DEPARTMENT OF BIOCHEMISTRY

B.Sc. (Honours) Biochemistry

(Three Year Full Time Program)

Syllabus for Three Years Bachelor Degree Course

(To be implemented from the Academic Year 2020 onwards)

CHOICE BASED CREDIT SYSTEM (CBCS)

YBNUNIVERSITY

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B.Sc. (Hons.) Biochemistry

Introduction

Biochemistry is the branch of dynamic science that explores the chemical processes within living organisms/ systems. The study of Biochemistry aims to understand how all the molecules that constitute living organisms interact, to maintain and perpetuate life. It deals with the complexity of living organisms, the microscopic and macroscopic structures within organisms that have specific functions and their systems for extracting and transforming energy from the environment. Biochemistry also explains how organisms adapt to their changing environments and gradually evolve.

The teaching of such a dynamic and evolving course is best achieved through **Choice-based Credit System (CBCS)** since it offers opportunities to provide solid foundation in the core discipline, while allowing freedom to students to select discipline specific courses that augment the learning in core courses. This freedom is further reiterated through flexibility in opting courses that enhance specific skills in the discipline as well as selection of courses from other disciplines / departments that widen the scope for higher education and employability. The **Learning Outcome-based Curriculum Framework (LOCF)** built into the CBCS offers focus and purpose to the programme providing a platform for self- evaluation by students and teachers in addition to global assessment by all stakeholders. The combination of LOCF and CBCS also allows for lateral movement of students between institutes of higher learning and offers a level playing field for them across the nation.

1a. Nature and Extent of the B.Sc. (Honours) Programme in Biochemistry

Biochemistry is an interdisciplinary science with areas of overlap with Chemistry, Physics and Mathematics. It is a laboratory based science that acts as a bridge between Biology and Chemistry. It also shares boundaries with other interdisciplinary subjects such as Microbiology, Genetics and Biophysics. This course is designed so as to enable the students to gain theoretical knowledge and hands- on-experience in the laboratory. The course content is aimed at encouraging students to cultivate keen observational skills and to develop the ability to analyze and interpret experimental data, making them suitable for future careers in higher education and employment in industry and research institutes.

1b. Aims of the Programme

The overall objective of the Bachelors (Honours) Programme in Biochemistry is to enable students to learn and integrate foundational knowledge in Biology and Chemistry that is relevant to Biochemistry and thus prepare them for post-graduate education and /or careers in related industries.

The program aims to:

Provide students with scholarly experiences, both theoretical and hands-on, that help instil deep interests in learning the chemistry underlying the working of biological systems while developing broad and balanced knowledge and understanding of key biological concepts, principles and theories. The idea is to equip students with appropriate tools of analysis so that they can independently tackle issues and problems in the field of biology and chemistry. Encourage students to study the structure and function of specific molecules and pathways and their interactions and networking in biological systems with particular emphasis on regulation of chemical reactions in living cells.

Develop in students an inquisitive learning approach to seek answers regarding the complex workings of various physiological systems, cellular multiplication and differentiation and communication within and between cells and organs, and the chemical bases of inheritance and disease.

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

Build concepts in biochemistry that would enable them to undertake further studies in Biochemistry and related areas or in multidisciplinary areas and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

1c. Program Duration, Design and Structure

Duration of the Program:

The BSc Biochemistry course is a three-year degree programme divided into six semesters. Each academic year (July - May) will consist of two semesters. Each semester willbe of fifteen weeks duration with one week designated for teaching break to promote co- curricular and co-scholastic activities.

Program Design:

The program has been designed to offer a variety of discipline specific and interdisciplinary courses disseminated through class-room, laboratory and out-of-classroom modes of teaching, monitored through a repertoire of assessment methods. The teaching- learning process will include theory classes of one hour duration and practical classes of two hour duration for every credit offered. The curriculum will be delivered through various methods including classical chalk and talk, power- point presentations, essay writing and quiz contests, audio and video tools, e-learning and e-content, virtual labs, field trips or educational tours, seminars by external experts, workshops and symposiums and class discussions and debates. The learning outcome will be assessed by direct and indirect methods comprising broadly of Internal Assessment or Continuous Evaluation and End- Semester Examination. The internal assessment will include mid-term written tests, multiple choice questions, home and class assignments, oral presentations (seminars), group tasks, class discussions and debates, essay and report writing. End-semester assessments will include written tests and practical examinations. Each theory paper will carry a maximum of 100 marks, with 25% marks allotted for internal assessment and 75% for end-semester examination. Each practical paper will carrya maximum of 50 marks including experimentation, viva-voce and practical notebook assessment.

Structure of the Programme:

The programme is structured into a variety of courses with different credits, some mandatory while others elective. Broadly, the programme comprises of Core Courses (CC) and elective courses. The core courses are all mandatory courses. The elective courses are of three kinds: Discipline- Specific Elective (DSE), Skill Enhancement Course (SEC) and Generic Elective (GE). The programme also includes two compulsory Ability Enhancement Courses(AEC).

To successfully complete the program, a student must study fourteen Core Courses, four Discipline-Specific Electives, two Skill Enhancement Courses and two compulsory Ability Enhancement Courses. The Core Courses, Discipline-Specific Electives and Generic Electives are six- credit courses. The Skill Enhancement Courses are four-credit courses while the Ability Enhancement Courses are two credit-courses. A student has to earn a minimum of 144 credits to get a degree inB.Sc. (H) Biochemistry.

The six-credit courses will include theory classes of four credits each and practicals of two credits each. The four-credit courses will comprise of two-credit theory classes and two- credit practical courses. However, the two-credit courses will include only theory classes. One credit is equivalent to one-hour lecture per week for theory classes and two-hour sessions for practical classes. Each batch of students for practical sessions will be of fifteen members. If the number of students exceed fifteen (by at least ten), they will be divided into two equal batches.

It is mandatory for students to study two Core Courses each in Semesters I and II, three Core Courses each in Semesters III and IV, and two Core Courses each in Semesters V and VI. The Core Courses will be of six credits each (four credits theory and two credits practicals).

Six courses of Discipline-Specific Electives (DSE) are offered in the programme, of which students will opt any two in each of the Semesters V and VI. The DSE courses will be of six credits each (four credits theory and two credits practicals). A particular DSE course will be offered only if the minimum number of students opting for that course is 10.

Generic Elective (GE) courses for the programme will be offered by other departments of the respective college. Students will elect one GE course each in Semesters I, II, III, and IV. The GE courses will be of six credits each (four credits theory and two credits practicals). The Department of Biochemistry will offer seven GE courses for students of other departments in the respective colleges.

From a list of six Skill Enhancement (SE) courses provided, students will undertake two Skill Enhancement (SE) courses of four credits each in Semesters III and IV. The SE courses will be of four credits each (two credits theory and two credits practicals). The two compulsory Ability Enhancement Courses (AEC), AE1 (Environmental Sciences) and AE2 (English communication), will be of two credits each (theory only). Students will undertake one each in Semesters I and II.

Learning Outcome-based Approach to Curriculum Planning

The learning outcomes-based curriculum framework (LOCF) for a B.Sc. degree in Biochemistry is intended to provide a broad framework within which the biochemistry programme is designed such that it enables students to acquire a skill set that helps them understand and appreciate the field of biochemistry. The structure or design of this framework shall ensure a high standard of the Honours degree in Biochemistry in the University. It shall subsequently pave the way for periodic updation and review of the programme, all within the boundaries of the set framework. This programme specification is intended as a reference point for prospective students, current students, examiners and academic and support staff involved in delivering the programme and enabling student development and achievement.

Program learning outcomes are the central organizing features of student learning. They are developed from the complex interaction of a range of competing and complementary factors. Since program learning outcomes can only be achieved and demonstrated through component courses, course learning outcomes and their assessment are integrally related to program learning outcomes. The LOCF in Biochemistry aims to achieve this important aspect of a modern teaching programme.

Characteristic Attributes of a Graduate in Biochemistry

A graduate in the Biochemistry programme is expected to demonstrate the following attributes:

Disciplinary knowledge and skills: Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in Biochemistry and other related fields of study, including interdisciplinary subfields such as life science in general, medicine and clinical biology, plant sciences, biotechnology, microbiology, nutrition, forensics, bioinformatics and environmental science; (ii) ability touse modern instrumentation for chemical and physical analysis of biological samples.

Critical thinker and problem solver: Ability to employ critical thinking and efficientproblem solving skills in the various areas of biochemistry and relateddisciplines.

Sense of inquiry: Biochemistry being the foundation for understanding all biological processes, a graduate in this discipline is expected to seek deeper knowledge by asking relevant/appropriate questions relating to issues and problems in the field of Biochemistry and related areas. It is also envisaged that the course will empower themwith the ability to plan, execute and report the results of an experiment or investigation.

Research skills: Capable of identifying a scientific problem, preparing/mobilising appropriateresources required for the project, and execute the project through to completion, while observing responsible and ethical scientific conduct; and biosafety and chemical hygiene regulations and practices.

Skilled communicator: Ability to transmit complex technical information relating to biochemistry in a clear and concise manner in both oral and written formats.

Team player/worker: Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.

Digitally literate: Capable of using computers for mining scientific information using modern library search tools from various open source platforms or journals and the ability to use technique specific software to conduct experiments and analyze data. The graduates are expected to be proficient in using computational & visualization tools to study bio-molecular structures, graphing and statistical software to analyze statistical significance of data and report data in the form of graphs, tables or figures.

Ethical awareness: The graduates of this programme will be able to avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism. They will learn to appreciate environmental and sustainability issues and their societal relevance.

Lifelong learners: Capable of self-paced and self-directed learning aimed at personaldevelopment and for improving knowledge/skill development and acquiring fresh skills.

Qualification Description

The qualification descriptors for B.Sc. (Honours) programme in Biochemistry include the following:

A student should demonstrate (i) a comprehensive and coherent understanding of the field of Biochemistry, its applications and links to related disciplinary areas of study; (ii) practical knowledge that enables different types of professions related to the discipline, including research and development, teaching, entrepreneurship as well as industrial research abilities; (iii) skills in areas pertaining to current developments in the academic field of study, including a critical understanding of the latest developments in the field of Biochemistry and an ability to use established techniques of analysis.

Demonstration of a comprehensive knowledge of study material, including current research articles, books and e-books relating to basic and advanced concepts.

Demonstration of skills in collection of relevant data gathered by reading or experimentation and analysis and interpretation of the data using appropriate methodologies.Ability to communicate the results of studies undertaken in an academic field accurately in the form of a paper, oral presentation or report.

Application of disciplinary knowledge and transferable skills to new or unfamiliarproblems and issues and the ability to seek solutions to real-life problems.

Imbibing the ability to function effectively either independently or as a constituent of ateam.

Programme Learning Outcomes (PO)

The curriculum is designed to achieve the following outcomes:

PO1: Inculcate the basic concepts of biochemistry including an understanding of the fundamental biochemical principles and their applications in a systematic, methodical, scientific, evidence-based process. The programme will also provide a general understanding of the related disciplines with a holistic knowledge generation in biological sciences.

PO2: Develop problem solving and analytical skills through case studies, research papers and hands- on-experience, especially integrated into skill enhancement courses.

PO3: Students will gain proficiency in basic laboratory techniques and be able to apply the scientific method to the processes of experimentation, hypothesis testing, data interpretation and logical conclusions.

PO4: Provide requisite knowledge of laboratory safety, data replication and quality control, record keeping and other aspects of "responsible conduct of research".

PO5: Ability to employ modern library search tools to locate and retrieve primary literature on a topic and critically evaluate the literature.

PO6: Students will be able to apply and effectively communicate scientific reasoning and data analysis in both written and oral forms. They will be able to communicate effectively with well- designed posters and slides in talks aimed at scientific audiences as well as the general public.

PO7: Students will learn to work collaboratively in a team.

PO8: Students will gain knowledge of ethical and good laboratory practices, health and biohazard regulations, plagiarism and intellectual property rights related issues practiced in modern era of scientific investigation.

PO9: Graduates will be able to apply the major theories and research procedures to contemporary social problems.

P10: The programme will prepare students to plunge into various fields of higher education or related profession in various disciplines, armed with plethora of knowledge, hands-on- experience andscientific attitude, at national and global levels.

Teaching-learning processes

The foremost effort of teaching is to impart to the students knowledge, factual as well as hypothetical. The manner in which this is communicated to the students determines the success of the teaching process. To be able to see tangible results, it is imperative that the teaching-learning process be bilateral. There are three critical components to the teaching learning process, namely content writing, content delivery and engaging the students to complete the course. A passive flow of information from the teacher to the taught should make way for a vibrant atmosphere of active participation from the students. Teachers participating in the programme would have a well-structured and well-planned lecture ready for the class that should compel the students to concentrate, understand and enjoy the discourse. Students would be encouraged to think independently and ask pertinent questions cultivating out-of-the-box thinking. The link between theory and practical would be made evident, as working with their hands reinforces the concepts first introduced in theory classes.

The traditional chalk and talk method of teaching is simple but very effective. Diagrams or additional material may be shown as slides but with minimum text-rich content. For concepts that are difficult to explain, power point presentations or videos would be used. Some laboratory experiments will be open ended. Students will be divided into small groups to encourage teamwork, healthy competition and to be able to complete the task in stipulated time frames. Students will be taken out of the classroom and into the world of research institutions as well as industries in the form of simple visits or internships or educational tours for maximum benefit. It will help them to correlate what theylearn in the classroom with the real world. Additionally, teachers will use MOODLE platform to create lessons and interact with students to create an open and effective two-way communication channel. Digital initiatives such as the Swayam portal, National digital library and open education resources will be used to greatly facilitate blended learning and flipped class rooms encouraging students to be responsible for learning. Group discussions, debates and scientific talks by external experts will be arranged for facile learning. Students will be encouraged to write comprehensive reviews of papers in a particular topic, reports, essays and short projects to augment their writing skills. Students will also be motivated to deliver seminars to strengthen their oratory skills.

