active site, specificity, derivation of Michaelis-Menten equation for uni-substratereactions.Differentplotsforthedeterminationof Km &Vmax and their physiological significances. Importance of Kcat/Km. Kinetics of zero & first order reactions. Significance and evaluation of energy of activation. Collision & transition state theories. Michaelis–pH functions & their significance. Classification of multi-substrate reactions with examples of each class. Reversible and irreversible inhibition. Competitive, non-and numerical basedon these. Suicide inhibitor.	18
III	**Mechanism of Enzyme Action:** Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Chemical modification of active site groups. Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, lysozyme, glyceraldehyde 3- phosphate dehydrogenase, aldolase, carboxypeptidase, triosephosphate isomerase and alcohol dehydrogenase	14
IV	**Enzyme Regulation:** General mechanisms of enzyme regulation,	16

	product inhibition. Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modifications of enzymes. Mono cyclic and multicyclic cascade systems with specific examples. Feedback inhibition and feed forward stimulation. Allosteric enzymes, qualitative description of "concerted"& "sequential"models forallosteric enzymes. Half site reactivity, Flip flop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamoylase& phosphofructokinase	
Total		**64**

Text Books:

1. Fundamentals of Ezymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, OxfordUniversity Press (2012).
2. Lehninger Principles of Biochemistry; D.L.Nelson and M.M. Cox, 7thEdn. MacMillanPublications(2017).

Reference:

1. An Introduction to Enzyme and Coenzyme Chemistry; Timothy B. Bugg,(1997)
2. Enzyme Kinetics; Roberts, D.V. (1977), Cambridge University Press.
3. The Enzymes; Boyer, 3rdedn. Academic Press, (1987).
4. Enzyme Kinetics; Irwin H. Segel (1976) Interscience-Wiley.
5. Enzyme Kinetics; the Steady state approach; Engel, P.C. (1981) 2nd Edn. Champmanand Hall.

PAPER II: MOLECULAR BIOLOGY
SUBJECT CODE: BCH154C203
CREDIT UNITS: L-T-P-C = 3-1-0-4
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course	Course Learning Outcomes	Teaching and Learning	Assessment Tasks

Objective		Activity	
To educate students as well as to demonstrate knowledge and understanding of the molecular machinery of living cells.	Students will learn about – 1. Students will learn about the central dogma of life, post transcriptional and post translational events, gene cloning and recombinant D.N.A. based technologies. 2. Students will understand the processes of central dogma, proteins involved in post transcriptional and post translational events and principles guiding gene cloning and recombinant D.N.A. based technologies. 3. Students will be able to analyse the interrelation of central dogma with the metabolic state of a cell, the implications of various processing events, and the nuances of gene cloning and recombinant D.N.A. based technologies. 4. Students will be able to evaluate the role of these events in maintaining a healthy cell.	Chalk and board teachings, power point presentations	Discussions, oral Questioning and analytical questions will be given to students. Internal exams and seminars will be conducted.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Replication of Genetic Materials:** Nucleic acid as the genetic material (Griffith's experiment, Avery, MacLeod and McCarty's experiment, Hershey-Chase experiment), RNA vs DNA as genetic materials, Basic structure of DNA: Watson and Crick model of DNA structure, Renaturation and Denaturation of DNA, Packaging of DNA, Organelle DNA, Central Dogma of Molecular Biology, Features of DNA replication, Meselson and Stahl Experiments, Replication of DNA in prokaryotes and in Eukaryotes, Replication of Telomeric ends, Mitochondrial DNA replication	**16**
II	**Transcription and Translation:** Synthesis of RNA in prokaryotes and in eukaryotes, RNA polymerase and its promoters in prokaryotes and eukaryotes, 5' and 3'modification of mRNA in eukaryotes, Splicing, Alternative Splicing, RNA editing, Genetic codes, Translation in pro- and eukaryotes; post-translational protein modification, Protein Trafficking.	**16**

III	**Regulation of Gene Expression:** Regulation of gene expression in prokaryotes- Lac operon of *E. coli*, lactose as a carbon source in *E. coli*, molecular details of lac operon regulation, Trp operon in *E. coli*, regulation of the Trpoperon, regulation of gene expression in phage lambda.Regulation of Gene expression in eukaryotes- Transcription initiation by activators, transcription initiation by repressors, regulation of gene activity by histones and chromatin remodeling, gene silencing by DNA methylation and regulatory RNAs and libraries.	**16**
IV	**Recombinant DNA Technology:** DNA manipulating enzymes – restriction endonucleases; Restriction modification. Restriction analysis (shotgun cloning, RFLP, chromosome walking); Genetic finger printing; PCR – reverse and real time; Applied biotechnology: Molecular and antisense probes, micro & siRNA, gene silencing and its uses; Transgenics, Human genome; SNP; Functional genomics: concept and applications. Concept and applications of genome, transcriptome, proteome metabolome and CRISPR/Cas technology.	**16**
Total		**64**

Text Books

1. Lewin B. Genes IX (2011) & Genes XII (2017), Jones & Bartlett Publ.
2. Alberts B., Johnson A., Lewis J., Raft M., Robert K. and Walter P. (2015) Molecular Biology of the Cell, Sixth Edition, Garland Sci. Publ.
3. Glick B.R. and Pasternack J.J. (2009) Molecular Biotechnology, A.S.M. Press.

References

1. Lodish (2013) Molecular Cell Biology, WH Freeman & C.O.
2. Trop P.B.E. (2011) Molecular Biology Genes to Proteins, Jones & Bartlett Publisher.
3. Watson, J.D. et al. (2014) Molecular Biology of the Gene, 7th Ed., Benjamin Cummings Publ.
4. Hardin et al. (2015) Becker's World of the Cell, Ninth edition, Pearson, U. K.
5. Pollard et al. (2017) Cell Biology, Third Edition, Elsevier I.E.

PAPER III:IMMUNOLOGY
SUBJECT CODE: BCH154C214

CREDIT UNITS: L-T-P-C = 3-1-0-4 STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To introduce the students to the concept of Immunology and the functioning of the different components of the immune system.	Students will learn about 1. Students will learn about organization of the immune system, antibodies and their diversity, immune reaction systems, immune disease, immuno-based assays and diseases associated with the immnune system. 2. Students will understand the basis of immune system organization, working mechanism of the immune reaction systems, working principles of the immune-based assays and the molecular basis of immune system based diseases. 3. Students will be able to analyse the inter-relations between the functioning of the different immune reaction systems. 4. Students will be able to evaluate the role of different immune systems in the development of immune related diseases.	Chalk and board teachings, powerpoint presentations	Discussions,oral Questioning and analytical questions will be given to students. Internal exams and seminars will be conducted

Detailed Syllabus:-

Modules	Course content	Periods
I	**Introduction to Immune System**: Memory, specificity, diversity, innate and acquired immunity, self vs non-self-discrimination. Structure and functions of primary and secondary lymphoid organs. Cells Involved in ImmuneResponsesPhagocyticcellsandtheirkillingmechanisms.Tand B lymphocytes. Differentiation of stem cells and idiotypic variations. Nature of Antigen and Antibody. Antigen vs lmmunogen, HaptensStructure and functions of immunoglobulins. lsotypic, allotypic and idiotypicvariations.	**16**

II	**Generation of Diversity in Immune System:** Clonal selection theory - concept of antigen specific receptor. Organization and expression of immunoglobulin genes: generation of antibody diversity. T cellreceptor diversity. Humoral and Cell Mediated immune Responses. Kinetics of primary and secondary immune responses. Complement activation and its biological consequences. Antigen processing and presentation. Cytokines and co stimulatory molecules: Role in immune responses. T and B cell interactions. Major Histocompatibility Complex (MHC) Genes and Products. Polymorphism of MHC genes. Role of MHC antigens in immune responses. MHC antigens intransplantation.	**16**
III	**Applications of immune reactions:** Development, Regulation and Evolution of the Immune System Measurement of Antigen - Antibody Interaction. Production of polyclonal and monoclonal antibodies: Principles, techniques and applications. Agglutination and precipitation techniques. Radio immunoassay.Immunofluorescence assays: Fluorescence activated cell sorter (FACS) technique. Measurement of TCell activation.Fractionofleukocytesondensitygradient.Delayedtype hypersensitivity technique. Leukocyte migration inhibition technique. Cytotoxicity assay. Cytokines assay: ELISA and ELISPOT	**16**
IV	**Immune associated diseases:** Tolerance vs Activation of immune System. Immune –tolerance. Immunosuppression. Hypersensitivity (Types I, II, III and IV).Immune Responses in Diseases. Immune responses to infectious diseases: viral, bacterial and protozoal, Cancer and immune system. Immunodeficiency disorders, Autoimmunity. Immunization, Active immunization (immunoprophylaxis). Passive immunization (Immunotherapy). Role of vaccines in the prevention of diseases.	**16**
Total		**64**

Text Books:

1. Kuby Immunology; Oven, Punt, Stranford, 8thEdn. W. H. Freeman (2018).
2. Roitt's Essential Immunology; Ivan, M. Rohitt&Petrer J Delves 13th (2011) Blackwell Science.