Assessment methods

Assessment methods are the strategies, techniques, tools and instruments for collecting information to determine the extent to which students demonstrate desired learning outcomes. Student learning outcomes cannot be ascertained by single evaluation criteria. A combination of direct and indirect assessments would thus be used. Direct methods of assessment will be used for students to demonstrate their learning while indirect methods will be used to observe students reflect on their learning. Written tests, essays, quiz, presentations and seminars will be used as direct methods of assessment, and indirect methods will include surveys, discussions, debates, participation in scientific meetings and festivals. Embedded assessments, in other words "classroom-based" or "continuous" assessments will be utilized as both a grading instrument as well as data for assessing student learning outcomes. Some examples of assessment methods that will be used are given below:

Method	**Description**	**Direct or Indirect Assessment**
Attendance	Regular participation in class activities (Theory and Practicals)	Indirect
Observations	Information can be collected while observing "events" such as classes, group work, study sessions.	Indirect
Performance	Students can be evaluated on participation in practicals, events, presentations, projects. Encourages public speaking skills.	Direct
Portfolio	Students' work is collected throughout the program which is assessed by faculty using a common scoring guide. Portfolios may contain assignments, reports, class tests, exams, case studies, presentations, practical file record etc.	Direct
Viva Voce or External Review	An interview conducted by external faculty to gauge the depth of theoretical knowledge, clarity, visualization and hands on practical skills of the student. Instills self confidence to face interviews in their future careers.	Indirect
Internally developed class tests	These are shorter tests held periodically through the semester to assess how well the students have grasped the concepts and skills. Also encourages regular attendance.	Direct
Course Exam	A comprehensive written exam given near the end of every 2 semesters to determine a student's acquisition and application of a particular type of knowledge or skill, as well as the ability to Integrate knowledge.	Direct

Structure of B.Sc. (Honours) Biochemistry under CBCS

Core Course

BCHC-1:Molecules of Life
BCHC-2:Cell Biology
BCHC-3:Proteins
BCHC-4:Enzymes
BCHC-5:Metabolism of Carbohydrates and Lipids
BCHC-6:Membrane Biology and Bioenergetics
BCHC-7:Hormone: Biochemistry and Function
BCHC-8:Human Physiology
BCHC-9:Gene Organization, Replication and Repair
BCHC-10:Metabolism of Amino Acids and nucleotides
BCHC-11:Conceptsin Genetics
BCHC-12:GeneExpressionandRegulation
BCHC-13:Genetic Engineering and Biotechnology
BCHC-14:Immunology

Discipline Specific Elective (*Any four*)

BCH DSE-1: Nutritional Biochemistry
BCHDSE-2: Advanced Cell Biology
BCH DSE-3: Microbiology
BCH DSE-4: Molecular Basis of Infectious Diseases
BCH DSE-5: Plant Biochemistry
BCH DSE-6: Advanced Methodologies

Generic Elective (*Any four*)

BCH GE-1: Biomolecules
BCH GE-2: Techniques in Biochemistry
BCH GE-3: Proteins and Enzymes
BCH GE-4: Biochemical Correlation of Diseases
BCH GE-5: Intermediary Metabolism
BCH GE-6: Biochemical Applications in Forensics
BCH GE-7: Recombinant DNA Technology

Ability Enhancement Compulsory Course

AECC-1: English communication
AECC-2: Environmental science

Skill Enhancement Elective Course (*Any two*)

BCH SEC-1: Biochemical Techniques
BCH SEC-2: Biostatistics
BCH SEC-3: Research Methodology
BCHSEC-4: Bioinformatics
BCH SEC-5: Microbial Techniques

SEMESTER-WISE COURSE STRUCTURE of B.Sc. (Honours) Biochemistry

SEMESTER I		SEMESTER II	
C1	Molecules of Life	**C3**	Proteins
C2	Cell Biology	**C4**	Enzymes
AECC1	English/MIL Communication or EVS	**AECC2**	English/MIL Communication or EVS
GE-I	Generic Elective (*Any one*)	**GE-II**	Generic Elective (*Any one*)
	I. Biomolecules (GE-1)		I. Proteins and Enzymes (GE-3)
	II. Techniques in Biochemistry (GE-2)		II. Techniques in Biochemistry (GE-2A)
			III. Biochemical Correlation of Diseases (GE-4)
SEMESTER III		**SEMESTER IV**	
C5	Metabolism of Carbohydrates and Lipids	**C8**	Human Physiology
C6	Membrane Biology and Bioenergetics	**C9**	Gene Organization, Replication and Repair
C7	Hormone: Biochemistry and Function	**C10**	Metabolism of Amino Acids and Nucleotides
SEC-I	Skill Enhancement Course (*Any one*)	**SEC-II**	Skill Enhancement Course (*Any one*)
	I. Biochemical Techniques (SEC-1)		I. Bioinformatics (SEC-4)
	II. Biostatistics (SEC-2)		II. Microbial Techniques (SEC-5)
	III. Research Methodology (SEC-3)		III. Research Methodology (SEC-3A)
GE-III	Generic Elective (*Any one*)	**GE-IV**	Generic Elective (*Any one*)
	I. Intermediary Metabolism (GE-5)		I. Biochemical Correlation of Diseases (GE-4A)
	II. Proteins and Enzymes (GE-3A)		II. Recombinant DNA Technology (GE-7)
	III. Biochemical Applications in Forensics (GE-6)		III. Biochemical Applications in Forensics (GE-6A)
SEMESTER V		**SEMESTER VI**	
C11	Concepts in Genetics	**C13**	Genetic Engineering and Biotechnology
C12	Gene Expression and Regulation	**C14**	Immunology
DSE-I	Discipline Specific Elective (*Any two*)	**DSE-II**	Discipline Specific Elective (*Any two*)
	I. Nutritional Biochemistry (DSE-1)		I. Molecular Basis of Infectious Diseases (DSE-4)
	II. Advanced Cell Biology (DSE-2)		II. Plant Biochemistry (DSE-5)
	III. Microbiology (DSE-3)		III. Advanced Methodologies (DSE-6)

C: Core Courses (14); **GE**: Generic Elective (04); **AECC**: Ability Enhancement Compulsory Course (02); **SEC**: Skill Enhancement Courses (02); **DSE**: Discipline Specific Elective (04). **Numbers within bracket indicate the total number of courses offered in each category.**

Courses containing "A" in their course code are repeated in different semesters.

YBN UNIVERSITY, RANCHI
DEPARTMENT OF BIOCHEMISTRY
B.Sc. (H) Programme in BiochemistryBased on CBCS Pattern)

SEM	COURSE OPTED	COURSE NAME	Distribution of Marks			
			END SEM	MID SEM	PRACTICAL	TOTAL
I	Ability Enhancement Compulsory Course-I	English Communications-I/ Environmental Science-I	50	20	30	100
	Core Course-I	Molecules of Life	50	20	30	100
	Core Course-II	Cell Biology	50	20	30	100
	Generic Elective-1	GE-1	50	20	20	100
II	Ability Enhancement Compulsory Course-II	English Communications-II/ Environmental Science-II	50	20	30	100
	Core Course-III	Proteins	50	20	30	100
	Core Course-IV	Enzymes	50	20	30	100
	Generic Elective-2	GE-2	50	20	30	100
III	Core Course-V	Metabolism of Carbohydrates and Lipids	50	20	30	100
	Core Course-VI	Membrane Biology and Bioenergetics	50	20	30	100
	Core Course-VII	Hormone: Biochemistry and Function	50	20	30	100
	Skill Enhancement Course-1	SEC-1	50	20	30	-
	Generic Elective-3	GE-3	50	20	30	100
IV	Core Course-VIII	Human Physiology	50	20	30	100
	Core Course-IX	Gene organization, replication and repair	50	20	30	100
	Core Course-X	Metabolism of Amino Acids and Nucleotides	50	20	30	100
	Skill Enhancement Course-2	SEC-2	50	20	30	-
	Generic Elective-4	GE-4	50	20	30	100
V	Core Course-XI	Concepts in Genetics	50	20	30	100
	Core Course-XII	Gene expression and regulation	50	20	30	100
	Discipline Specific Elective-1	DSE-1	50	20	30	100
	Discipline Specific Elective-2	DSE-2	50	20	30	100
VI	Core Course-XIII	Genetic Engineering and Biotechnology	50	20	30	100
	Core Course-XIV	Immunology	50	20	30	100
	Discipline Specific Elective-3	DSE-3	50	20	30	100
	Discipline Specific Elective-4	DSE-4	50	20	30	100

SCHEME FOR CHOICE BASED CREDIT SYSTEM

B.Sc. BIOCHEMISTRY

SEMESTER	COURSES OFFERED	COURSE NAME	CREDITS
I	Ability Enhancement Compulsory Course 1	English communication / Environmental Science	2
	Core course 1	Molecules of Life	4
	Core course 1 Practical	Molecules of Life	2
	Core course 2	Cell Biology	4
	Core course 2 Practical	Cell Biology	2
	Genetic Elective 1	GE–1	4
	Generic Elective 1 Practical	GE–1	2
II	Ability Enhancement Compulsory Course 2	English communications/ Environmental Science	2
	Core course 3	Proteins	4
	Core course 3 Practical	Proteins	2
	Core course 4	Enzymes	4
	Core course 4 Practical	Enzymes	2
	Generic Elective – 2	GE-2	4
	Generic Elective – 2 Practical	GE-2	2
III	Core course 5	Metabolism of Carbohydrates and Lipids	4
	Core course 5 Practical	Metabolism of Carbohydrates and Lipids	2
	Core course 6	Membrane Biology and Bioenergetics	4
	Core course 6 Practical	Membrane Biology and Bioenergetics	2
	Core course 7	Hormone: Biochemistry and Function	4
	Core course 7 Practical	Hormone: Biochemistry and Function	2
	Skill Enhancement Course -1	SEC-1	2
	Generic Elective – 3	GE-3	4
	Generic Elective – 3 Practical	GE-3	2
IV	Core course 8	Human Physiology	4
	Core course 8 Practical	Human Physiology	2
	Core course 9	Gene organization, replication and repair	4
	Core course 9 Practical	Gene organization,	2

		replication and repair	
	Core course 10	Metabolism of Amino Acids and Nucleotides	4
	Core course 10 Practical	Metabolism of Amino Acids and Nucleotides	2
	Skill Enhancement Course - 2	SEC-2	2
	Generic Elective - 4	GE-4	4
	Generic Elective - 4 Practical	GE-4	2
V	Core course 11	Concepts in Genetics	4
	Core course 11 Practical	Concepts in Genetics	2
	Core course 12	Gene expression and regulation	4
	Core course 12 Practical	Gene expression and regulation	2
	Discipline Specific Elective-1	BCH DSE-1	4
	Discipline Specific Elective-1 Practical	BCH DSE-1	2
	Discipline Specific Elective-2	BCH DSE-2	4
	Discipline Specific Elective – 2 Practical	BCH DSE-2	2
VI	Core course 13	Genetic Engineering and Biotechnology	4
	Core course 13 Practical	Genetic Engineering and Biotechnology	2
	Core course 14	Immunology	4
	Core course 14 Practical	Immunology	2
	Discipline Specific Elective-3	BCH DSE-3	4
	Discipline Specific Elective-3 Practical	BCH DSE-3	2
	Discipline Specific Elective-4	BCH DSE-4	4
	Discipline Specific Elective-4 Practical	BCH DSE-4	2

Note: 1 Credit is equivalent to 1 hour of teaching per week for theory courses and 2 hourof teaching for practical courses.

Course Structure (Biochemistry-Major) Details of courses under B.Sc. (Honours)

Course	*Credits	
	Theory+ Practical	Theory + Tutorial
I. Core Course		
(14 Papers)	**14×4= 56**	**14×5=70**
Core Course Practical / Tutorial*		
(14 Papers)	**14×2=28**	**14×1=14**
II. Elective Course		
(8 Papers)		
A.1. Discipline Specific Elective	**4×4=16**	**4×5=20 (4 Papers)**
A.2 Discipline Specific Elective		
Practical/Tutorial*	**4×2=8**	**4×1=4**
(4 Papers)		
B.1. Generic Elective/ Interdisciplinary	**4×4=16**	**4×5=20(4Papers)**
Generic Elective		
Practical/ Tutorial*	**4×2=8**	**4×1=4**
(4 Papers)		
III. Ability Enhancement Courses		
1. Ability Enhancement Compulsory		
(2 Papers of 2 credit each)	**2×2=4**	**2×2=4**
Environmental Science		
English/MIL Communication		
2. Ability Enhancement Elective		
(Skill Based) (Minimum 2)	**2×2=4**	**2×2=4**
(2 Papers of 2 credit each)		
Total credit	**140**	**140**

***wherever there is a practical there will be no tutorial and vice-versa.**

COURSE STRUCTURE OF BSc. BIOCHEMISTRY FIRST SEMESTER													
Course Details				**External Assessment**		**Internal Assessment**				**Credit Distribution**			**Allotted Credits**
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3BCH101	Ability Enhancement Course	English communication / Environmental Science	100	50	17	20	07	30	10	2	-	-	2
1Y3BCH102	Core Course-I	Molecules of Life	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH102P	Core Course-I Practical	Molecules of Life	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH103	Core Course-II	Cell Biology	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH103P	Core Course-II Practical	Cell Biology	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH104	Generic Elective-I	GE–1	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH104P	Generic Elective-I Practical	GE–1	30	30	10	-	-	-	-	-	-	2	2
Grand Total		**400**											**20**

Minimum Passing Marks are equivalent to Grade DA
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%
Syllabus of Generic Elective will be as per concerned Department Syllabus

CORE PAPER: B.Sc. (HONOURS) BIOCHEMISTRY
Core Course-I (CC-I)
Molecules of Life (1Y3BCH102)
Semester - I

Course Objectives

The course aims to provide students with an understanding of biomolecules, the basic building blocks of living organisms, focusing on their structural underpinnings, unique properties, biological roles and functions and inter relations. The course will outline the importance of water as a biological solvent and vitamins as vital ingredients of life. Emphasis will be on the associationbetween structure and function of various biomolecules at a chemical level with a biological perspective as well as hands on approach and laboratory techniques.