Reference:

1. Antibodies– A Laboratory Manual; E. D. Harlow, David Lane, 2nd Edn. CSHLPress (2014).
2. Basic and Clinical Immunology; Stites et al., [6thedn] (2011) Lange.
3. Veterinary Immunology: Ian R. Tizard, 10thEdn. I.R. Thomsonpress.
4. The Immune System. By Peter Parham 4thEdn. Publisher Garlandpublishing

PAPER IV: PRACTICAL II
SUBJECT CODE: BCH154C214
CREDIT UNITS: L-T-P-C = 0-0-3-3
STUDENT'S SCHEME OF EVALUATION: PRACTICAL (P)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To introduce the basic techniques in molecular biology and spectrophotometric detection of biomolecules and their separation.	Students will learn about- 1. Students will learn about the principles of enzyme based assays, estimation of haemoglobin and measurement of blood cells like WBC, R.B.C., separation of biomolecules using different techniques, designing primers, running PCR and immune assays. 2. Students understand the basis of adding different chemicals and working steps for carrying out the experiments. 3. Students will be able to analyse their	Chalk and board teachings, calculations guidance, video presentation of the methodology, conversion of moles, molar, mg, g, L etc, weighing, handling equipments and	Discussions, oral Questioning and analytical questions will be given to students. Students' hands on' learning will be regularly monitored

	results and make adjustments to their protocols when required. 4. Students will be able to evaluate the results and discuss the reasons behind the results.	hands on practicals	

Detailed Syllabus:-

Modules	Course content	Periods
I	1. Isolation of protein and its estimation by Bradford method. 2. Assay of Vmax and Km of enzymes like salivary amylase and alkaline phosphatases. 3. Determination of effect of pH on salivary amylase.	**24**
II	1. Blood grouping. 2. Enumeration ofWBC's 3. Radial immunodiffusion assay. 4. Double diffusion method.	**24**
III	1. Isolation of D.N.A. andAgarose gel electrophoresis. 2. Isolation of R.N.A. andAgarose gel electrophoresis. 3. Isolation of proteins and its separation using SDS PAGE.	**24**
IV	1. Demonstration of ELISA. 2. Demonstration of PCR 3. Designing of primers. 4. Demonstration of western blotting.	**24**
Total		**96**

Text Books:

1. Biochemistry, ed. Plummer Tata 3rdEdn.-McGraw Hill,
2. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. C.B.S. Publishers.

Reference:

1. Practical Clinical Biochemistry: Methods and Interpretation, 4thedn. Ranjna Chawla, Jaypee Brothers Medical Publishers.
2. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers.

PAPER I: ADVANCED ENZYMOLOGY
SUBJECT CODE: BCH154C301
CREDIT UNITS: L-T-P-C = 2-1-0-3
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To provide a deeper insight into the fundamentals of enzyme structure, multi-	1. Various aspects of enzymes like multisubstrate reactions, turnover of enzymes, cooperation between enzyme subunits, multienzyme systems, vitamins in enzyme reactions and reaction mechanisms	Powerpoint presentations, teaching using chalk and board, regular oral	Students will be asked questions; Quiz, internal assessment

unit enzyme interactions and regulation.	of enzymes. 2. Students will understand the biochemistry of multisubstrate reactions, cellular requirements for turnover of enzymes, conformational changes in protein cooperation, and advantages of multienzyme systems and role of vitamins in enzyme reactions. 3. Students will be able to apply the gained knowledge in carrying out enzyme related studies. 4. Students will be able to analyse the interdependence of the various aspects discussed in the functioning of the enzymes.	discussion sessions in the class on topics taught previously	Tests will be conducted.

Detailed Syllabus:-

Modules	Course content	Periods
I	Review of unisubstrate enzyme kinetics and factors affecting the rates of enzyme catalyzed reactions. Michaelis pH functions and their significance. Classification of multisubstrate reactions with examples of each class.Kinetics of multisubstrate reactions. Derivation of the rate of expression for Ping Pong and ordered Bi Bi reaction mechanism. Concept of Convergent and Divergent evolution ofenzymes.Flexibility and conformational mobility of enzymes.	**12**
II	Enzymes Turnover and methods employed to measure Turnover of enzymes. Significance of enzymes Turnover. Protein - Ligand binding, including measurement, analysis of binding isotherms. Co- operativity phenomenon. Hill and Scatchard Plots. Allosteric enzymes, Sigmoidal kinetics, and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes and their significance. Immobilized enzymes and their industrial applications.	**12**
III	Multienzyme system: Occurrence, isolation, and their properties. Polygenic nature of multienzyme systems. Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complexes. Immobilized MultienzymeSystems and their applications. Co-enzymes and cofactors: Water soluble vitamins as coenzymes. Metallo enzymes.	**12**

IV	Detailed Mechanisms of Catalysis of serine proteases. Ribonuclease, and Triose phosphate isomerases. Enzyme regulation: General mechanisms of enzyme regulation: Feed Back Inhibition and Feed forward stimulation; Enzyme repression, induction and degradation, control of enzymatic activity by products and substrates; Reversible and irreversible covalent modifications of enzymes.	**12**
Total		**64**

Text books:

1. Enzymes; Trevor Palmer, East –2nd edn. West Press Pvt. Ltd., Delhi (2004).
2. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, 2nd edn. Wiley-VCH Publishers (2000).Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.

Reference

1. Fundamentals of Ezymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).
2. *Lehninger Principles of Biochemistry*, Nelson, D.L., Cox, M.M., WH Freeman and Company, New York, U.S.A. 7th edition, 2017
3. Principles of Biochemistry; Smith et al., Ed. McGrawHill, (1986).
4. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, 3rd edn. (2012), Blackwell Science.

PAPER II:CLINICAL BIOCHEMISTRY
SUBJECT CODE: BCH154C302
CREDIT UNITS: L-T-P-C = 2-1-0-3
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course	Course Learning Outcomes	Teaching and Learning	Assessment Tasks

Objective		Activity	
To introduce the various parameters that determine a healthy and diseased state and to understand the workings of disease progression and development.	Students will learn about- 1. The method of specimen collection and analysis; metabolic disorders, syndromes arising out metabolic disorders and the biochemistry of cancer. 2. Students will understand the various aspects clinical biochemistry, their implications in health, causes and implications of metabolic disorders and the biochemical basis of cancer. 3. Students can apply the knowledge gained to deliberate on clinical findings, check the relation of metabolites and syndromes associated with build-up of metabolites and the biochemical reasons leading to cancer progression. 4. Students will be to analyse the relation of body metabolites and their deregulation with appearance of metabolic syndromes and relate the buildup of cancer specific conditions in the progression of cancer.	Teaching will be conducted both through white board mode and power point presentation Mode. Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any.	Oral questions will be asked; students will be asked to discuss the topic. Quiz, internal assessment Tests will be conducted.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Specimen collection and analysis:**Concepts of accuracy, Precision, Reliability, Reproducibility, Normal values, Specimen collection and processing, Blood Collection-Anticoagulants, Venipuncture, Urine collection, CSF, Aminotic fluid, pH of blood, acid base equilibrium, sodium, potassium, chloride, bicarbonate.	12
II	**Inborn errors of metabolism:**Carbohydrate metabolism: galactosemia, Normal levels, renal threshold, Factors influencing blood glucose, Glycogen storage disorders, Pentosuria, Aminoacid metabolism- alkaptonuria, maple syrup urine disease, phenylketonuria, homocystinuria, proteinuria, albinism, multiple myeloma.Lipid metabolism: Hyperlipidemia, Hyperlipoproteinemia, Fatty liver.Nucleotide metabolism: Lesch-Nyhan Syndrome, Biochemistry of anemia, thalassemia,	12

	porphyria	
III	**Endocrine Disorders:**Diabetes, obesity, atherosclerosis, Conn's syndrome, Addison's disease, Cushing's syndrome, hypo- and hyperthyroidism, gonadal dysfunction, dwarfism and gigantism,Diseases caused by chromosomal abnormalities-Down, Turner and Klinefelter syndromes.	12
IV	**Cancer Biochemistry:**carcinogenesis, characteristics of cancer cell,agents promoting carcinogenesis. Cellular differentiation, carcinogen, diagnosis of cancer, treatment of cancer.	12
Total		**48**

Text books:

1. Lehninger Principles of Biochemistry, Nelson, D.L., Cox, M.M. 7th Edition, 2017, WH Freeman and Company, New York, U.S.A.
2. A C Deb Fundamentals of Biochemistry, 10 edition, (2018), New Central Book Agency, London.
3. Berg,J.M.,Tymoczko,J.L.andStryer.,Biochemistry,,W.HFreemanandCo.,9thedition,2019.
4. Allan Gaw, Michael Murphy, Rajeev Srivastava, Robert Cowan, Denis O'Reilly, Clinical Biochemistry, 5th Edition, 2013.
5. Text book of medical biochemistry by S.Ramakrishnan, K G Prasannan 3rdEdn.