Course Learning Outcomes

On successful completion of the course students will be:

Acquainted with chemical and molecular foundations of life and appreciate the role of waterin biological systems.
Able to comprehend the structure, function and acid base properties of amino acids.
Introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids.
Aware of the importance of vitamins in biological systems.
Able to independently identify and quantitate various biomolecules in the laboratory.

Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I : The foundations of biochemistry **No. of hours : 6**

Cellular and chemical foundations of life, Water: unique properties, weak interactions in aqueous systems, ionization of water, buffering action in biological system, water as a reactant and fitness of the aqueous environment.

UNIT II: Amino Acids **No. of hours: 8**

Structural features and classification; Physical properties, optical properties (Stereoisomerism); Chemical properties (acid base properties, titration curve) of amino acids; Uncommon amino acids andtheir functions

UNIT III: Carbohydrates and Glycobiology **No. of hours : 16**

Monosaccharides - structure of aldoses and ketoses; Ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers; Structure of biologically important sugar derivatives, oxidation and reduction of sugars; Formation of disaccharides, reducing and non-reducing disaccharides; Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides; Structure and role of glycoconjugates - proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides); Carbohydrates as informational molecules.

UNIT IV: Lipids **No. of hours : 14**

Building blocks of lipids - fatty acids, glycerol, ceramide; Storage lipids - triacyl glycerol andwaxes; Structural lipids in membranes – glycerophospholipids; Galactolipids and sulpholipids, ether lipids3, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids; Lipids as signals, cofactors and pigments.

UNIT V: Nucleic Acids **No. of hours : 10**

Nucleotides - structure and properties of bases, pentoses, nucleosides; Nucleic acid structure – Watson-Crick model of DNA, forms of DNA; Structure of major species of RNA - mRNA, tRNA and rRNA; Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA; Other functions of nucleotides - source of energy, component of coenzymes and second messengers.

Unit VI: Vitamins **No. of hours : 6**

Structure and active forms of water soluble and fat soluble vitamins; Deficiency diseases and symptoms, hyper vitaminosis

Core Course-I (Practical) CC-I (P)
Course Code-1Y3BCH102P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time $1^1/2$ Hrs

Safety measures in laboratories.

Preparation of normal and molar solutions.
Preparation of buffers, phosphate and acetate buffers.
Determination of pKa of acetic acid and glycine.
Qualitative tests for carbohydrates.
Qualitative test for lipids.
Qualitative test for amino acids, proteins.
Qualitative test for nucleic acids.
Separation of amino acids/ sugars/ bases by thin layer chromatography/paper chromatography.
Estimation of vitamin C.

References

Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 /ISBN:10:1-4292-3414-8.
Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M.,John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

CORE PAPER: B.Sc. (HONOURS) BIOCHEMISTRY
Core Course-II (CC-II)
Cell Biology (1Y3BCH103)
Semester I

Course Objective

The objective of this paper is to offer insights into the basic structure nd function of a cell and cellular organelles. The course also aims to impart understanding of cell cycle, cell death, cell renewal processes and various techniques of cell biology.

2.1 Course Learning Outcomes

The objective of this paper is to offer insights into the basic structure nd function of a cell and cellular organelles.
Students will learn about cell theory and basic cell structure
Students will be introduced to cell fractionation and cell visualization techniques Students will gain knowledge about the structure and function of various cell organelles in a eukaryotic cell
Students will get knowledge about the composition of cytoskeleton and extracellular matrix
Students will acquire insight into cell division and cell death mechanisms

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to Cell Biology **No. of hours: 5**

Cell theory, Structure of prokaryotic and eukaryotic cell, exceptions to cell theory, mycoplasma, viruses, viroids, prions, cells as experimental models

UNIT 2: Tools of Cell Biology **No. of hours: 10**

Cell Fractionation techniques: Principle of centrifugation, Sedimentation Coefficient, Differential and Density Gradient (isopycnic and rate zonal) centrifugation. Cell Visualization techniques: Principle of Light microscope, Phase Contrast microscope, Fluorescence microscope, Confocal microscope and Electron microscope; Sample preparation and staining techniques for different kinds of microscopy. Basic principles of identification of sub cellular organelles.

UNIT III: Cell Organelles (structure and function) **No. of hours: 17**

Nucleus: Structure of nuclear envelope, nuclear pore complex nucleolus and chromatin Endoplasmic Reticulum: RER - Brief overview of cotranslational and posttranslational transport of proteins; SER – Lipid synthesis, brief overview of export of proteins from ER Golgi: organization, brief overview of glycosylation of proteins within Golgi, lipid and polysaccharide metabolism in Golgi

Lysosomes: Development of different forms of lysosomes, role in cellular digestion, lysosomal storage diseasesPeroxisomes: assembly, functions (H_2O_2 metabolism, fatty acid oxidation), glyoxysomes
Mitochondria: structure, endosymbiont theory, genome Chloroplast: structure, endosymbiont theory, genome

UNIT IV: Cell Wall, Extracellular Matrix and Cell Junctions **No. of hours: 10**

Prokaryotic and eukaryotic cell wall structure; ECM components – proteins, polysaccharides and adhesion proteins; basic concept of anchoring junctions, tight junctions and communication junctions (gap junctions and plasmodesmata)

UNIT V: Cytoskeleton **No. of hours: 08**

Structure, assembly and function of Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies) Microfilaments: Actin and Myosin Intermediate Filaments: different classes. Role of cytoskeletal elements in the entry of infectious agents

UNIT VI: Cell Cycle, Cell Death and Cell Renewal **No. of hours: 10**

Eukaryotic Cell Cycle, Checkpoints, Cell Division (mitosis and meiosis); Brief overview of apoptosis and necrosis ; Types and potency of Stem Cells, cancer- types , salient features of a transformed cell, causes of cancer. Apoptotic death in relation to cell cycle

Core Course-II (Practical) CC-II (P)
Course Code-1Y3BCH103P

PRACTICALS

CREDIT : 2

TOTAL HOURS: 60
Full Marks: 30
Time $1^1/2$ Hrs

To study the parts of a microscope
Cytochemical staining of proteins by Methylene blue Cytochemical staining of RNA by Methyl Green Pyronin Cytochemical staining ofpolysaccharides by PAS
To study different stages of mitosis by temporary preparation in onion root tip
To study different stages of meiosis by temporary preparation in onion flower buds/grasshopper testes
To study of cell organelles by using electron micrographs
To study of the effect of isotonic, hypotonic and hypertonic solution on cells

2.3 References

The Cell: A Molecular Approach (2013) 6th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0- 87893-300-6.

Additional Resources:

Cell and Molecular Biology: Concepts and Experiments. (2010). Karp, G., 6th ed. John Wiley and Sons. Inc. ISBN: 978-1-118-65322-7

Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

COURSE STRUCTURE OF BSc. BIOCHEMISTRY SECOND SEMESTER													
Course Details				**External Assessment**		**Internal Assessment**				**Credit Distribution**			**Allotted Credits**
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3BCH201	Ability Enhancement Course	English communication / Environmental Science	100	50	17	20	07	30	10	2	-	-	2
1Y3BCH202	Core Course-III	Proteins	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH202P	Core Course-III Practical	Proteins	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH203	Core Course-IV	Enzymes	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH203P	Core Course-IV Practical	Enzymes	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH204	Generic Elective-II	GE-2	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH204P	Generic Elective-II Practical	GE-2	30	30	10	-	-	-	-	-	-	2	2
Grand Total		**400**											**20**

Minimum Passing Marks are equivalent to Grade DA
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%
Syllabus of Generic Elective will be as per concerned Department Syllabus

CORE PAPER: B.Sc. (HONOURS) BIOCHEMISTRY
Core Course-III (CC-III)
Proteins (1Y3BCH202)
Semester II

Course Objectives

The course aims to introduce "proteins" and their importance to modern biochemistry, high lighting their structural features and unique characteristics that help them participate in every physiological process in life, thus also playing important role in disease manifestation and their interventions.

2.1 Course Learning Outcomes

After completion of the course, a student will

Understand the diverse functions of proteins in a cell
Understand the hierarchy of protein architecture– primary, secondary, tertiary & quaternary structure, with the ability to distinguish features of globular & fibrous proteins
Be able to comprehend the fundamental mechanisms of protein folding and stability and their relation to conformational diseases
Be able to describe and discuss the separation and purification techniques used in protein chemistry
Learn to access and use the databases related to protein sequence and structure
Understand specialized proteins like membrane proteins, defense proteins and motorproteins
Gain comprehension of structure-function relationship of proteins and their significance in physiology, diseases and applications in industry and medicine.

2.2. Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to amino acids, peptides and proteins **No. of hours: 4**

Amino acids and their properties - hydrophobic, polar and charged. Multimeric proteins, Conjugated proteins and Metallo-proteins. Diversity of peptide and protein function and their applications. Solid phase peptide synthesis.

UNIT II: Hierarchy of protein structure **No. of hours: 18**

Organization of protein structure into primary, secondary, tertiary and quaternary structures. N-terminal and C-terminal amino acid analysis. Sequencing techniques - Edman degradation.Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Forces stabilizing the protein structure - covalent and non-covalent. Importance of primary structure in protein folding. The peptide bond, dihedral angles psi and phi, helices, sheets and turns, Ramachandran map. Motifs and domains. Structures of myoglobin and haemoglobin, α-keratin, silk fibroin, collagen.

UNIT III: Protein folding and conformational diseases **No. of hours: 6**

Denaturation and renaturation of Ribonuclease A – discovery of protein folding. Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases associated with misfolding –Alzheimer's and Prion based.

UNIT IV: Specialized proteins **No. of hours: 10**

Transport protein: Haemoglobin -Oxygen binding curves, influence of 2,3-BPG, CO2 and H^+ Cooperativity between subunits and models to explain the phenomena - concerted and sequential models. Haemoglobin disorders-sickle cell anemia, thalassemias. Motor proteins- Actin and myosin. Defense proteins- Antibodies, Membrane proteins- Integral and membrane associated proteins. Hydropathy plots to predict transmembrane domains.

UNIT V: Extraction, purification and characterization of proteins **No. of hours: 18**

Solubilization of proteins from their cellular and extracellular locations. Use of mechanical and chemical methods, homogenization, ultrasonication, French press and centrifugation. Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization Ion- exchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC and FPLC. Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient. IEF, SDS-PAGE and 2-D electrophoresis.

UNIT VI: Introduction to Protein Databases **No. of hours: 4**

Introduction to protein sequence and structure databases (UNIPROT, SWISS-PROT & PDB),Protein sequence file Format (FASTA) and Visualization softwares.

Core Course-III (Practical) CC-III (P)
Course Code-1Y3BCH202P

PRACTICALS
CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time 1 1/2 Hrs

Estimation of proteins using UV-absorbance and Biuret method.Estimation of proteins using Lowry/Bradford method.
Isoelectric pH of casein.
Ammonium sulphate fractionation of proteins.
Separation of proteins using anion-exchange chromatography.SDS-PAGE analysis of proteins.
Molecular Visualization Softwares: Pymol and Rasmol for protein structures fromPDB

2.3 References

Biochemistry 5th Edition Jeremy M Berg, John L Tymoczko, and LubertStryer, New York: W H Freeman; 2002. ISBN-10:0-7167-3051

Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, D.L., and Cox, M.M. W.H.Freemand company, ISBN13: 9781464126116, ISBN10: 1464126119

Biochemistry 4th edition Donald Voet and Judith G Voet , ISBN: 9781118025024,1118025024

Protein Structure and function by David Whitford, Wiley ISBN-13: 978-047149894ISBN-10: 0471498947

Principles of protein structure. **Schulz**, G.E., **Schirmer**, R.H. Springer, ISBN 978-1-4612-6137-7

The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd Protein Purification.

Principles and Practice. Robert K Scopes, Springer, ISBN 978-1-4737-2333-5

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

CORE PAPER: B.Sc. (HONOURS) BIOCHEMISTRY
Core Course-IV (CC-IV)
Enzymes (1Y3BCH203)
Semester - II

Course Objectives

The objective of the course is to provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life, so as to develop an understanding of enzyme kinetics, mechanism of enzyme action and their regulation. The course also aims to outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry.

Course Learning Outcomes

Students will learn the nature and importance of enzymes in living systems

Students will gain insight into the thermodynamic and molecular basis of catalysis byenzymes and the underlying basis of their specificity

Students will learn about the mechanisms of enzyme action, kinetics of enzymecatalyzed reactions and clinical importance of enzyme inhibitors

Students will also learn to appreciate how enzymes are regulated and thephysiological importance of enzyme regulation in the cell

The course will introduce students to the applications of enzymes in research andmedicine as well as in industry, which will bolster their foray into industrial and biomedical research.