PAPER III: Practical III
SUBJECT CODE: BCH154C314
CREDIT UNITS: L-T-P-C = 3-0-0-3
STUDENT'S SCHEME OF EVALUATION: Practical Papers (P)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To develop skills of	Students will learn-	Chalk and board teachings,	Discussions,

performing basic biochemical tests important in clinical investigations.	1. Students will learn the principles of determination of activation energy, estimation of serum metabolites like cholesterol, urea etc, activity determination of SGOT and SGPT. 2. Students will understand the principles and the various reasons behind the protocols being followed. 3. Students will be able to analyse the results and make changes in the protocols as required. 4. Students will be able to evaluate the health status based on the results of the serum metabolites and enzymes.	calculations guidance, video presentation of the methology, conversion of moles, molar, mg, g, L etc, weighing, handling equipments and hands on practicals	oral Questioning and analytical questions will be given to students. Students' hands on'learning will be regularly monitored

Detailed Syllabus:-

Modules	Course content	Periods
I	**1.** Determination of activation energy of enzyme. **2.** Determination of influence of temperature on enzyme activity. **3.** Immobilisation of urease in calcium alginate beads.	**24**
II	**1.** Determination of type of inhibition (reversible or irreversible) of amylase. **2.** Modelling of an enzyme active site using in silico method.	**24**
III	**1.** Estimation of glucose by Folin-Wu method. **2.** Estimation of cholesterol by Zack's method. **3.** Estimation of haemoglobin by Wong's method **4.** Estimation of urea in blood by Diacetylmonoxime method. **5.** Estimation of serum calcium by Clark and Collips method.	**24**
IV	**1.** Determination of A/G ratio by Biuret method. **2.** Analysis of SGOT-SGPT (A.S.T., A.L.T.) / creatine kinase/ acid or alkaline phosphatase. **3.** Qualitative analysis of Urine sample for normal and abnormal constituents.	**24**

	4. Estimation of uric acid in serum and urine by Caraway's method **5.** Determination of urine Chloride by Volhard-Arnold method. **6.** Estimation of urine Bilirubin.	
Total		**96**

Text books:

1. Biochemistry, ed. Plummer Tata 3rd Edn.-McGraw Hill,.
2. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. C.B.S. Publishers.

Reference books:

1. Hawk's Physiological Chemistry, ed. Oser, 14th Edn., Tata-McGraw Hill.

2 .Practical Clinical Biochemistry: Methods and Interpretation, 4th edn. Ranjna Chawla, Jaypee Brothers Medical Publishers.

3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers.

PAPER III: Practical III
SUBJECT CODE: BCH154C314
CREDIT UNITS: L-T-P-C = 3-0-0-3
STUDENT'S SCHEME OF EVALUATION: Practical Papers (P)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To develop skills of performing basic	Students will learn- 1. Students will learn the principles of determination of activation energy,	Chalk and board teachings, calculations guidance, video	Discussions, oral Questioning

biochemical tests important in clinical investigations.	estimation of serum metabolites like cholesterol, urea etc, activity determination of SGOT and SGPT. 2. Students will understand the principles and the various reasons behind the protocols being followed. 3. Students will be able to analyse the results and make changes in the protocols as required. 4. Students will be able to evaluate the health status based on the results of the serum metabolites and enzymes.	presentation of the methology, conversion of moles, molar, mg, g, L etc, weighing, handling equipments and hands on practicals	and analytical questions will be given to students. Students' hands on'learning will be regularly monitored

Detailed Syllabus:-

Modules	Course content	Periods
I	**4.** Determination of activation energy of enzyme. **5.** Determination of influence of temperature on enzyme activity. **6.** Immobilisation of urease in calcium alginate beads.	**24**
II	**3.** Determination of type of inhibition (reversible or irreversible) of amylase. **4.** Modelling of an enzyme active site using in silico method.	**24**
III	**6.** Estimation of glucose by Folin-Wu method. **7.** Estimation of cholesterol by Zack's method. **8.** Estimation of haemoglobin by Wong's method **9.** Estimation of urea in blood by Diacetylmonoxime method. **10.** Estimation of serum calcium by Clark and Collips method.	**24**
IV	**7.** Determination of A/G ratio by Biuret method. **8.** Analysis of SGOT-SGPT (A.S.T., A.L.T.) / creatine kinase/ acid or alkaline phosphatase. **9.** Qualitative analysis of Urine sample for normal and abnormal constituents. **10.** Estimation of uric acid in serum and urine by Caraway's method	**24**

	11. Determination of urine Chloride by Volhard-Arnold method. **12.** Estimation of urine Bilirubin.	
Total		**96**

Text books:

4. Biochemistry, ed. Plummer Tata 3rd Edn.-McGraw Hill,.
5. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. C.B.S. Publishers.

Reference books:

1. Hawk's Physiological Chemistry, ed. Oser, 14th Edn., Tata-McGraw Hill.

2 .Practical Clinical Biochemistry: Methods and Interpretation, 4th edn. Ranjna Chawla, Jaypee Brothers Medical Publishers.

6. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers.

4TH SEMESTER SYLLABUS

PAPER I: MICROBIOLOGY
SUBJECT CODE: BCH154C402
CREDIT UNITS: L-T-P-C = 2-1-0-3
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
The course aims To give students a conceptual foundation for understanding pathogenic microorganisms, with a focus on the underlying processes of their pathogenicity.	1. Study the distinction between prokaryotes and eukaryotes 2. Gain an understanding of microbial diversity, bacterial morphology and its growth patterns. 3. Study about microbe pathogenicity and analyze the mechanism of action and epidemiology of pathogens, 4. As well as evaluate the industrial applications of microorganisms. 5. Analyze several microscopy techniques, their operating principles, applications, and distinctions.	Students will be asked to orally revise the previousclass before every new class helping them in better understanding andtheir doubtsCleared, if any.Videos will beshown in the classfor a betterunderstanding ofThe concepts.Teaching will beconducted boththrough white board mode and power point presentationsmode	Oral questions will be asked inthe class. Problems will be assigned to test student'sanalytical ability. Class tests willbe conducted for internalAssessment.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Introduction to Microbiology and Diversity:**Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff and Edward Jenner. Systems of classification (Binomial Nomenclature, Whittaker's five kingdom and	14

	Carl Woese's three kingdom classification systems and their utility). Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: Acellular microorganisms (Viruses, Bacteriophages, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.	
II	**Microbial genetics, Physiology and Metabolism:**Genomeorganization. Coli, Saccharomyces.Organelle genome: Chloroplast and Mitochondria. Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast-2 μ plasmid.Transformation, Conjugation (mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping). Transduction (Generalized transduction, specialized transduction). Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate. Nutritional categories and requirements of microorganisms.Concept of aerobic respiration, anaerobic respiration and fermentation.	14
III	**Industrial and Medical Microbiology:**Microorganisms in industries – citric acid and lactic acid production, production of beer and wine.Food borne infection and food borne intoxication.Epidemiology of bacterial, fungal and viral diseases, production of antibiotics from microorganisms and chemotherapy.	10
IV	**Tools and Techniques in Microbiology:**Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; Stain and staIning techniques.Microscopy and its different types.Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.Physical and Chemical methods of microbial control: Types and mode of action.	10
Total		**64**

Text books:

1. *Lehninger Principles of Biochemistry*, Nelson, D.L., Cox, M.M., WH Freeman andCompany, New York, USA. 7th Edition, 2017
2. Prescott, Harley and Klein's Microbiology, J.M. Willey, L.M. Sherwood and C.J.Woolverdon (2017), 10th ed.,McGraw Hill Publishers.
3. Frazier and Westhoff. Food Microbiology 5th Edition, McGrawHill
4. Brock et al. Jawetz, Milnick and Adelberg's Medical Microbiology. 27th Edn (2016) Lange Me
5. Biology of Microorganisms, 15th Edn. Brock Prentice Hall(2017).
6. Industrial Microbiology; Miller and Litsky (Eds.) (1976) McGraw HillPublishers.
7. Microbiology; Lansing M. Prescot, Hartley and Klein, 5th Edn. McGraw Hill(2002).
8. Microbiology; Essentials and Applications, Larry Mckane and J. Kandel (19)2nd Edn.McGrawHillpublishers.