Course ContentsTHEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to enzymes and features of catalysis **No. of hours: 8**

General characteristics of enzymes; nature of enzymes - protein and non-protein (ribozymes – RNaseP, self-splicing introns, abzymes).Co-factor and prosthetic group, apoenzyme, holoenzyme. Classification and nomenclature of enzymes. Enzyme assays-discontinuous,continuous, coupled assays; Enzyme activity, specific activity, units to express enzyme activity. Features of enzyme catalysis, factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory. Catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

UNIT II: Enzyme kinetics **No. of hours: 12**

Relationship between initial velocity and substrate concentration, equilibrium constant, steady state kinetics, mono-substrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Determination of KM and Vmax, Kcat, specificity constant. Effect of pH and temperature on the activity of enzymes. Types of bisubstrate reactions (sequential – ordered and random, ping pong reactions), examples. Differentiating bi- substrate mechanisms (diagnostic plots, isotope exchange).

UNIT III: Enzyme inhibition **No. of hours: 8**

Reversible inhibition (competitive, uncompetitive, non-competitive and mixed) and irreversible inhibition. Substrate inhibition. Structural analogs (allopurinol, methotrexate and trimethoprim). Mechanism based inhibitors (β-lactam antibiotics, difluoromethyl ornithine), clinical importance of enzyme inhibitors.

UNIT IV: Mechanism of action of enzymes **No. of hours: 12**

General features - proximity and orientation, strain and distortion, acid-base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues. Coenzymes in enzyme catalyzed reactions. Structure, vitamin precursors, types of reaction involved in: TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate and lipoic acid.

UNIT V: Regulation of enzyme activity No. of hours: 10

Control of activities of single enzymes and metabolic pathways, feedback inhibition, allosteric modulation (aspartate transcarbamylase), regulation by reversible covalent modification (glycogen phosphorylase and glycogen synthase). Proteolytic cleavage (zymogens- chymotrypsinogen, trypsinogen, procaspases)**.** Regulation of multi-enzyme complex, properties (pyruvate dehydrogenase). Isoenzymes - properties and physiological significance (lactate dehydrogenase, hexokinase and glucokinase).

UNIT VI: Applications of enzymes No. of hours: 10

Enzymes as reagents (glucose oxidase, cholesterol oxidase);Marker enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases);Enzyme linked immunoassay(ALP and HRP);Enzyme therapy (streptokinase);Enzymes in research (Taq polymerase, restriction endonucleases). Immobilized enzymes and industrial applications of enzymes.

Core Course – IV (Practical) CC-IV (P)
Course Code- 1Y3BCH203P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time $1^1/2$ Hrs

Partial purification of an enzyme using bulk methods or chromatographyAssay to determine enzyme activity and specific activity
Progress curve plot for an enzyme
Effect of pH/temperature on enzyme activity Determination of KM and Vmax using Lineweaver-Burk plotCalculation of inhibitory constant (Ki) for an enzyme Continuous assay of an enzyme

References

Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 /ISBN:10:1-4292-3414-8.
Biochemistry (2019) 9th ed., Stryer, L., Berg J., Tymoczko J., Gatto G., W.H. Freeman(New York), ISBN-13: 9781319114671
Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., OxfordUniversity Press Inc. (New York), ISBN:0 19 850229 X.

Additional Resources:

Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons AsiaPvt. Ltd. (New Jersey), ISBN:978-1180-25024.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

COURSE STRUCTURE OF B.Sc. BIOCHEMISTRY THIRD SEMESTER													
Course Details				**External Assessment**		**Internal Assessment**				**Credit Distribution**			**Allotted Credits**
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3BCH301	Core Course V	Metabolism of Carbohydrates and Lipids	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH301P	Core Course-V Practical	Metabolism of Carbohydrates and Lipids	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH302	Core Course-VI	Membrane Biology and Bioenergetics	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH302P	Core Course-VI Practical	Membrane Biology and Bioenergetics	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH302	Core Course-VII	Hormone: Biochemistry and Function	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH303P	Core Course-VII Practical	Hormone: Biochemistry and Function	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH304	Skill Enhancement Course- I	SEC-1	70	50	17	-	-	20	07	1	-	-	1
1Y3BCH304P	Skill Enhancement Course- I Practical	SEC-1	30	30	10	-	-	-	-	-	-	1	
1Y3BCH305	**Generic** Elective Elective- III	GE-3	70	50	17	-				4	-	-	4
1Y3BCH305P	Generic Elective-III Practical	GE-3	30	30	10	-	-	20	07	-	-	2	2
Grand Total	**500**												**26**

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%
Syllabus of Generic Elective will be as per concerned Department Syllabus

Core Course: B.Sc. (HONOURS) BIOCHEMISTRY

Core Course – 5 (CC-5)
Metabolism of Carbohydrates and Lipids (1Y3BCH301)
Semester - III

Course Objective

The objective of this course is to provide an understanding of metabolism of carbohydrates and lipids, the enzymes involved in various metabolic pathways and regulation of metabolism in cells. The course also aims to outline the importance of such pathways in relation to metabolic defects.

2.1 Course Learning Outcomes

The learners will be able to:

Understand the concepts of metabolism, characteristics of metabolic pathways andstrategies used to study these pathways.
Gain a detailed knowledge of various catabolic and anabolic pathways
Understand the regulation of various pathways
Gain knowledge about the diseases caused by defects in metabolism with emphasis onthe metabolic control

2.2Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Glycolysis, and pentose phosphate pathway **No of hours: 12**

Autotrophs, Heterotrophs, catabolism, anabolism, metabolic pathways, ATP as energy currency, experimental approaches to study metabolism, High energy compounds. Glycolysis: overview, reactions, regulations including hormones, fates of pyruvate, feeder pathways for glycolysis, galactosemia. Lactose intolerance. Cori and Cori cycle. Pentose phosphate pathway and its importance, Relationship between glycolysis and pentose phosphate pathway. Anaerobic ATP production, fermentation.

UNIT II: Additional pathways in carbohydrate metabolism **No of hours: 12**

Glycogen synthesis, glycogen breakdown, regulation of glycogen metabolism, gluconeogenesis. glycogen storage diseases; Von Gierke, Pompe, Cori and McArdle. Gluconeogenesis. Photosynthesis dark reaction: Calvin cycle, regulation, Photo respiration, C4 and CAM pathways in plants.

UNIT III: Citric acid cycle **No of hours: 10**

Overview of citric acid cycle, synthesis of acetyl Coenzyme A, enzymes of citric acid cycle, regulation of citric acid cycle, anaplerotic reactions, amphibolic nature, Malate aspartate shuttle, Glyceraldehyde 3 phosphate dehydrogenase shuttle, Glyoxylate cycle in plants. Signaling pathways, regulation of carbohydrate metabolism by hormones, diseases associatedwith metabolic irregularities.

UNIT IV: Degradation of lipids **No of hours: 10**

Lipid digestion, absorption and transport. Fatty acid oxidation: transport to mitochondria, activation of fatty acids, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal β oxidation, ω oxidation and a oxidation. Ketone-body metabolism.

UNIT V: Synthesis of lipids **No of hours: 10**

Transport of mitochondrial Acetyl Co A to cytosol, Fatty acid synthase complex enzyme. Synthesis of saturated, unsaturated, odd and even chain fatty acids, regulation of fatty acid metabolism. Synthesis of glycerophospholipids and sphingolipids. Cholesterol metabolism, diseases associated with abnormal lipid metabolism.

UNIT VI: Regulation of metabolism **No of hours: 06**

Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis.

Core Course -5 (Practical) CC- V (P) Course
Code – 1Y3BCH301P

PRACTICALS

CREDIT : 2 **TOTAL HOURS : 60**
Full Marks:30
Time $1^1/2$ Hrs

Estimation of blood glucose.
Sugar fermentation by microorganisms.
Assay of salivary amylase.
Isolation of lipids from egg yolk and separation by TLC.
Cholesterol estimation.

2.3 References

Lehringer's Principles of Biochemistry (2019), Nelson, D.L. and Cox, M.M., W.H.Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN-13: 978-1429234146 ISBN-10: 9781429234146
Textbook of Biochemistry with Clinical Correlation,7th Edition. Textbook of Biochemistry 7th Edition. Thomas M. Devlin (Editor). ISBN: 978-0-470-28173-4
Biochemistry (2013) 4th ed.,Voet, Donald,Voet, Judith &Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

CORE PAPER: B.Sc. (HONOURS) BIOCHEMISTRY
Core Course – 6 (CC-6)
Membrane Biology and Bioenergetics (1Y3BCH302)
Semester III

Course Objective

The objective of the course is to provide students with:

Knowledge of membrane composition, structure-function relationship and properties.
Understanding of mechanism of membrane transport
Knowledge of basics of Bioenergetics and mechanisms of oxidative phosphorylation and photophosphorylation.

Course Learning Outcomes

On successful completion of the course, students will:

Understand the general composition and structure of biomembranes.
Understand the basic properties of membranes such as membrane fluidity.
Have knowledge about the various types of membrane transport mechanisms.
Understand the basic tenets of Bioenergetics.
Understand the concept of chemiosmotic theory and the mechanism of Oxidative phosphorylation and ATP synthesis**.**
Understand the basic mechanisms of photophosphorylation in plants and microbes.

Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Membrane composition and structure **No. of hours: 12**

Historical background and various membrane models. Overview of membrane functions. Composition of membranes: Lipids -Phospholipids, Glycolipids, sterols, Proteins - Peripheral Proteins, Integral Membrane Proteins and Lipid-Anchored proteins, and carbohydrates. Comparison of the composition of various cellular and subcellular membranes. Lateral and transverse asymmetry in membranes. Role of Flippase, Floppase and Scramblase. Model systems to study membranes - Model systems to study membranes - Lipid Monolayers, Planar Bilayer and Liposome, and their application. Polymorphic Lipid–Water Systems. The various determinants of polymorphic phases: CMC, lipid shape, critical packing parameter. Membrane Fusion: Mechanism of Entry of Enveloped Animal Viruses

UNIT II: Membrane dynamics **No. of hours: 8**

Membrane fluidity: lateral, transverse and rotational motion of lipids and proteins. Factors affecting membrane fluidity- composition, barriers (tight junctions), cytoskeleton interactions, microdomains – rafts, caveolae. Fence and gate model. Study of RBC membrane architecture. Homeoviscous Adaptation. Techniques to study membrane dynamics: FRAP,TNBS, SPT.

UNIT III: Membrane transport **No. of hours: 12**

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport- glucose transporter and anion transporter. Primary active transporters- P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na+ - glucose symporter. ABC family of transporters – MDR and CFTR. Group translocation and bacteriorhodopsin. Ion channels: voltage-gated ion channels (Na+ /K+ voltage-gated channel) and ligand-gated ion channels (acetyl choline receptor), and aquaporins. Ionophores: valinomycin, gramicidin. Relationship of membrane transport and diseases.

UNIT IV: Introduction to Bioenergetics **No. of hours: 8**

Laws of thermodynamics. Concept of state functions, free energy change, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, and phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, PEP, 13 BPG and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

UNIT V: Oxidative phosphorylation **No. of hours: 10**

The electron transport chain - its organization and function. Peter Mitchell's chemiosmotic hypothesis and Proton motive force. FoF1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis Alternative respiratorypathways in plants.

UNIT VI: Photophosphorylation **No. of hours: 10**

General features of photophosphorylation, historical background and Hill's reaction. Role of photosynthetic pigments and light harvesting systems in plants and microbes. Bacterial photophosphorylation in purple bacteria and Green sulfur bacteria. Photophosphorylation in plants. Molecular architecture of Photosystem I and Photosystem II. The Z-scheme of photosynthetic electron flow. Cyclic photophosphorylation and its significance.

Core Course – 6 (Practical) CC-6 (P) Course
Code – 1Y3BCH302P

PRACTICALS

CREDIT:2 **TOTAL HOURS: 60**
Full Marks:30
Time: $1^1/2$ Hrs

Effect of lipid composition on the permeability of a lipid monolayer.
Determination of CMC of detergents.
Preparation of RBC ghost cell.
Study the photosynthetic O2 evolution in hydrilla plant.
Isolation of chloroplast from spinach leaves and estimation of chlorophyll content.
Study the Hill reaction by using artificial electron acceptor.
Separation of photosynthetic pigments by TLC. Separation of
RBC membrane proteins by SDS-PAGE.
Isolation of mitochondria from liver and assay of marker enzyme SDH.

References

Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.

Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2.

Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning(Boston), ISBN-13:978-0-495-11464-2.

Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., JohnWiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2

Additional Resources:

Molecular cell Biology (2016) 8th ed., Lodish, H., Berk, A., Kaiser, C. A., et al. W.H.Freeman, ISBN-13: 978-1464183393 ISBN-10: 1464183392

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

CORE PAPER: B.Sc. (HONOURS) BIOCHEMISTRY

Core Course-7 (CC-7)
Hormone: Biochemistry and Function (1Y3BCH 303)
Semester - III

Course Objective

The course is designed to provide an understanding of the process of cellular communication including signal reception, transduction, amplification and response. It imparts an understanding of the different endocrine factors that regulate metabolism, growth, ionic homeostasis, glucose homeostasis and reproductive function

2.1 Course Learning Outcomes

On successful completion of the course, a student will:

Understand and appreciate the different cognate and non-cognate modes of communication between cells in a multi-cellular organism
Understand the role of endocrine system in maintaining ionic and glucosehomeostasis
Should be able to describe molecular, biochemical and physiological effects of allhormones and factors on cells and tissues.
Understand the integrative communications that regulate, growth, appetite,metabolism and reproduction

2.2Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to Endocrinology and Cellular signaling **No of hours: 17**

Functions of hormones and their regulation. Chemical signalling - endocrine, paracrine,autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. Generalintroduction to Endocrine methodology.