PAPER II: MEMBRANE BIOLOGY
SUBJECT CODE: BCH154C402
CREDIT UNITS: L-T-P-C = 2-1-0-3
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
The course aims To educate students about the structures and functions of basic components of prokaryotic and eukaryotic	Students will 1. Study about the structure of bio-membranes, the fluid mosaic model, and the liposome. 2. Micelles, membrane asymmetry, macro and micro domains in membranes, lipid rafts, caveolae, tight junctions, and R.B.C. membrane architecture will be discussed. 3.Explore membrane dynamics and the	Students will be asked to orally revise the previous class before every new class. Teaching will be conducted both	Oral questions will be asked inthe class. Problems will be assigned to test student's Analytical ability. Class tests willbe conducted for internalassessment.

cells.	membrane transport thermodynamics, 4. As well as technical applications for studying membrane dynamics. 5. Evaluate the importance of various transport modes, channels and proteins in catalyzing the translocation of solutes across the membrane to achieve tissue homeostasis	through white board mode and power point presentations mode	

Detailed Syllabus:-

Modules	Course content	Periods
I	**Introduction to bio membranes:** Composition of bio membranes - prokaryotic, eukaryotic, neuronal, and subcellular membranes.Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems.	**12**
II	**Membrane structures:** Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. C.M.C., critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. R.B.C. membrane architecture.	**10**
III	**Membrane dynamics:** Lateral, transverse, and rotational motion of lipids and proteins. Techniques used to study membrane dynamics- FRAP, TNBS labelling etc. Transition studies of lipid bilayer,Transition temperature. Membrane fluidity, factors affecting membrane fluidity.	**12**
IV	**Membrane transport:** Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na+ -glucose symporter. A.B.C. family of transporters - M.D.R., CFTR.Group translocation. Ion channels - voltage-gated ion channels (Na+ /K+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, and bacteriorhodopsin. Ionophores - valinomycin, gramicidin.	**14**
Total		**48**

Text books:

1. *Lehninger Principles of Biochemistry*, Nelson, D.L., Cox, M.M., WH Freeman andCompany, New York, U.S.A. 7th edition, 2017
2. Victor Rodwell, David Bender, P. Anthony Weil, Peter Kennelly. *Harpers Illustrated Biochemistry* 31th Edition,2018
3. Text book of medical biochemistry by M N Chatterjee, Rana Sindhe. 8thEdn
4. Text book of medical biochemistry by S. Ramakrishnan, K G Prasannan. 3rdEdn.
5. J.M. Berg, J.L. Tymoczko, L. Stryer. . Biochemistry, 9th Edn. (2019) WH Freeman and Company, New York and England.
6. R. Verna. Membrane Technology, Raven Press, New York., U.S.A.
7. H. Lodish, A. Berk, S.L. Zipursky, P. Matsudaira, D. Baltimore, J. Darnell. Molecular Cell Biology, 8th Edn. WH Freeman and Company, NY and England
8. H.R. Petty. Molecular Biology of Membranes Structure and Function, Plenum Press, New York, U.S.A. and London.
9. D.F.H. Wallach. Membrane Molecular Biology of Neoplastic Cells, (1975) Elsevier Scientific Publishing Company, Amsterdam, Oxford and New York., U.S.A.

PAPER III: PRACTICAL IV
SUBJECT CODE: BCH154C413
CREDIT UNITS: L-T-P-C = 0-0-3-3
STUDENT'S SCHEME OF EVALUATION: Theory Papers (T)

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To teach students how to execute fundamental microbiological	Students will 1.learn the principles behind stain-reagent- and culture medium- preparation 2. Evaluate the critical role of	Chalk and board teachings, video presentations of	Discussions, oral Questioning and analytical

and membrane based practical.	sterilization in microbiology experiments. 3. Learn about bacterial isolation, staining, identify bacteria using biochemical tests and motility and comprehend the bacterial growth patterns and as well as conduct SDS-PAGE. 4.understand and assess the effect of detergents on erythrocytes, the effect of ethanol on beetroot membranes, and the influence of lipid composition on lipid monolayer permeability	the methodology, calculations guidance, conversion of moles, molar, mg, g, L etc., weighing, and handling equipment	questions will be given to students. Students' hands on' learning will be regularly monitored

Detailed Syllabus:-

Modules	Course content	Periods
I	**1.** Preparation of stains andreagents **2.** Preparation of various culturemedia **3.** Preparation of broth andslants 4. Sterilization of culture media by autoclavemethod	**24**
II	**1.** Sterilization of glassware by hot airoven **2.** Isolation and propagation ofbacteria **3.** Staining of bacteria – Simple staining, differentialstaining, staining of spores andcapsules 4. Determination of growth curve ofbacteria	**24**
III	**1.** Biochemical tests and motility for the identificationof bacteria. **2.** Investigation of the effect of osmotic change on membranes **3.** Investigate the effect of temperature on membrane permeability. **4.** Investigate the effect of pH change on membrane. 5. Study of osmosis	**24**
IV	1. Effect of detergents and other membrane activesubstances onErythrocytes. 2. Effect of ethanol on beetrootmembrane. 3. Effect of lipid composition on the permeability of alipid monolayer.	**24**

Total		**96**

Text books:

1. G.F. Brooks, J.S. Butel, S.A. Morse, J.L. Melnick, E. Jawetz, E.A. Adelberg. Jawetz, Melnick&Adelberg's Medical Microbiology, 27th Edn. Lange Publication. U.S.A.
2. P. Cossart, P. Boquet, S. Normark, R. Rappuoli. Cellular Microbiology, 2ndEdn.American Society for Microbiology Press. U.S.A.
3. A.A. Salyers, D.D. Whitt. Bacterial Pathogenesis: A molecular approach. American Society for Microbiology Press, Washington, DCUSA
4. J. Hacker, U. Dorbindt. Pathogenomics: Genome analysis of pathogenic microbes, Wiley- V.C.H. Germany
5. D.H. Persing, F.C. Tenover, J. Versalovic, Y. Tang, E.R. Unger, D.A. Relman, T.J. White.. Molecular Microbiology: Diagnostic Principles and Practice, 2nd Edn. American Society for Microbiology Press. U.S.A.
6. K.E. Nelson, C.M. Williams, N.M.H. Graham. Infectious Disease Epidemiology: Theory and Practice, 3rd Edn. (2013) an Aspen Publication.
7. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. C.B.S. Publishers (.
8. Hawk's Physiological Chemistry, ed. Oser, 14th Edn, Tata-McGraw Hill.

DISCLIPLINE SPECIFIC ELECTIVE

M.SC. BIOCHEMISTRY (CBCS STRUCTURE)
DISCIPLINE SPECIFIC ELECTIVE (D.S.E.) COURSES

Discipline Specific Elective Course – I (DSE - I): BIOANALYTICAL TECHNIQUES
Subject Code:BCH154D101
Credits: 3-1-0-4; Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
The objective of the course is to provide students with a broad understanding of the principles of	1. Students willgain familiarity with working principle, tools and methodology of analytical techniques 2. Students will understand the strengths, limitations and creative use of techniques in biological science 3. Students will execute the techniques for	Markerand board, Powerpoint presentations, student interaction	Students will be given assignment for example; oral questions will be asked

bioanalytical instrumentation and to provide an appreciation of their uses.	biological experiments 4. Students will be able to make a strategy on molecular techniques for the improvement of the results Students will assess the industrial application of the laboratory techniques		

Detailed Syllabus:-

Modules	Course content	Periods
I	Electrophoretic techniques: Principles of electrophoretic separation. Continuous, free, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, and pulse field gel electrophoresis.Spectroscopy: Concepts of spectroscopy, Visible and U.V. spectroscopy, Laws of photometry.Beer-Lambert's law, Principles and applications of colorimetry.	**16**
II	Chromatography: Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC, gas chromatography.	**16**
III	Centrifugation: Principles of centrifugation, concepts of R.C.F., different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, sub cellular fractionation	**16**
IV	Electron microscopy: Light, electron (scanning and transmission), phase contrast, fluorescence microscopy, freeze-fracture techniques, specific staining of organelles or marker enzymes.	**16**
Total		**64**

Text books:

1. Principles and Techniques of Practical Biochemistry, Keith Wilson and John Walker, 5th edition, 2000.
2. Physical Biochemistry, application to Biochemistry and Molecular Biology, David Freifelder, 2nd Edition, 1982.

Reference books:

1. R. F. Boyer, Modern experimental biochemistry, Benjamin Cummings, San Francisco, 3rd ed., 2000.

2. R. F. Boyer, Biochemistry laboratory: modern theory and techniques, Prentice Hall, Boston, 2nd ed., 2012.

3. D. Harvey, Modern analytical chemistry, McGraw-Hill, Boston, 2000.

Discipline Specific Elective Course – I: PLANT BIOCHEMISTRY
Code: BCH154D101
Credits: 4; Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
The course aims at providing deep understanding of metabolic processes in plants	1. Students will be introduced to basic plant cell structure, photosynthesis, carbon cycle, stress responses, and plant defences. 2. Students will be able to understand the basic make up of cell structure, scheme of photosynthesis, the reactions of carbon cycles, the hormones and metabolites in stress and pathogen response. 3. Students will be able to	Teaching will be conducted through both black board mode and power point presentation mode. Special lecture will be organized on current aspects of photosynthesis and carbon	Preparation of summary of differences of plant cells from cells of various other organisms; Retrieval of original research papers on photosynthesis, accessory pigments, water splitting complex, light reactions and associated topics. They will separate photosyntheticpigmentsby T.L.C.

	analyse the functioning of the plant cell metabolism under various conditions. 4. Students will be able to evaluate the metabolites and biochemical pathways that are critical for plant survival.	fixation.	

Detailed Syllabus:-

Modules	Course content	Periods
I	**Introduction to plant cell structure and photosynthesis:** Introduction to Plant cells, Plasma membrane, Vacuole and Tonoplast membrane, Cell wall, Plastids and Peroxisomes. Molecules involved in photosynthesis: chlorophyll and carotenoids. Antenna molecules. Structure of P.S.I. and PSII complexes. Photosynthetic reactions and the Z scheme. Role of the P.S.I. and PSII in photosynthetic reactions. Regulation of P.S.I. and PSII activity. Functioning of oxygen evolving complex.	**16**
II	**Carbohydrate biosynthesis in plants:** CO2 fixation- stages and regulation. Energetic requirements and light driven enzymes of Calvin cycle. Photorespiration, C4 and C.A.M. pathways. Salvage pathway. Rubisco activity in C4 and C.A.M. plants. Biosynthesis of starch and sucrose and its regulation. Synthesis of cellulose.	**16**
III	**Regulation of plant growth and stress physiology:** Introduction to plant hormones. Biosynthesis of plant hormones- site and pathways of synthesis, transport, mode of action. Plant responses to abiotic and biotic stresses, Water deficit and drought resistance, Flooding, Temperature stress, Salt stress.	**16**
IV	**Secondary metabolites and plant defence:** Cutin, waxes and suberin- structure and role in plant defence. Secondary metabolites- biosynthetic pathways and types. Terpenes- biosynthesis, roles in plant growth and defence. Phenolic compounds- types, biosynthesis, activation, functions in plant growth and defence. Role of amino acids, proteins and hormones in plant defence. Response of plants to infections	**16**
Total		**64**

Text Books:

1. Plant Physiology by Taiz, L. and Zeiger, E. (2015). (6th Ed.).
2. Lehninger Principles of Biochemistry, Nelson, D.L., Cox, M.M., WH Freeman and Company, New York, U.S.A. 7th edition,2017

References

1. Buchann (2015). Biochemistry and Molecular Biology of plant. (2nd Ed.).
2. Caroline Bowsher, Martin steer, Alyson Tobin (2015). Plant Biochemistry. Garland Science.
3. Dey, P. M. and J.B. Harborne, J.B., (Editors) (2013). Plant Biochemistry.

Discipline Specific Elective Course–II (DSE-II): NUTRITIONAL BIOCHEMISTRY
Subject Code: BCH154D201
Credits: 3; Total Hours: 48

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To understand the basic nutrients and their functioning in the tissues	1. Students will be able to learn the basics of nutritional biochemistry, vitamins, minerals, and diseases associated with excessive sugar intake and malnutrition. 2. Students will understand the role of different nutrients in maintaining the healthy state, and the working mechanisms of various nutrition associated diseases. 3. Students will be able to analyse the biochemical functioning of different nutrients. 4. Students will be able to evaluate the importance of nutrients in health	Students will be asked to revise the previous class before every new Class orally. Teaching will be conducted boththrough whiteboard mode andpower pointpresentationMode.	Students will be asked questions, Quiz, internal assessment. Tests will be conducted.

	and the issues arising out of malnutrition, fasting and obesity.		

Detailed Syllabus:-

Modules	Course content	Periods
I	Basic concepts: Function of nutrients. Measurement of the fuel values of foods. Direct and Indirect calorimetry. Basal metabolic rate: factors affecting B.M.R., measurement, and calculation ofB.M.R. Measurement of energy requirements. Specific dynamic action of proteins.Elements of nutrition: Dietary requirement of carbohydrates, lipids and proteins. Biological Value of proteins. Concept of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids, and their physiological functions.	**12**
II	Minerals: Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.Vitamins: Dietary sources, biochemical functions, requirements, and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins.	**12**
III	Malnutrition: Prevention of malnutrition, improvement of diets.Recommended dietary allowances, nutritive value of common foods. Protein-calorie malnutrition. Requirement of proteins and calories under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing.	**12**
IV	Starvation: Techniques for the study of starvation. Protein metabolism in prolonged fasting.Obesity: Definition, Genetic and environmental factors leading to obesity.	**12**
Total		**48**

Text Books:

1. Nutritional Biochemistry. Author, Tom Brody. Edition, 2. Publisher, Harcourt, Braces, 1999.
2. Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford university press.

Reference books:

1. Krause's Food and Nutrition Care process (2012); Mahan, L.K Strings, S.E, Raymond, J. Elsevier's Publications.

2. The vitamins, Fundamental Aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications.

3. Principles and Techniques of Practical Biochemistry, Keith Wilson and John Walker, 5th edition, 2000.
4. Physical Biochemistry, application to Biochemistry and Molecular Biology, David Freifelder, 2nd Edition, 1982.

Discipline Specific Elective Course –II (DSE-II): NEUROBIOCHEMISTRY
Subject Code: BCH154D201
Credits: 3, Total Hours: 48

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
This paper provides a basic understanding of the nervous system and nerve cell functioning	1. Students will learn about the nervous system, transmissions, transmitters and neuro-degradative diseases. 2. Students will understand the biochemistry of nerve signaling, transmitters and neuro-degradative diseases. 3. Students will be able to analyse the functioning of the nervous systems and the significance the various transmitters in the nerve	Students will be asked to orally revise the previous class before everynew class helpingthem in betterunderstanding andtheirdoubtscleared, if any. Videos will beshown in the classfor a better Understanding ofthe concepts. Teaching will beconducted	Oral questions will be asked in the class. Problems will be assigned to test student's analytical ability. Class tests will be conducted for internal assessment.

	functioning. 4. Students will be able to evaluate the biochemical events leading to the development of neuro-degradative diseases.	boththrough white boardmode and powerpoint presentations mode	

Detailed Syllabus:-

Modules	Course content	Periods
I	**Neuron:** Neuro cellular anatomy, neural membrane, classification of neuron, nerve fibers, axonal transport, neural growth, neuroglia, nervous system, blood-brain barrier, cerebrospinal fluid.	**12**
II	**Neuronal signalling:** Membrane potentials, ion channels, recording neuronal signals, ionic basis of resting potential and action potential, propagation of action potential. Synaptic transmission- Synapse, Electrical synapse transmission, chemical synaptic transmission, Synaptic transmitter release, synaptic potentials, synaptic delay, synaptic plasticity, molecular mechanism of synaptic transmission, myoneural junction.	**12**
III	**Neurotransmitters:** Chemistry, synthesis, storage, release, receptors and function- acetyl choline, catecholamines, serotonin, histamine, glutamate, asparatate, GABA, glycine, neuropeptides, nitric oxide.	**12**
IV	**Neural processing and neurodegenerative disorders:** Learning and memory, neurochemical basis of drug abuse, neurodegenerative disorders, Parkinson's disorder, Alzheimer's disorder, Amyotrophic Lateral Sclerosis, Senile Dementia	**12**
Total		**48**