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP3, DAG, Ca2+, Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin and Ras - MAP kinase cascade. Non receptor tyrosine kinase-erythropoietin receptor JAK - STAT pathway. Steroid hormone Receptor. Receptor regulation and cross talk.

UNIT II: Hypothalamic- hypophysial system: **No. of hours: 5**

Hypothalamic - Pituitary axis: anatomy, histology, vasculature and secretions. Physiological and biochemical actions of hypothalamic hormones and Anterior pituitary hormones;

Hormone feed- back regulatory cascade. Posterior pituitary hormones –structure, physiologyand biochemical actions of AVP and Oxytocin; Diabetes insipidus.

UNIT III: Hormones regulating Metabolism, Calcium homeostasis and Growth: **No. of hours: 14**

Thyroid gland- Histology; Biosynthesis of thyroid hormone and its regulation: Role of TRH and TSH in T4 synthesis and response. Physiological and biochemical action of Thyroxine. Pathophysiology of thyroxine secretion: Hyper and hypothyroidism, Goitre, Graves' disease, Cretinism, Myxoedema.
Regulation of calcium homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca2+ regulation and Pathways involving bone, skin, liver, gut and kidneys.
Pathophysiology - rickets, osteomalacia, osteoporosis.
Regulation of Growth: growth hormone and somatomedin, Endocrine disorders - gigantism, acromegaly, dwarfism, pygmies. Physiology and biochemical actions of Growth factors- EGF, PDGF and EPO

UNIT IV: Hormones of the adrenals: **No. of hours: 8**

Histology of Adrenal Gland. Physiology and action of Aldosterone; the Renin Angiotensin System. Physiology and Biochemical actions of Cortisol. Regulation of cortisol synthesis: POMC and CRH. Adrenal medullary Hormones: Epinephrine and Norepinephrine. The Fight or flight response; Dual receptor hypothesis. General adaptation syndrome: acute and chronicstress response. Pathophysiology – Addison's disease, Conn'ssyndrome, Cushing syndrome.

UNIT V: Pancreatic and GI tract hormones: **No. of hours: 10**

Cells involved in release of gastrointestinal hormones; the gastrin family of hormones and CCK: the secretin family of hormones; Incretins; Ghrelin; Summary of hormone metabolite control of GI function. Hormones of the Pancreas: Structure, synthesis, physiology and biochemical actions of insulin and glucagon. Adipocyte hormones: Adiponectin and leptin; Appetite and satiety control. Pathophysiology - . Type I and type II Diabetes mellitus, Obesity and Metabolic syndrome.

UNIT VI: Reproductive hormones: **No. of hours: 6**

Male and female sex hormones. Interplay of hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone based contraception. Understand conditions like ammenorrhea, menorrhagia, PMS, PCOS, Menopause

Core Course- 7 (Practical) CC-7(P)
Course Code – 1Y3BCH303P

PRACTICALS

CREDIT: 2 **TOTAL HOURS: 60**
Full Marks:30
Time: $1^1/2$ Hrs

Glucose tolerance test.
Estimation of serum Ca^{2+} .
Estimation of serum T4
HCG based pregnancy test.
Estimation of serum electrolytes.
Case studies.

2.3 References

Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0- 87893-300

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

COURSE STRUCTURE OF BSc. BIOCHEMISTRY FOURTH SEMESTER													
Course Details				**External Assessment**		**Internal Assessment**				**Credit Distribution**			**Allotted Credits**
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3BCH401	Core Course VIII	Human Physiology	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH401P	Core Course-VIII Practical	Human Physiology	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH402	Core Course-IX	Gene organization replication & repair	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH402P	Core Course-IX Practical	Gene organization replication & repair	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH403	Core Course-X	Metabolism of Amino Acids & Nucleotides	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH403P	Core Course-X Practical	Metabolism of Amino Acids & Nucleotides	30	30	10	-	-	-	-	-	-	2	2
1Y3BCH404	Skill Enhancement Course- II	SEC-2	70	50	17	-	-	20	07	1	-	-	1
1Y3BCH404P	Skill Enhancement Course- II Practical	SEC-2	30	30	10	-	-	-	-	-	-	1	1
1Y3BCH405	Generic Elective Elective- IV	GE-4	70	50	17	Generic Elective-IV Practical		20	07	4	-	-	4
1Y3BCH405P	Generic Elective- IV Practical	GE-4	30	30	10	Generic Elective-IV Practical		20	07	-	-	2	2
Grand Total	**500**												**26**

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%
Syllabus of Generic Elective will be as per concerned Department Syllabus

CORE PAPER: B.Sc. (HONOURS) BIOCHEMISTRY

Core Course -8 (CC-8)

Human Physiology (1Y3BCH401)

Semester - IV

Course Objectives:

The objective of the course in human physiology is to provide a comprehensive study of the molecular and cellular mechanisms that govern the integrative working and regulation of the various organ systems in the human body. The course will provide a foundation of the physiological principles and the application of the same in real-life situations. It also outlines the factors and biochemical events that disrupt homeostasis leading to pathophysiology. The course will prepare students for higher education in any field related to molecular medicine.

Course Learning Outcomes:

On successful completion of this core paper, students should be able to:

Understand the basic organization and homeostatic control of the human body from the cell itself to organ systems and the functioning of the whole body.

Comprehend and appreciate the importance of the fluid components of the body in regulating and connecting the various organ systems; particularly the heart and vascular system.

Appreciate and understand the biochemical, molecular and cellular events that orchestrate the coordinate working of the organ systems that regulate life processes. Get a holistic understanding of the different organ systems with respect to their basic functioning, which involves both integrative learning and the regulatory roles of the Nervous and Endocrine system.

Develop in students an inquisitive learning approach to seek answers regarding the complex workings of brain.

Understand the factors that cause an imbalance to the Homeostatic control in the body and how these lead to disorders and diseases.

Perform and analyze various physiological tests that examine the function of various systems of the human body.

Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to Human body and Understanding Homeostasis No. of hours: 3

Physiology: overview and definition, levels of structural organization, organ system. Body fluid compartments: intracellular, extracellular and interstitial fluid. Homeostasis: definition and control mechanisms (negative and positive feedback mechanisms).

UNIT II: Blood, Heart and Circulation: No. of hours: 16

Components of blood: Plasma - Composition, SPE - electrophoretic pattern of serum proteins, major plasma proteins and their role, Erythrocytes- erythropoiesis, function and metabolism, Leukocytes, Platelets- structure and function; Hemostasis and its molecular mechanism, role of platelets in coagulation, role of vitamin K in coagulation, Anticlotting and fibrinolytic systems. Anemias: definition and types (Hemolytic, hemorrhagic, megaloblast, pernicious, iron deficiency and aplastic anemia), polycythemia, Hemophilia and Thrombosis.
Anatomy of heart. Automacity of the cardiac muscle conducting fibres; Physiology of cardiac contracting muscle fibres, Relationship between cardiac cycle, heart sound, ventricular volumes and the ECG. Control of Heart rate and stroke volume. The vascular system:Arteries, arterial blood pressure and its measurement, Capillaries and bulk flow across the capillary walls, Veins and determination of venous pressure. Regulation of systemic arterial pressure. Long term and short-term regulation of cardiac efficiency and blood pressure. Hypertension, congestive heart disease, atherosclerosis, Heart failure and myocardial infarction.

UNIT III: Life Processes: **No. of hours: 22**

Respiratory Physiology

Organization of the pulmonary system, site of gas exchange, Ventilation and lung mechanics. Inspiration, Expiration, Lung compliance and its determinants. Lung Volumes and Capacities. Transport of oxygen and carbon dioxide in blood. Haldane and Bohr's effect. Transport of hydrogen ions between tissues and lungs. Control of respiration. Hering-Breuer reflex. Asthma, Chronic Obstructive Pulmonary Disease (COPD), Hypoxia, Emphysema.

Renal physiology

Anatomy of the kidney and the nephron. Regulation of renal blood flow. Cell biology of the Bowmans' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Micturition. Regulation of ion and water balance. Urine concentration: The counter current multiplier system. Blood buffer systems, renal responses to acidosis and alkalosis. Assessment of kidney function. Glomerular nephritis. Dialysis: Hemodialysis and peritoneal dialysis. Diuretics.

Gastrointestinal and hepatic physiology

Histology of the gastrointestinal tract. Propulsion and motility of food and digested material.Enteric reflexes. Secretory functions of the gastrointestinal tract, digestion and absorption ofmacronutrients and micronutrients. Peptic ulcer, Sprue, Celiac disease, IBD, regurgitation.
Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile. Enterohepatic cycle, detoxification in liver. Jaundice, liver cirrhosis and fatty liver.

UNIT IV: Muscle **No. of hours: 04**

Structure of Skeletal, smooth and cardiac muscle, Molecular mechanisms of skeletal muscle contraction: role of troponin, tropomyosin, and calcium in contraction, excitation-contraction coupling. Smooth muscle contraction and its control. Excitation-contraction coupling incardiac muscle.

UNIT V: Reproductive Physiology: **No. of hours: 06**

Sex determination and differentiation. Development of female and male genital tracts. Oogenesis, Spermatogenesis, capacitation and transport of sperm, blood-testis barrier.Fertilization. Early development, Implantation. Placentation and Parturition.

UNIT VI: Neurophysiology: **No. of hours: 09**

Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. Structure and maintenance of neurons. Functional classes of neurons. Membrane potentials: Resting Membrane Potential, Graded potentials, Action potential. Synapse: excitatory and inhibitory. Temporal and spatial summation. Neurotransmitters and neuromodulators (definition with examples). Somatic sensation: definition and cellular pathways of pain transmission and modulation. Physiology of EEG, sleep.

Core Course – 8 (Practical) CC- 8 (P)
Course Code – 1Y3BCH401P

PRACTICALS

CREDITS: 2

TOTAL HOURS: 60
Full Marks: 30
Time: $1^1/2$ Hrs

Hematology:

Packed Cell Volume, Bleeding Time and Clotting time. Preparation of blood smear and Differential leucocyte count.
Enumeration of Blood cells: RBC and WBC counting, Calculation of blood Indices.
Estimation of hemoglobin

Determination of total iron binding capacity.
Pulmonary function tests, spirometry and measurement of blood pressure.Separation of isoenzymes of LDH by electrophoresis.
Case studies: Renal clearance, ECG, LFT, EEG (any two)

References

Vander's Human Physiology (2019) 15th edition ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publication (New York), ISBN: **:** 978-1259903885
Human Physiology (2018) 15th ed., Stuart Ira Fox., McGraw Hill International Publications, (New York) ISBN 978-1259864629.

Additional Resources

Textbook of Medical Physiology (2016) 13th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd.(New Delhi).ISBN:978-1455770052
Introduction to Human Physiology (2012) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

Core Course B.Sc. (HONOURS) BIOCHEMISTRY
Core Course -9 (CC-9)
Gene Organization, Replication and Repair (1Y3BCH402)

Semester - IV

Course Objective

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides comprehensive understanding of DNA replication, recombination, mutations and repair processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

Course Learning Outcomes

Students will acquire basic information about the structure of DNA and various forms of DNA, about organization of genome in various life forms, super coiling of DNA and its significance Students will learn about the molecular basis of processes like DNA replication, recombination and transposition and understand the significance of these processes Students will learn about the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage

Course Contents

THEORY

CREDIT : 4 **TOTAL HOURS: 60**

UNIT I: Structure of DNA **No. of hours: 10**

Building blocks of DNA structure, Watson and Crick model, features of the double helix, various forms of DNA, denaturation and renaturation of DNA, hyperchromicity, melting temperature, factors affecting Tm of DNA molecules. Supercoiling of DNA, linking number, topoisomerases and their classification. Topoisomerase inhibitors and their clinical importance.

UNIT II: Genes and genomic organization **No. of hours: 10**

Definition of a gene, organization of genes in viruses, bacteria and eukaryotes, concept of split genes, introns, exons, satellite DNA, highly repetitive DNA, centromere and telomere sequences. Nucleosome structure and packaging of DNA into higher order structures.

UNIT III: Replication of DNA **No. of hours: 16**

General features of replication, the chemistry of DNA synthesis, DNA polymerase, ther eplication fork, enzymes and proteins in DNA replication, E coli DNA polymerases, stages of replication-initiation, elongation and termination, origin of replication, relationship between replication and cell division, replication in eukaryotes, end replication problem, telomerase, various modes of replication. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine.

UNIT IV: Recombination and transposition of DNA **No. of hours: 12**

Homologous recombination, biological role and models for homologous recombination, proteins and enzymes in homologous recombination, site-specific recombination, serine and tyrosine recombinases. Transposition, the three classes of transposable elements-DNA transposons, virus-like retrotransposons and poly-A retrotransposons. DNA transposition by cut and paste and replicative mechanism.

UNIT V: Molecular basis of mutations **No. of hours : 6**

Importance of mutations in evolution of species. Types of mutations - transition, transversion, frame shift mutations. DNA damage by hydrolysis, alkylation, oxidation and radiation. Mutations caused by base analogs and intercalating agents. Ames test.

UNIT VI: Various modes of DNA repair **No. of hours : 6**

Replication errors and their repair, mismatch repair system. Repair of DNA damage-direct reversal of DNA damage, base excision repair, nucleotide excision repair, recombination repair, trans-lesion DNA synthesis. DNA repair and diseases.

Core Course – 9 (Practical) CC-9 (P) Course
Code -1Y3BCH402P

PRACTICALS

CREDITS : 2 **TOTAL HOURS : 60**
Full Marks: 30
Time: $1^{1}/2$ Hrs

To hydrolyze DNA and separate nucleotide bases by paper chromatography
To plot ultraviolet absorption spectrum of DNA
Determination of DNA concentration by A260nm
Determination of the melting temperature
Isolation of chromosomal DNA from *E coli* cells

References

Watson: Molecular Biology of the Gene (2008) 7th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN:978-0-321-50781-5.