Text Books:

1. Arthur C. Guyton and John E Hall, Text book of medical physiology 11th Edition;2006

2. David Nelson and Michael Cox, Lehninger Principles of Biochemistry, 4th edition;2005

Reference books:

1. Bruce Alberts, Alexander Johnson, Juliana Lewis, Martin Raff, Keith Roberts and Peter Walter, Molecular biology of the cell, 4th Edition;2004

2. Gordon Shepherd, Neurobiology, 3rd Edition;1994

3. MarkFBear,BarryWConnorsandMichaelAParadiso,Neuroscience:Exploringthebrain,4th Edition; 2015

Discipline Specific Elective Course – III /IV/V: Environmental Science
Subject Code: BCH154D304
Credits: 4, Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
This course introduces students to environment concerns factors affecting it, environmental ethics and its protection	1. Students will learn the basics of environmental science, types of resources, pollution, and biodiversity. 2. Students will understand the basics of environmental sciences, the functioning of various resources, sources and causes of pollution, and the importance of biodiversity. 3. Students will be able to analyse the importance of renewable resources, ways to curb pollution, and importance of biodiversity. 4. Students will be able to evaluate the losses arising out of	Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be conducted both through white board mode and power point presentations mode	Oral questions will be asked; students will be asked to discuss the topic. Quiz, internal assessment tests will be conducted.

	environmental degradation and help in conservation.		

Detailed Syllabus:-

Modules	Course content	Periods
I	**The multidisciplinary nature of environmental studies:** Definition, scope and importance. Need for public awareness.	**8**
II	**Natural resources: renewable and non-renewable resources:** Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non- renewable energy sources, use of alternate energy sources, Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.	**24**
III	**Environmental pollution:** definition, Causes, effects and control measures. Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.	**18**
IV	**Bio-diversity and its conservation:** introduction, definition Genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local levels. India as a maga-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity : In-situ and Ex-situ conservation	**16**

	of biodiversity	
Total		**64**

Text Books:

1. Anne E. Magurran. 2003. Ecological diversity and its measurements. Blackwell Publications.

2. V.H. Heywood and Watson R.T. (Ed). 1995. Global Biodiversity Assessment: UNEP. Cambridge University Press.

Reference books:

1. M. Dayal. (6th Ed). 1997. Renewable Energy: Environment and Development. Konark Pub. Pvt.Ltd.

2. S. K. Agarwal. 2003. Nuclear Energy: Principles Practice and Prospects. APH Publishing Corporation.

3. A. K. De. (3rd Ed). 2008 Environmental Chemistry. New Age Publications India Ltd.

4. I.L. Pepper, C.P. Gerba and M.L. Bresseau. 2006. Environment and Pollution Science. Academic Press.

Discipline Specific Elective Course – III/IV/V: Research Methodology
Subject Code: BCH154D301/302/303
Credits: 4; Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
Students will be introduced to the basics of research process, design, report	1. Students will learn about research methodology, defining research problems, experimental designs and result analysis. 2. Students will understand the processes involved in research	Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Teaching will be	Oral questions willbe asked; students will be asked to discuss the topic.

writing and statistical analysis	methodology, identifying research problems, experimental designs and result analysis 3. Students will be able to analyse the research problems and research results. 4. Students will be able to evaluate the research issues, results and how to move ahead with the statistical analysis.	conducted both through black board mode and power point presentation mode.	

Detailed Syllabus:-

Modules	Course content	Periods
I	Introduction to research methodology, objectives and motivation in research.	**8**
II	Defining the Research Problem .Selecting and defining a research problem, Reviewing and conducting literature search, developing a research plan.	**18**
III	Designing of Experiment Different experimental designs – single and multifactorial design, Making measurements and sources of error in measurements, Methods of data collection and record keeping.	**20**
IV	Data Processing and Statistical Analysis .Processing operations, tabulation, and graphical representation, Statistics in research: Concepts of sample and population, Measure of central tendency, dispersion, asymmetry (skewness, kurtosis), Normal distribution (p-value), Statistical tests and hypothesis (Standard error, t-test, chi-square test), and regression analysis, Report writing, Writing a research paper - abstract, introduction,	**18**

	methodology, results and discussion.	
Total		**64**

Text Books:

1. Research in Education (1992) 6th ed. Best, J.W. and Kahn, J.V., Prentice Hall of India Pvt. Ltd. ISBN-978-81-203-3563-9.

2. AttheBench:ALaboratoryNavigator(2005)Barker,K.,ColdSpringHarborLaboratoryPress (New York), ISBN: 978-087969708-2.42

Reference books:

1. Research Methodology - Methods and Techniques (2004) 2nd ed., Kothari C.R., New Age International Publishers. ISBN –81-224-1522-9

2. Research Methodology: A Step by Step Guide for Beginners (2005) 2nded. Kumar R., Pearson Education. ISBN: 978-1-4129-6467-8.

3. Biostatistics: A Foundation for Analysis in the Health Sciences (2013) 10th ed., Daniel W.W., John Wiley and Sons Inc. ISBN-13: 978-1118302798 ISBN-10:1118302796

4. Statistics at the Bench: A Step-by-Step Handbook for Biologists (2010) Bremer, M. and Doerge, R.W., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-0-879698-57-7.

Discipline Specific Elective Course – III/IV/V: Genetics for Biologist
Subject Code: BCH154D301/302/303
Credits: 4, Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To introduce students to mendelian, human and microbial genetics	1. Students will learn about mendelian, human and microbial genetics 2. Students will understand the differences in the mendelian and non-mendelian genetics, 3. Students will be able to analyse the	Students will be asked to orally revise the previous class before every new class helping them in better	Oral questions will be asked in the class. Problems will be assigned

genetics and DNA mutation, repair	pedigrees. 4. Students will be able to evaluate the gene maps	understanding and their doubts cleared, if any. Videos will be shown in the class for a better understanding of the concepts. Teaching will be conducted both through white board mode and power point presentations mode	to test student's analytical ability. Class tests will Be conducted for internal assessment.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Mendelian and Post-Mendelian Genetics:** Mendelian Laws of Genetics (Dominance, segregation, and independent assortment), Mendelian genetics in humans, Incomplete dominance, codominance, maternal effect, extranuclear genes, extranuclear inheritance, Multiple alleles, ABO blood groups, lethal alleles and null alleles. Pleiotropy gene interaction, epistatic and non-epistatic, interaction between gene(s) and environment. Penetrance and expressivity, Chromosome theory of inheritance.	**16**
II	**Concept of Human Genetics:** Human Chromosome and abnormalities, Chromosomal Non-disjunction and human genetic disorders, Mendelian pedigree pattern, polygenic and multifactorial inheritance, Hardy-Weinberg equilibrium, genotype and allele frequency, Genotypic sex determination, Human sex determination, sex chromosomes, sex linkage, sex linked traits, non-disjunction of X chromosomes, Genotypic sex determination, X-linked recessive inheritance, X-linked dominant inheritance, Y-linked inheritance.	**16**
III	**Microbial Genetics:** Genetic Analysis of Bacteria- Prototroph and Auxotroph, Bacterial chromosome and plasmids, Conjugation- Lederberg and Tatum experiment, The Sex factor-F, Hfr strain, F' factors, Using Conjugation to map bacterial genes-interrupted mating experiments. Transformation- Natural vs artificial transformation, Griffith's Transformation experiment, Transformation as means of Genetic mapping in bacteria. Transduction-Bacteriophage and their genetic systems,	**16**

	Generalized Transduction, Specialized Transduction, Genetic mapping in Bacteria using Transduction.	
IV	**Mutations, DNA Damage and Repair:** DNA mutations-spontaneous and induced mutations, Repair of DNA damage-DNA repair mechanisms in prokaryotes and eukaryotes, diseases associated with DNA replication and repair mutations, Silencing by DNA methylation and regulatory RNAs. Mutations at the chromosomal levels, variations in chromosomal structure, variations in chromosome number, diseases arising out of aberrations at the chromosomal level.	**16**
Total		**64**

Text Books:

1. Fundamentals of Biochemistry: Life at the molecular level, 4th Edition. D. Voet, J.G. Voet and W. Pratt (2012).

2. Principles of Biochemistry, 4Th Edition. Nelson, D.L. and M.M. Cox (2005). 3. Biochemistry, 5th Edition. Jeremy M. Berg, John L. Tymoczko and LubertStryer (2002).

Reference books:

1. iGenetics, 3rd Edition, Peter J Russel.

2. Molecular Biology of the Gene, Watson et al. 7thedition.

3. Benjamin Lewin, Genes XI. Jones & Bartlett Learning; 11th edition (2012).

Discipline Specific Elective Course (DSE) – III/IV/V: Bioinformatics and Biostatistics
Subject Code: BCH154D101
Credits: 3-1-0-4, Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course	Course Learning Outcomes	Teaching and	Assessment

Objective		Learning Activity	Tasks
The course is aimed at introducing the application of bioinformatics and statistics in biology	1. Students will learn the basics of bioinformatics, protein structure visualization, genomics, proteomics, and statistical methods. 2. Students will understand the basics of bioinformatics, the bioinformatics tools functioning, and the basis for using different statistical methods. 3. Students will be able to analyse the bioinformatics tools and learn the hands on techniques. 4. Students will be able to evaluate the different bioinformatics tools and be able to utilize different statistical methods to deal with different types of data.	Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts Cleared if any. Teaching will be conducted both through white board mode and power point presentations mode	Students will be asked questions; Internal assessment tests will be conducted.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Basics of Bioinformatics:** definitions, scope and goal, applications in computational biology, limitations; Biological database: types of database, biological database, information retrieval from the biological database; Sequence alignment: pairwise, multiple, database similarity search, scoring matrices, Molecular phylogenetics: distance-based methods, character based methods.	**16**
II	**Structural Bioinformatics:** proteins and its structure, determination of protein 3-dimensional structure, protein structure visualization, comparison, secondary and tertiary	**16**

	structure prediction, Genomics and Proteomics: genome mapping, genome sequence, genome sequence assembly, comparative genomics, Functional Genomics: sequence-based approaches, microarray-based approach, Proteomics: technology of protein expression analysis, protein sorting, protein-protein interaction; Computer Aided Drug Designing (CADD), pharmacophore modeling.	
III	**Statistical Tools:** measures of central tendencies and dispersion, concept of probability and theoretical distributions (bionomial, poisson, and normal distribution), correlation and regression; univariate and multivariate multiple regression, random numbers, sampling methods, random plot design, basics of testing of hypothesis, Analysis of variance (one way and two way), Students t test, Chi-square test, F-test, and Z- test.	**16**
IV	**Statistical Science and Biological Assay:** importance, nature and planning of bioassays, direct and indirect bioassays, design of experiments by Analysis of variance and Dose-response analysis. **Analysis of Biochemical Data:** application of multiple regressions in epidemiologic and clinical data, study of associations between disease and risk factors, Application of odds ratio, Logistic regression with dichotomous response variable.	**16**
Total		**64**

Text Books:

1. Baxevanis A.D. And Ourllette BFF. (2001) Bioinformatics, Second edition, Wiley Interscience.

2. Mount D.W. (2004) Bioinformatics: Sequence and Genome Analysis, Second Edition. CSHL Press.

Reference books:

1. Lesk A.M. (2013) Introduction to Bioinformatics. Fourth Edition. Oxford University Press.

2. Grohima M.M. (2010) Protein Bioinformatics. Elsevier Publications.

3. Ghosh Z. and Mallick B. (2008) Bioinformatics: Principles and Applications. Oxford University Press

Discipline Specific Elective Course – VI/VII/VIII: Biochemistry of Common Disorders
Subject Code:BCH152D401/402/403
Credits: 4, Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To provide knowledge about common life style disorders and the molecular details of their development.	Students will 1. study about the diverse components of human physiology, **2.** acquire knowledge about numerous illnesses and disorders that typically occur in humans and analyze various biochemical indicators that occur during these diseases and disorders. 3. gain understanding about the biochemical phenomena in cardiovascular disorders, renal diseases, and cancer and AIDS**.** 4. evaluate and learn applications of numerous diagnostic tools for detecting biochemical parameters and markers in blood under pathophysiological settings.	Teaching will be conducted both through white board mode and power point presentation mode. Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any.	Oral questions will be asked; students will be asked to discuss the topic. Quiz, internal assessment tests will be conducted.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Human Physiology:** Introduction and brief description of cells, tissues and organs, their functions; Body fluids and their composition. Introduction to molecules as building blocks. Definition and differentiation of disease and disorder, types and causes. Relation between food, environment and illness. Analysis of various biochemical parameters in body fluids and specific tissues during disorders, diseases and forensics.	**16**
II	**Life style diseases**- Diabetes, major causes of diabetes, major genes involved in diabetes. Obesity, major genes involved in obesity. Atherosclerosis, major factors contributing to atheroschlerosis. Cardiovascular diseases. Major underlying causes. Genes involved in CVD.	**16**
III	Cirrhosis, alcoholic liver disease, fatty liver, Gall stones, pancreatitis- Biochemical mechanisms, Causes, Prevention and dietary management. Renal disease: Nephrotic syndrome. Biochemical mechanisms. Acute and Chronic renal failure- biochemical mechanisms, diagnostic procedures and dietary management.	**16**
IV	Viral infections- Hepatitis, (A, B, and C), routes of infections, viral life cycle, and treatment. HIV/AIDS: Biochemistry of HIV infection, ART and social issues. Vaccines against HIV. Biochemistry of SARS-COVID I and II viral infections.	**16**
Total		**64**

Text Books:

1.Biochemistry; Donald Voet, Judith G. Voet, 4th Edition, John Wiley and sons (2010).

2. Lehninger - Principles of Biochemistry; David L. Nelson and Michael M. Cox, 6th Edition, W. H. Freeman (2013). 46

Reference books:

1. Biochemistry- The Chemical Reactions of Living Cells; David E. Metzler, 2nd Edition, Academic Press(2001).

2. Outlines of Biochemistry; Eric E. Conn, Paul K. Stumpf, George Breuning, Roy H. Doi, 5th Edition, John-Wiley and sons(2009).

3. Biochemistry- The Chemical Reactions of Living Cells; David E. Metzler, 2nd Edition, Academic Press (2001).

Discipline Specific Elective Course – VI/VII/VIII: General Pharmacology
Subject Code: BCH154D401/402/403
Credits: 4, Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
To introduce the mode of action, transport and effects of drugs.	Students will 1. study the pharmacological actions of several drug classes 2. describe drug action mechanisms at the organ system, subcellular, and macromolecular levels. 3. able to investigate the effect of medications on animals through simulated studies; 4. apply their fundamental pharmacological knowledge in the prevention and treatment of various illnesses 5. evaluate the correlation between	Regular chalk and board teaching along with PPT presentations. Class discussions on syllabus topics will be performed. Software's/ Videos will be issued to demonstrate animal experiment. Practical demonstration will	MCQ based assignments will be given to students to check their understanding of the subject. Oral questions will be asked in the class. Students will be given to prepare power

	pharmacology and other biomedical disciplines.	be given.	point presentation on the assigned topics related to the class teachings. Problem solving assignments, regular question answer sessions, and unit-test for internal assessment