Lehringer: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W. H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

CORE COURSE: B.Sc. (HONOURS) BIOCHEMISTRY
Core Course – 10 (CC-10)
Metabolism of Amino Acids and Nucleotides (1Y3BCH403)
Semester - IV

Course Objective

The main objective of the course is to offer detailed and comprehensive knowledge about the synthesis and degradation pathways of amino acids and nucleotides and their importance in the proper functioning of the cells. This course also interrelates the metabolismof these molecules with respect to health diseases in addition to providing overview of inhibitors of metabolism for treating the diseases of metabolic disorders.

Course Learning Outcomes

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

Extend their school level concepts of nitrogen cycle to understand the mechanism bywhich nitrogen is fixed by microbes and how it's incorporation in diet is critical to human nutrition as well as comprehend the mechanism by which ammonia is incorporated in biomolecules
Systematically learn the breakdown and synthesis of amino acids and nucleotides inhumans and recognize its relevance with respect to nutrition and human diseases
Gain knowledge of how amino acids are converted into a variety of precursors Acknowledge the role of inhibitors of nucleotide metabolism which are potentiallybeing used as chemotherapeutic drugs
Comprehend how theamino acid and nucleotide metabolism are integrated withcarbohydrate and lipid metabolism

Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Overview of Nitrogen metabolism and Amino Acid Metabolism No. of hours: 8

Nitrogen cycle, incorporation of ammonia into biomolecules. Digestion and absorption of dietary proteins. Role of essential and non-essential amino acids in growth and development. Protein calorie malnutrition - Kwashiorkar and Marasmus, Nitrogen balance. Metabolic fates of amino groups. Transamination, role of pyridoxal phosphate, glucose-alanine cycle, Kreb's bicycle, urea cycle, its regulation and inherited defects of urea cycle. Gamaglutamyl cycle.

UNIT II: Catabolism and Biosynthesis of amino acids No. of hours: 18

Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methyl malonic acidemia (MMA), homocystinuria and Hartnup's disease. Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation.

UNIT III: Precursor functions of amino acids No. of hours: 8

Biosynthesis of creatine and creatinine, polyamines (putresine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.

UNIT IV: Biosynthesis, Degradation of purine and pyrimidine nucleotides No. of hours: 14

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways. Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

UNIT V: Deoxyribonucleotides and synthesis of nucleotide triphosphate and Co- enzymes **No. of hours: 6**

Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.

UNIT VI: Integration of metabolism **No. of hours: 6**

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

Core Course – 9 (Practical) CC -9 (P) Course
Code -1Y3BCH403P

PRACTICALS

CREDITS: 2

TOTAL HOURS: 60
Full Marks: 30
Time: $1^1/2$ Hrs

Assay of serum transaminases – SGOT and SGPT.
Estimation of serum urea.
Estimation of serum uric acid.
Estimation of serum creatinine.
Estimation of bilirubin
Assay of glutamate dehydrogenase

References

Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.

Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4 / BRV ISBN:978-0-470- 60152-5.

Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

COURSE STRUCTURE OF BSc. BIOCHEMISTRY FIFTH SEMESTER													
Course Details				**External Assessment**		**Internal Assessment**				**Credit Distribution**			**Allotted Credits**
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3BCH501	Core Course- XI	Concepts in Genetics	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH501P	Core Course-XI Practical	Concepts in Genetics	70	50	17	-	-	-	-	-	-	2	2
1Y3BCH502	Core Course- XII	Gene expression and regulation	30	30	10	-	-	20	07	4	-	-	4
1Y3BCH502P	Core Course- XII Practical	Gene expression and regulation	70	50	17	-	-	-	-	-	-	2	2
1Y3BCH503	Discipline Specific Elective-I	BCH DSE-1	30	30	10	-	-	20	07	4	-	-	4
1Y3BCH503P	Discipline Specific Elective-I Practical	BCH DSE-1	70	50	17	-	-	-	-	-	-	2	2
1Y3BCH504	Generic Elective-V	GE-V	30	30	10	-	-	20	07	4	-	-	4
1Y3BCH504P	Generic Elective-V Practical	GE-V	100	50	17			-	-	-	-	1	2
Grand Total		**400**											**24**

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

CORE COURSE: B.Sc. (HONOURS) BIOCHEMISTR
Core Course – 11(CC-11)
Concepts in Genetics (1Y3BCH501)
Semester - V

Course Objectives

The aim of the course is to provide an understanding of both classical and modernconcepts in the areas of transmission, molecular and population Genetics.

Practicals are well correlated with the theory topics and designed to support skilloriented learning outcomes.

2.1 Course Learning Outcomes

Understanding the principles of Mendelian genetics, extensions and applications.

Learning and appreciating the various factors that confer genotypic and phenotypicvariability.
Using the concepts of bacterial and viral genetics to understand resistance patternsand to create linkage and genetic maps.
Use statistical tools to analyse biological data.
The students will be able to apply the principles of transmission and inheritance inreal life situations.

2.2Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Principles of heredity and Transmission genetics: **No of hours: 21**

Mendelian Genetics and Chromosomal basis of heredity

Mendelian laws and ratios, Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences.

Extensions to Mendelian Genetics:

Complementation test giving examples from Drosophila eye colour mutants. Allelic variationand gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropic gene interaction - epistatic and non- epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.

Human pedigree analysis:

Pedigree conventions, characteristics of dominant and recessive inheritance; sex linked, sex influenced and sex limited traits. Applications of pedigree analysis

Organelle heredity

Extra nuclear inheritance, tests for organelle heredity and maternal effect**.**

Inheritance of complex traits

Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hybrid vigor.

UNIT II: Genetics of bacteria and viruses **No. of hours: 7**

Concept of cistron. Bacterial and viral genomes, Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.

UNIT III: Linkage, crossing over and mapping techniques: **No. of hours: 10**

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in *Drosophila*, detection of linked loci by pedigree analysis in humans, LOD score, somatic cell hybridization for positioning genes on chromosomes and physical maps using molecular markers.

UNIT IV: Molecular genetics **No. of hours: 10**

Sex determination and genetic control of development

Genetic basis of sex determination in Humans, *Drosophila melanogaster and C. elegans. Drosophila* development-maternal effect genes, morphogens and zygotic genes; Genetic basis of flower development in *Arabidopsis*-ABC model

Epigenetics:

Mechanism of dosage compensation ; X Chromosomal inactivation in humans and *Drosophila melanogaster*, Epigenetic mechanism of transcriptional regulation Monoallelic expressions and Genomic imprinting.

UNIT V: Chromosomal Abberation:

Variations in chromosome number: aneuploidy and polyploidy. Variations in chromosome structure- inversions, deletions, duplications and translocations.

UNIT VI: Population and Evolutionary Genetics: **No. of hours: 6**

Hardy-Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy- Weinberg principle.

Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

Core Course – 11 (Practical) CC- 11(P)
Course Code – 1Y3BCH501P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks:30
Time: $1^1/2$ Hrs

Squash preparation of salivary glands of Dipteran larva to observe polytenechromosomes.
Induction of polyploidy in onion roots.
Smear technique to demonstrate sex chromatin in buccal epithelial cells.
Monohybrid crosses in *Drosophila* for studying autosomal and sex linked inheritance.PTC testing in a population and calculation of allelic and genotype frequencies.
Study of abnormal human karyotype and pedigrees (dry lab)

2.3 References

Genetics (2012) 6thed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1- 118-09242-2
Genetics - A Conceptual Approach (2012), 6th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.

Additional Resources:

An Introduction to Genetic Analysis (2017), 11th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN: 1464109486

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY

Core Course – 12 (CC-12)
Gene Expression and Regulation (1Y3BCH 502)
Semester - V

Course Objective

The objective of the course is to introduce to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem solving skills.

2.1 Course Learning Outcomes

After completion of the course students will:

acquire basic knowledge about the processes of transcription and translation inprokaryotes and eukaryotes
learn about the features of the genetic code and various experimental approaches usedto crack the code
develop understanding of the molecular basis of RNA processing and RNA splicing
learn about the various ways in which these biological processes are regulated and thesignificance of regulation in maintaining life forms

2.2Course Contents

THEORY

CREDIT : 4 **TOTAL HOURS : 60**

UNIT I: Transcription in prokaryotes **No. of hours : 8**

Comparison between transcription and DNA replication, RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, various stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Inhibitors of transcription and applications as antimicrobial drugs.

UNIT II: Transcription in eukaryotes **No. of hours : 8**

Comparison between prokaryotic and eukaryotic transcription. The three classes of eukaryotic RNA polymerases, transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, transcription by RNA polymerase I and III. Inhibitors of eukaryotic transcription and their applications.

UNIT III: RNA Processing **No. of hours : 8**

Various types of RNA processing- polyadenylation and capping, processing of rRNA and tRNA. Chemistry of RNA splicing, the **No. of hours : 16**

Salient features of the genetic code, triplet nature, degenerate, wobble in the anticodon. Experimental approaches used to decipher the genetic code. Suppressor tRNAs. Exceptions to the nearly universal genetic code. Messenger RNA, transfer RNA, charging of tRNA. The structure of ribosome. Three stages of translation-initiation, elongation and termination. Translation in eukaryotes. Regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis. Inhibitors of translation and their clinical importance.

UNIT V: Regulation of gene expression in prokaryotes **No. of hours : 10**

Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon. Regulatory RNAs in bacteria, small RNA and riboswitches.

UNIT VI: Regulation of gene expression in eukaryotes **No. of hours : 10**

Gene regulation by chromatin remodeling, regulation of galactose metabolism in yeast, actionof enhancers and insulators, working of activators and repressors, concept of combinatorial control. Regulatory RNAs in eukaryotes: synthesis and mechanism of siRNA and miRNA.

Core Course – 12 (Practical) CC- 12 (P)
Course Code – 1Y3BCH502P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Estimation of RNA by Orcinol Method Extraction of total nucleic acids from plant tissue
To study growth curve and diauxic growth curve effect in *E. coli*
Isolation of total RNA from bacteria/yeast
To study the effect of inhibitors on protein synthesis

2.3 References

Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1
.Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.

Additional Resources:

Lewin's Gene X (2018) 10th edition. Benjamin Lewin; Jocelyn E Krebs; Stephen T Kilpatrick; Elliott S Goldstein, Bartlett Learning publishers, LLC, ISBN: 978-0-7637-6632-0.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks

COURSE STRUCTURE OF BSc. BIOCHEMISTRY SIXTH SEMESTER													
Course Details				**External Assessment**		**Internal Assessment**				**Credit Distribution**			**Allotted Credits**
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min. Marks				
1Y3BCH601	Core Course-XI	Genetic Engineering and Biotechnology	70	50	17	-	-	20	07	4	-	-	4
1Y3BCH601P	Core Course-XI Practical	Genetic Engineering and Biotechnology	70	50	17	-	-	-	-	-	-	2	2
1Y3BCH602	Core Course-XII	Immunology	30	30	10	-	-	20	07	4	-	-	4
1Y3BCH602P	Core Course-XII Practical	Immunology	70	50	17	-	-	-	-	-	-	2	2
1Y3BCH603	Discipline Specific Elective-I	BCH DSE-2	30	30	10	-	-	20	07	4	-	-	4
1Y3BCH603P	Discipline Specific Elective-I Practical	BCH DSE-2	70	50	17	-	-	-	-	-	-	2	2
1Y3BCH604	Generic Elective-II	GE-6	30	30	10	-	-	20	07	4	-	-	4
1Y3BCH604P	Generic Elective-II Practical	GE-6	100	50	17			-	-	-	-	1	2
Grand Total		**400**											**24**

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

CORE PAPER: B.Sc. (HONOURS) BIOCHEMISTRY
Core Course – 13 (CC-13)
Genetic Engineering and Biotechnology (1Y3BCH 601)
Semester –VI

Course objectives:

The objective of the course is to teach the basics of theoretical and practical aspects of recombinant DNA technology and various techniques for DNA manipulation in prokaryotes and eukaryotes. Applications of these techniques in production of recombinant therapeutic proteins and vaccines will also be outlined in this course.

Course Learning Outcome

The students will be able to understand:

The process for isolation and engineering of DNA using restriction and modificationenzymes.
Use of cloning and expression vectors.
The methods for creation of genomic and cDNA libraries, their applications and use.
Understanding the methods for protein production and their application in industrialproduction systems.

Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: The basic principle of gene cloning **No of hours: 10**

Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules. Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters, homopolymer tailing, Synthetic oligonucleotides.

UNIT II: Cloning vectors for prokaryotes and eukaryotes **No of hours: 12**

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage, andin vitro packaging. Vectors for yeast, Ti-plasmid, and retroviral vectors, high capacity vectorsBAC and YAC.

UNIT III: Introduction of DNA in cells, selection for recombinants and cloneidentification
No of hours: 10

Uptake of DNA by cells. Selection and identification for transformed cells, insertional inactivation, blue-white selection. Transfection. Chemical and physical methods of DNA introduction into cells. The problem of selection, direct selection, marker rescue. Identification of recombinant phages, cDNA and Genomic libraries, identification of a clone from gene library, colony and plaque hybridization probing, Southern and Northern hybridization, methods based on detection of the translation product of the cloned gene.

UNIT IV: Expression of cloned genes **No of hours: 06**

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Hybrid promoter strc, tac, pL and T7 promoter based expression vectors. Challenges in producing recombinant protein in *E. coli.* Production of recombinant protein by eukaryotic cells. Fusion tags such as, poly-histidine, glutathione, maltose binding protein and their role in purification of recombinant proteins.