Detailed Syllabus:-

Modules	Course content	Periods
I	**General Pharmacology:** Introduction to Pharmacology-Definition, historical landmarks, and scope ofpharmacology, nature and source of drugs, essential drugs concept and routes ofdrug administration, Agonists, antagonists (competitive and non-competitive), spare receptors, addiction, tolerance, dependence, tachyphylaxis, idiosyncrasy, allergy.Pharmacokinetics- Membrane transport, absorption, distribution, metabolism, and excretion of drugs. Enzyme induction, enzyme inhibition, kinetics of elimination	**8**
II	**General Pharmacology:** Pharmacodynamics- Principles and mechanisms of drug action. Receptor theories and classification of receptors, regulation of receptors. drug receptors interactions signal transduction mechanisms, G-protein–coupled receptors, ion channel receptor, transmembrane enzyme linked receptors, transmembrane JAK-STAT binding receptor and receptors that regulate transcription factors, dose response relationship, therapeutic index, combined effects of drugs and factors modifying drug action.Adverse drug reactions. Drug interactions (pharmacokinetic and pharmaco dynamic)Drug discovery and clinical evaluation of new drugs -Drug discovery phase, preclinical evaluation phase, clinical trial phase, phases of	**12**

	clinical trials andpharmacovigilance	
III	**Pharmacology of drugs acting on peripheral nervous system:** Organization and function of ANS. Neurohumoraltransmission,co-transmission and classification of neurotransmitters. Parasympathomimetics, Parasympatholytics, Sympathomimetics, sympatholytics. Neuromuscular blocking agents and skeletal muscle relaxants (peripheral). Local anesthetic agents. Drugs used in myasthenia gravis and glaucoma	**10**
IV	**Pharmacology of drugs acting on central nervous system:**Neurohumoral transmission in the C.N.S.special emphasis on importance of various neurotransmitters like with GABA, Glutamate, Glycine, serotonin, dopamine. General anaesthetics and pre-anaesthetics. Sedatives, hypnotics and centrally acting muscle relaxants. Anti-epileptics Alcohols and disulfiram Psychopharmacological agents: Antipsychotics, antidepressants, anti-anxiety agents, anti-manics and hallucinogens. Drugs used in Parkinsons disease and Alzheimer's disease. CNS stimulants and nootropics. Opioid analgesics and antagonists. Drug addiction, drug abuse, tolerance and dependence.	**15**
Total		**64**

Text Books:

1. Rang, H. P., Henderson, G., Flower, R. J., Dale, M. M. (2015). Rang&Dale's Pharmacology. 8th edition.United Kingdom. ChurchilLivingstoneElsevier
2. Katzung B. G., Masters S. B., Trevor A. J.(2013). Basic and clinical pharmacology, 11th edition. New Delhi. Tata McGraw-Hill

Reference Book:

1. Sharma. H. L., Sharma, K. K. (2017). Sharma & Sharma's Principles of Pharmacology. India: Paras Medical Publisher.
2. Stitzel, R. E. (2004). Modern Pharmacology with Clinical Applications. 6th edition. United Kingdom: Lippincott Williams & Wilkins.
3. Ghosh MN.(2015).Fundamentals Of Experimental Pharmacology. India: Hilton & Company.

Discipline Specific Elective Course – VI/VII/VIII: Molecular Endocrinology
Subject Code: BCH154D401/402/403
Credits: 4, Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
The objectives of this course are to introduce the basic principles, organs and systems in mammalian (human) endocrinology	1. Students will learn about the endocrine glands and their diseases, details about thyroid hormones, adrenal gland hormones and pancreatic hormones. 2. Students will understand about the workings of the different hormones and the resultant diseases. 3. Students will be able to analyse the biochemistry of hormone actions and the responsible proteins involved in regulating hormone action. 4. Students will be able to evaluate the reasons and mode of action of various drugs aimed at countering hormonal diseases.	Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared,if any. Teaching will be conducted both through white board mode and power point presentations mode	Students will be evaluated Through class discussion, Assignments, presentations and tests.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Hypothalamo - Hypophysial – Hormones:** Bio-chemistry and mechanism of action, regulation, synthesis and secretion Hypo and hyperactivity of pituitary hormones - Hypothalamic releasing factors, Anterior Pituitary hormones, Vasopressin, Oxytocin. Regulation of synthesis. Lactogenic hormones. Glycoprotein hormones of the POMC family, endorphins,	**16**

	Gigantism, Dwarfism, Acromegaly, diabetic insipidus, syndromes of inappropriate ADH secretion. Mechanism of action and functions of melatonin	
II	**Thyroid and para thyroid hormones**: Synthesis, secretion, transport and mechanism of action. Metabolic fate and biological action, thyroid diseases, thyrotoxicosis, goiter, hypothyroidism, grave's disease, Hashimoto's disease, thyroid function tests, calcium and phosphorus metabolism, calcitriol, pathophysiology.	**16**
III	**Adrenal hormones:** Adrenal cortex, glucocorticoids and mineralocorticoids, Synthesis, secretion, transport and mechanism of action. Metabolic fate and biological actions, Hormones of Adrenal Medulla - Catecholamines - Biosynthesis, storage, metabolism, regulation of synthesis. Abnormal secretion of adrenal hormones, congenital adrenal, hyperplasia, phaeocromocytoma. Gonadal hormones, Androgen, estrogen, synthesis, secretion, transport and mechanism of action. Metabolic fate and biological action, Ovarian cycle. Pregnancy, Biochemical changes in pregnancy.	**16**
IV	**Pancreatic Hormones:** Islets of langerhans and hormone secretions, biosynthesis, secretion and mechanism of action, receptor signaling, pathway of insulin and glucagon, somatostatin, pancreatic poly peptide and insulin- like growth factors, gastro intestinal hormones- synthesis, structure, secretion and function. GIP, VIP, gastric, CCK and other peptides.	**16**
Total		**64**

Text Books:

1. Endocrinology : Mac Hadley
2. William text book of Endocrinology :Larcen Et Al

Reference books:

1. MemalianBiochemistry : White Handler Smith
2. Harper's Biochemistry : Murray Etal
3. Principles of Biochemistry : Nelson Cox

Discipline Specific Elective Course –VI/VII/VIII: Genetic Engineering
Subject Code: BCH1545D401/402/403
Credits: 4; Total Hours: 64

Facilitating the achievement of Course Learning Outcomes

Course Objective	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
This course aims to give an insight into the direct manipulation of DNA to alter the characteristics of an organism in a particular way.	1. Students will learn about thescope of genetic engineering , enzymes involved, cDNA library construction, tools of genetic engineering, applications of genetic engineering. 2. Students will be able to understand the principles of genetic engineering, working mechanisms of enzymes involved in genetic engineering, making of libraries, and the use of genetic engineering. 3. Students will be able to analyse the role of enzymes in genetic engineering, and its potential applications in curing diseases. 4. Students will be able to evaluate the ethical issues concerning genetic engineering.	Students will be asked to orally revise the previous class before every new class helping them in better understanding and their doubts cleared, if any. Videos will be shown in the class for a better understanding of the concepts. Teaching will be conducted both through white board mode and power point presentations mode	Oral questions will be asked in the class. Problems will be assigned to test student's analytical ability. Class tests will be conducted for internal assessment.

Detailed Syllabus:-

Modules	Course content	Periods
I	**Scope to genetic engineering:** Introduction to Genetic Engineering and Biotechnology. Enzymes as Tools for Genetic Engineering: Restriction Enzymes, Restriction-Modification System, DNA-modifying enzymes, T4 and *E. coli* DNA Polymerase (Klenow), DNA-methylase, Polynucleotide Kinase, DNA-ligase, Taq DNA polymerase, Reverse Transcriptase, T7	**16**

	and T3 RNA polymerases. Vehicles for DNA cloning: Plasmid DNA vectors, bacteriophage lambda-derived vectors.	
II	**Recombination and cloning:** DNA (Gene) cloning, recombinant DNA, cDNA library, genomic library. Isolation of gene from gene library. Screening and identification of recombinant DNA clone from gene library. Expression of recombinant protein from a DNA clone in bacteria and purification of the protein. Some examples of the useful recombinant proteins: Insulin, Streptokinase, enzymes, antibodies, vaccines.	**16**
III	**Recent advances in genetic technology:** Polymerase Chain Reaction (PCR) and Site-directed, Restriction enzyme digestion. Transgenic animals, Ligation, Cloning, Transformation, Calculation of transformation efficiency. Mutagenesis. Recent trends in Gene technology. Gene Targeting: Knock-ins and Knock-outs. Targeted Genome Editing: ZFNs, TALENs, CRISPRs, etc.	**16**
IV	**DNA Sequencing and Genome Analysis, Model Genomes:** Human Genome Project and Human Genome Sequences. Applications of Genetic Engineering and Biotechnology in agriculture, medicine and its economic and social implications, Ethical precautions.	**16**
Total		**64**

Text Books:

1. Primrose, S.B. and Twyman, R. (2006) Principles of Gene manipulation and Genomics (7th edition) Blackwell Publishing.

2. Nicholl, D.S.T. (2008) An introduction to Genetic Engineering (3rd edition) Cambridge University Press.

Reference books:

1. Watson, J.D. (2006) Recombinant DNA (3rd edition) Cold Spring Harbor Laboratory Press.

2. Brown, T.A. (2001) Gene Cloning and DNA Analysis: An Introduction.

3. A PBS Documentary entitled, “Playing God” [History of Genetic Engineering