UNIT V: Polymerase chain reaction and DNA sequencing **No of hours: 10**

Fundamentals of polymerase chain reaction, Types of PCR; hot start, multiplex, reverse transcriptase PCR and Nested PCR, quantitative PCR, Primer, designing for PCR. Cloning PCR products. DNA sequencing by Sanger's method including Automated Sanger's DNA sequencing. Introduction to Next Generation Sequencing.

UNIT VI: Applications of genetic engineering in Biotechnology **No of hours: 12**

Site–directed mutagenesis, Protein engineering (T4-lysozyme), yeast two hybrid systems, Production of recombinant pharmaceuticals such as insulin, human growth hormone, factor
VIII. Recombinant vaccines. Gene therapy (SCID), Applications in agriculture – *Bt* cotton,glyphosate herbicide resistant crops, ethical concerns.

Core Course – 13 (Practical) CC – 13 (P)
Course Code – 1Y3BCH601P

PRACTICALS

CREDITS : 2 **TOTAL HOURS: 60**
Full Marks:30
Time: $1^1/2$ Hrs

Transformation of *E. coli* cells with plasmid DNA.
Isolation of plasmid DNA from *E. coli* cells.
Digestion of plasmid DNA with restriction enzymes.Amplification of a
DNA fragment by PCR.
Complementation of β−galactosidase for Blue and White selection.
Hyper expression of poly histidine-tagged recombinant protein and purification using Ni– affinityresin.

References

Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.

Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.

Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN:978-1-55581-498-4 (HC).

Molecular Cloning: A laboratory manual (2014),4th ed., Michael R Green and J. Sambrook Cold spring Harbor laboratory press (3vol.), ISBN: 978-1-936113-42-2

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

CORE PAPER: B.Sc. (HONOURS) BIOCHEMISTRY

Core Course – 14 (CC-14)

Immunology (1Y3BCH602)

Semester VI

Course Objective

This course describes the molecular and cellular basis of the development and function of the immune system. The course will provide the basic framework in immunology that will cover the major topics including innate and adaptive immunity, antibodies and antigens, the molecular events leading to the generation of antibody, humoral and cell mediated adaptive immune response, hypersensitivity, self-tolerance, autoimmunity and vaccines.

Course Learning Outcomes

Upon completion of this course, a student will be able to

Trace the history and developments in immunology.
Have an overview of the immune system including cells, organs and receptors.
Describe the basic mechanism, differences and functional interplay of innate and adaptive immunity
Understand Antigens & its Recognition, antigen processing and presentation
Understand the structure & functions of different classes of Immunoglobulins, and understand the genetic basis of antibody diversity
Define the cellular and molecular pathways of humoral and cell-mediated immune responses
Describe the mechanisms involved in different types of hypersensitivity
Explain the principles of tolerance and autoimmunity
Understand Immunotherapy and basic concept of Vaccines
Summarize role of immunity in protection against pathogens

Course contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Immune System and Innate Immunity **No. of hours: 10**

Historical Perspective, Innate and Adaptive Immunity, Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues. Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, localized and systemic response. Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies.

UNIT II: Antigens and Antibody **No. of hours: 12**

Antigens, carriers, adjuvantes and haptens, factors responsible for immunogenicity, B and T cell epitopes. Structure, classes and subclasses of immunoglobulins (Ig, Ig fold), effector functions of antibody, antigenic determinants on Ig, Ig super family. Monoclonal antibodies production and applications

UNIT III: Biology of the B lymphocyte & Humoral Immunity **No. of hours: 10**

Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, mechanisms of antibody diversity. Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response,anatomical distribution of B cell populations

UNIT IV:Biology of the T lymphocyte & CellMediated Immunity **No. of hours: 12**

General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, pathways of antigen processing and presentation. Structure and role of T cell receptor (TCR) and co-receptor, T cell development, generation of receptor diversity, selection and differentiation. General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NK - T cells and antibody dependent cellular cytotoxicity (ADCC).

UNIT V: Autoimmunity and hypersensitivity **No. of hours: 10**

Self-tolerance and possible mechanisms of induction of autoimmunity, Organ specific and systemic autoimmune diseases, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity

UNIT VI: Transplantation immunology and Vaccines **No. of hours: 6**

Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy and privileged sites. Vaccines - active and passive immunization, types of vaccines

Core Course – 14 (Practical) CC – 14 (P)
Course Code – 1Y3BCH602P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks:30
Time: $1^1/2$ Hrs

Isolation of lymphocytes from blood / spleen.
Purification of immunoglobulin's
Assays based on precipitation reactions - Ouchterlony double immunodiffusion (DID) and Mancini radial immunodiffusion (SRID).
Assays based on agglutination reactions - Blood typing (active) & passive agglutination.Enzyme linked immunosorbent assay (ELISA) & DOT ELISA

References

Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0- 7617-8590- 0.
Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., JohnWiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
Janeway's Immunobiology 2012 8th ed., Murphy, K., Mowat, A., and Weaver, C.T.,Garland Science (London & New York), ISBN: 978-0-8153-4243-4

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)

DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES

B.Sc. (HONOURS) BIOCHEMISTRY

DISCIPLINE SPECEFIC ELECTIVE (DSE) COURSES

DSE-1

Nutritional Biochemistry (1Y3BCH503)

Semester - V

Course Objective

This course provides students with knowledge and understanding of the characteristics, function, assimilation, distribution and deficiency of macro and micronutrients in the human body. It involves integrated learning between the areas of Biochemistry and Nutrition.

2.1 Course Learning Outcomes

At the end of the course, the students are expected to:

Critically analyze and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition.
Appreciate the biochemical underpinning of human nutrition in maintaining health.
Demonstrate understanding of the biochemical basis of essentiality of macro and micronutrients and their nutritional deficiencies.
To be aware of techniques used in the assessment of Nutritional status and nutritional disorders.
To understand drug nutrient interactions.

2.2 Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to Nutrition and Energy Metabolism **No. of hours: 6**

Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. Physiological energy value of foods, SDA. Measurement of energy expenditure, BMR and RMR- factors affecting BMR. Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

UNIT II: Macronutrients **No. of hours : 20**

Food sources of carbohydrates, Review functions of carbohydrates. Factors affecting Digestion, absorption and utilization. Glycemic index and glycemic load. Dietary fiber androle of fibre in health. Role of Gut microbiome in maintaining health. Role of pre and probiotics in nutritive health.

Essential Fatty Acids; Functions of EFA, RDA, – excess and deficiency of EFA. Dietary implications of fats and oils, Combination ratios of n6 and n3, MUFA, PUFA and SFA Factors affecting Digestion, absorption and utilization. Importance of the following: a) Omega – fatty acids. Omega 3/ omega 6 ratio b) Phospholipids c) Cholesterol in the body d)Mono, Polyunsaturated and Saturated Fatty Acids.

Review of functions of proteins in the body, Digestion and absorption. Essential and Nonessential amino acids. Complete protein, Amino Acid Availability, Antagonism, Toxicity, Imbalance, Amino acid complementation and Supplementation in foods. Effects of deficiency. Food source and Recommended Dietary Allowances for different age group. Amino acid pool. NPU, Biological Value, Nitrogen balance. PEM and Kwashiorkor.

UNIT III: Micronutrients: Vitamins **No. of hours : 12**

Vitamin A, D, E, K Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis.

Vitamin C- Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME); role as cofactor in amino acid modifications. The B Complex vitamins- Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME); Thiamine-TPP roe in metabolism and deficiency disease; Niacin- Metabolic interrelation between tryptophan, Niacin and NAD/ NADP; Vitamin B6-conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms; Vitamin B12 and folate-metabolic role, homocysteine cycle, Biochemical basis for deficiency symptoms.

UNIT IV: Micro Minerals and trace elements **No. of hours : 10**

Calcium, Iron and Phosphorus- Distribution in the body digestion, Absorption, Utilization , Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA. Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology, Function, deficiency, Toxicity and Sources

UNIT V: Assessment of Nutritional status **No. of hours : 6**

Direct methods of assessment-Anthropometric measurements; Biochemical assessment; clinical signs; dietary records and nutrient intake. ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

UNIT VI: Food-drug interactions and Nutraceuticals **No. of hours: 6**

Nutrient interactions affecting ADME of drugs. Drug induced nutrient deficiency: Alcohol, Antibiotics, Antimalarial drugs. Food as medicine: turmeric, garlic, ginger, cumin, asafetida

DISCIPLINE SPECEFIC ELECTIVE (DSE) COURSES
DSE-1 Practical
Course Code – 1Y3BCH503P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks:30
Time: $1^1/2$ Hrs

Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
Blood Lipid profile
Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate.Estimation of vitamin in drugs/food/serum.
Estimation of minerals in drugs/food/serum.
Glycosylated haemoglobin
Nutritive value of foods
Case studies.

References

Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley &Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
Krause's Food and Nutrition Care process.(2012); Mahan, L.K Strings, S.E, Raymond, J.Elsevier's Publications. ISBN- 978-1-4377-2233-8.
The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr.
Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press.
ISBN: 9780195171693
Nutritional Biochemistry. Author, *Tom Brody*. Edition, 2. Publisher, Harcourt Braces,1999. ISBN, 9814033251, 9789814033251.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES
DSE-2
Advanced Cell Biology (1Y3BCH504)
Semester - V

Course Objective

The course aims to give advance knowledge of cell biology techniques, function of organelles, the structure and function of cytoskeleton and its role in motility, the details of cellular interaction with cells and tissues around, the molecular regulation of cell growth and cell death, the molecular details cancer origin, diagnosis and treatment.

Course Learning Outcomes

The learning outcomes will be as follows:

The student will develop understanding of the principle and application of some of theclassical and advanced cell biology techniques
The student will be able to describe the role of organelles in the secretion of matureproteins and key role of the cytoskeleton in the living cell.
The student will be able to understand the factors regulating mitosis, meiosis, apoptosis and necrosis. They will also be able to comprehend the role and therapeutic value of stem cells.
The student will be able to understand the genetic basis of development of cancer, the molecular diagnosis and molecular drugs which are used for chemotherapy.

Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

No. of hours: 6

UNIT I: Advanced Methods in Cell Biology

Principle and application of Ultracentrifugation

UNIT II: Protein Sorting and Secretory Pathway **No. of hours: 16**

Transport of proteins across Nuclear Envelope; Regulation of Nuclear Protein Import and Export. Overview of The Endomembrane System; Targeting, modification and sorting of Proteins From And Into Endoplasmic Reticulum; Synthesis And Targeting Mitochondrial Protein; Chloroplast Proteins A\and Peroxisomal Proteins; Mechanism Of Vesicular Transport; Coat Proteins And Vesicle Budding; Vesicle Fusion; Targeting Of Proteins T

UNIT III: Cytoskeleton and Cell Motility **No. of hours: 10**

Function and origin of The Cytoskeleton; Organization and Assembly of Actin Filaments andMyosin; Assembly and Dynamics of Microtubules and Intermediate Filaments; Assembly and organization

UNIT IV: Cell Division and its Regulation **No. of hours: 10**

Overview of The Cell Cycle; Eukaryotic Cell Cycle; Events Of Mitotic Phase; Cytokinesis;Events Of Meiosis And Fertilization; Regulation Of Cell Division And Cell Growth;

UNIT V: Cell Death and its regulation **No. of hours:8**

Apoptosis and Necrosis, Application of stem cells in health and disease. Hematopoiesis,Embryonic Stem Cells and Therapeutic Cloning.

UNIT VI: Molecular Basis of Cancer Biology **No. of hours: 10**

Development and causes Of Cancer; Genetic Basis of Cancer; Oncogenes, Tumor Viruses;Molecular Approach to Cancer Treatment.

DISCIPLINE SPECEFIC ELECTIVE (DSE) COURSES
DSE-2 Practical
Course Code – 1Y3BCH504P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Learn the technique of Plant/Animal Tissue Culture Study of
pinocytosis by paramecium under microscopy
Calculating viability of cells after exposure the bacterial culture to UV raysPreparing
temporary mount of nerve cell from mammalian spinal cord
Differential centrifugation of cell and validation of separated organelles by enzymemarkers
Study of cell- cell agglutination by lectin and calculation of haem-agglutination titre.
Demonstration of phagocytosis/apoptosis by fluorescent label under fluorescentmicroscope

References

The Cell: A Molecular Approach (2009) 7th ed., Cooper, G.M. and Hausman, R.E., ASMPress & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-30

The World of the cell, 7th edition (2009). Lewis J. Kleinsmith, Jeff Hardin, Gr Wayne M.Becker. ISBN-13: 978-0805393934 ISBN-10: 0805393935.

Cell and Molecular Biology: Concepts and Experiments. (2010). Karp, G., 8thedition. John Wiley & Sons. Inc. ISBN : 978-1-118-65322-7

Additional Resources:

Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-14641-0981-2 / ISBN:10: 1-4641-0981-8.

Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY

DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES

DSE-3

Microbiology (1Y3BCH505)

Semester - V

Course Objectives

The objective of the course is to trace the history of development of the discipline of Microbiology and to emphasize the existence of the immense diversity in the microbial worldand maintenance of microbes under laboratory conditions. The course also aims to make the students aware of both pathogenic as well as beneficial microbes to prepare students for higher education in microbiology-related disciplines.

2.1 Course Learning Outcomes

On successful completion of this paper, students should be able to:

Identify different microbes

Perform routine microbiological practices including sterilization, media preparation,maintenance of microbial culture, staining etc.

To carry out research using microbes.

To test microbial culture for antibiotic resistance.

2.2 Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: History of Microbiology **No. of hours: 8**

History of development of microbiology as a discipline, Spontaneous generation versusbiogenesis, contributions of Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Richard Petri, Charles Chamber land, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei Winogradsky, Alexander Fleming, Elie Metchnikoff and Emil von Behring

UNIT II: Diversity of Microbial world and Microbial Cell organization No. of hours: 14

Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi and Protozoa) with emphasis on distribution, occurrence and morphology. Cell-wall: Composition and detailed structure of Gram positive and Gram negative cell walls, mechanism of Gram's staining. Cell Membrane:Structure, function and chemical composition of bacterial and archaeal cell membranes.

UNIT III: Microbial Nutrition and Growth **No. of hours: 14**

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH, temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics. Use of physical methods (heat, low temperature, filtration, radiation) and chemical agents (phenolics, halogens, heavy metals, sterilizing gases) in microbial control.

UNIT IV: Pathogenicity of Microorganisms and Antimicrobial Chemotherapy

No. of hours: 8

Introduction to pathogenic microbes; Bacteria, Viruses, Algae, protozoa and fungi. General Characteristics of antimicrobial drugs, determining the level of microbial activity: dilution susceptibility test and disc diffusion test. Range of activity and mechanism of action of penicillin, vancomycin and tetracycline.

UNIT V: Food and Industrial Microbiology **No. of hours: 16**

Importance of microbiology in food and industries; Basic design of fermenter, continuous and discontinuous culture. Preparation of fermented food products such as yoghurt, curd and cheese. Preparation of alcoholic beverages like wine and beer. Single cell proteins. Treatment of waste water (Municipal treatment plant) and sewage. Bioremediation and biodegradation.

DISCIPLINE SPECEFIC ELECTIVE (DSE) COURSES
DSE-3 Practical
Course Code – 1Y3BCH505P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

To prepare and sterilize the culture media for the growth of microorganisms
To perform various culture transfer techniques: Solid to solid (streaking), liquid to solid (spreading), liquid to liquid, solid to liquid and determine CFU/ml
To stain bacteria using methylene blue.
To perform gram staining
To prepare temporary mount of algae (spirogyra)
To prepare temporary mount of fungi (Penicillium)
Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs

2.3 References

J. Willey, L. Sherwood & C. Woolverton, Prescott's Microbiology,.10th Ed., McGraw Hill international, (2017). ISBN 9781259657573
MJ Chan, ECS Krieg & NR Pelczar, Microbiology, 5th Ed. M McGraw Hill, International (2004). ISBN 13:780094623206

Additional Resources:

M.T. Madigan, J.M. Martinko & D.A. Stahl, Brock Biology of Microorganisms, 13th Ed.,Pearson Education International. (2010). ISBN 13: 9780321649638.
J.G. Cappuccino, and N. Sherman, Microbiology: A Laboratory manual, 10th Ed.Benajamin/ Cummings (2013), ISBN 13: 9780321840226.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES
DSE-4
Molecular Basis of Infectious Disease (1Y3BCH605)
Semester - VI

Course Objective

The course aims to provide knowledge about various microbial infectious agents such as bacteria, virus, parasites and fungi that cause diseases in humans, the concepts of treatment and biochemical basis of mechanism of action and drug resistance for various antimicrobial agents. The course will also provide outline of the various strategies that are employed for preventing infectious diseases and the role of vaccination in eradication of diseases. It will cover the concept of emergence and re-emergence of diseases and idea of bio-terrorism and its impact worldwide. The course will also summarize the significance of hygiene, sanitation, drugs and vaccination in prevention and eradication of infectious diseases.

2.1 Course Learning Outcomes

Students will understand various classes of pathogens and their mode of action andtransmission.
Students will be exposed to molecular basis of treatment, diagnosis and vaccine designstrategies for all the diseases listed.
Students will gain insight into host immune responses that ensue following infection.
Students will learn the details of diseases such as tuberculosis, AIDS and malaria whichare highly prevalent in Indian subcontinent.

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Infectious diseases: an introduction **No. of hours : 7**

Classification of infectious diseases, Nosocomial infections; Patterns of Disease; Measuring infectious disease frequency; Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens. Safety measure when working with pathogen biosafety levels, infection and evasion

UNIT II: Strategies for management of infectious diseases **No. of hours : 4**

Role of drugs, vaccines, hygiene and sanitation in prevention, transmission control andtreatment of infectious diseases

UNIT III: Diseases caused by bacteria **No. of hours : 20**

Classification of bacterial pathogens based on structure and nutritional requirements; Overview of bacterial virulence factors and host pathogen interactions; Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, diagnostics, therapeutics and vaccines, drug resistance and implications on public health. Other bacterial diseases - virulence factors, host pathogen interaction, symptoms, diagnosis, vaccines and drugs against - Typhoid, Diphtheria, Pertussis, Tetanus, Botulism Cholera, Anthrax and Pneumonia

UNIT IV: Diseases caused by Viruses **No. of hours : 15**

Structure of viruses, Baltimore system for virus classification; Overview of viral virulence factors and host pathogen interactions; Detailed study of AIDS: history, causative agent, pathogenesis, diagnostics, drugs; Other viral diseases including hepatitis, Influenza (Antigenic shift and antigenic drift), Rabies, Dengue and Polio; Chicken Pox, Herpes Virus

UNIT V: Diseases caused by Parasites **No. of hours: 8**

Detailed study of Malaria: history, causative agents, vectors, life cycle, Host parasite interactions, diagnostics, drugs, vaccine development. Other diseases including Leishmaniasis and Amoebiasis, Giardiasis and Trypanosoma infections

UNIT VI: Diseases caused by Fungi **No. of hours: 6**

Fungal diseases such as Candidiasis, Sporotrichosis, Aspergillosis and Ring worm: general disease characteristics, medical importance, pathogenesis, diagnosis and treatment

DISCIPLINE SPECEFIC ELECTIVE (DSE) COURSES
DSE-5
Course Code – 1Y3BCH605P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Isolation and enumeration of bacteriophages (PFU) from water/sewage sampleWIDAL test
Gram staining Acid
fast staining
Permanent slides of pathogens: Mycobacterium tuberculosis, Leishmania, Plasmodiumfalciparum
MIC determination using Kirby Bauer / Alamar Blue assayFungal staining
Research and presentation on current trends in infectious diseases

2.3 References

Klien's Microbiology (2008) 7th ed., Prescott, Harley, Wiley, J.M., Sherwood, L.M., Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007- 126727

Sherris Medical Microbiology: An introduction to infectious diseases (2010) Kenneth J. Ryan, C.,George Ray, Publisher: McGraw-Hill. ISBN-13: 978-0071604024 ISBN-10: 0071604022

Jawetz, Melnick & Adelbergs Medical Microbiology 27th ed., McGraw Hill Education ISBN-10: 0071790314 ISBN-13: 978-0071790314

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
DISCIPLINE SPECIFIC ELECTIVE PAPER
DSE-5
Plant Biochemistry (1Y3BCH606)
Semester - VI

Course Objectives

The course aims at providing deep understanding of metabolic processes in plants and the role of different biosynthetic pathways in plant growth and development. The course will also impart basic concepts and applications of plant tissue culture.

Course Learning Outcomes

Successful completion of this course will provide students with the following learning outcomes:

Understanding of plant cell structure and organization.

Understanding of the biochemical processes and metabolic pathways specific to plants, including photosynthesis, photorespiration, cell wall biosynthesis, nitrogen fixation and assimilation and plant secondary metabolism.

Gaining insight on how plants have evolved to cope up with the different stress conditions. Understanding of the basic concepts of plant tissue culture and its application ingenerating transgenic crops.

Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to plant cell structure and carbon fixation **No. of hours: 16**

Introduction to Plant cells, Plasma membrane, Vacuole and Tonoplast membrane, Cell wall, Plastids and Peroxisomes. Photosynthesis and Carbon assimilation. Structure of PSI and PSII complexes, Light reaction, Cyclic and non-cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration, Photo inhibition of photosynthesis, Photosynthetic carbon reduction (PCR) cycle, Synthesis ofpolysaccharides in plants.

UNIT II: Respiration **No. of hours: 12**

Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.

UNIT III: Nitrogen metabolism **No. of hours: 10**

Biological nitrogen fixation by free living and in symbiotic association; Structure and function of the enzyme nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by gutaminesynthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

UNIT IV: Regulation of plant growth and stress physiology **No. of hours: 8**

Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.Plant stress, Plant responses to abioticand biotic stresses, Water deficit and drought resistance, Flooding, Temperature stress, Salt stress, Ion toxicity, Pollution stress and potential biotic stress (insects and diseases).

UNIT V: Secondary metabolites and toxins **No. of hours: 8**

Representative alkaloid group and their amino acid precursors, function of alkaloids. Examples of major phenolic groups; simple phenylpropanoids, coumarins, benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

UNIT VI: Plant tissue culture and biotechnology **No. of hours: 6**

Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation. Germplasm storage and cryo- preservation. Brief introduction to transgenic plants.

DISCIPLINE SPECEFIC ELECTIVE (DSE) COURSES
DSE-5
Course Code – 1Y3BCH606P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
Extraction and assay of urease from Jack bean
Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables.
Separation of photosynthetic pigments by TLC.
Culture of plants (explants).

References

Caroline Bowsher, Martin steer, Alyson Tobin (2008), Plant Biochemistry, Garlandscience ISBN 978-0-8153-4121-5.
Buchann (2015), Biochemistry and molecular Biology of plant, 2edition. Publisher: IK International. ISBN-10: 8188237116, ISBN- 978047 07 14218
P.M Dey and J.B. Harborne (Editors) (1997), Plant Biochemistry, Publisher: Academic Press ISBN-10:0122146743, ISBN-13:978-0122146749

Additional Reading

Taiz and Zeiger, Plant Physiology, 5th edition, Sinauer Associates Inc.ISBN-13: 978-0878938667, ISBN-10: 0878938664

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)
DISCIPLINE SPECIFIC ELECTIVE PAPER
DSE-6
Advanced Methodologies (1Y3BCH-606)
Semester - VI

Course Objectives

The objective of the course is to provide students with a sound background of latest techniques used in biochemistry research and to provide them with an understanding of the principles underlying these techniques. The course is designed to impart laboratory skills in the form of practical exercises so that students can apply this knowledge to augment their research acumen and improve their understanding of the subject.

2.1 Course Learning Outcomes

Students will acquire knowledge about the principles and applications of latestmethods used to analyze nucleic acids and proteins.
Students will learn about the principle and applications of microscopy and variouscell biology techniques.
Students will also be exposed to various methods of labeling DNA, proteins andwhole cells and their applications in research.
The course will also provide them an opportunity for hands-on-experience to developtheir laboratory skills expected of any biochemist working in a research lab.

2.2 Course Contents

THEORY

CREDITS: 4

TOTAL HOURS: 60

UNIT I: Methods for analysis of nucleic acids **No. of hours :20**

Hybridization methods: Southern blotting, Northern blotting, *In situ* hybridization, Colony hybridization. Binding of nucleic acids with protein: DNA pull down assays, Electrophoretic Mobility Shift Assay (EMSA), DNA footprinting, Primer Extension, Chromatin immunoprecipitation (ChIP), ChIP on ChIP. Gene expression analysis: Reporter assays - example luciferase assay, DNA Microarrays, RNA seq.

UNIT II: Methods for analysis of proteins **No. of hours :20**

Protein-Protein Interaction: Immunoprecipitation, Co-Immunoprecipitation (Co-IP), Pull down assays, Yeast two hybrid, Protein fragment complementation assay, Western blotting,Far western blotting, Protein microarrays, ELISA. Protein Separation: Isoelectric focusing,2D protein gel electrophoresis, 2D-DIGE, Pulse field Electrophoresis; Structural Analysis: Mass Spectrometry, MS/MS, LC/MS.

UNIT III: Microscopy based methods **No. of hours : 6**

Fluorescence microscopy, Scanning electron microscopy, Transmission electron microscopy,Confocal microscopy

UNIT IV: Cell Biology techniques **No. of hours : 8**

Cell culture and transfection, Immunohistochemistry, Immunofluorescence, Flow cytometry,FACS, TUNEL assay, Non-invasive scanning of soft tissue

UNIT V: Labeling methods **No. of hours : 6**

Radioactive and Non-radioactive labeling: DNA, Proteins, Whole cells, Fluorescent labeling.DNA, Proteins, bacteria, living cells; Metabolic labeling, Pulse chase analysis

DISCIPLINE SPECEFIC ELECTIVE (DSE) COURSES
DSE-6 Practical
Course Code – 1Y3BCH607P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Western Blotting Southern
hybridization
Labeling DNA with Biotinylated primers using PCREMSA
Protein Pull down assay
Virtual lab on Microarray profiling or 2D DIGE

2.3 References

Protein-Protein Interactions: Methods and Applications (Methods in Molecular Biology) (2004) Vol. 261, Haian, F. (ed), Humana Press (Totowa, NJ), ISBN: 1-58829-120-0 / ISBN: 978-1588291202.

Protein-Protein Interactions: A Molecular Cloning Manual (2005) 2nd ed., Golemis, E.A. and Adams, P.D., Cold Spring Harbour Laboratory Press (New York), ISBN: 0879697237/ ISBN: 13: 9780879697235.

The Ultimate Guide to Your Microscope (2008) Levine, S. and Johnstone, L., Sterling, ISBN: 9781402743290.

Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.

Principles and Techniques of Biochemistry and Molecular Biology (2010) 7th ed., Wilson, K., and Walker, J. (eds), Cambridge University Press (New Delhi), ISBN: 978-0-521-73167-6 / ISBN: 978-0-521-51635-8.

Introduction to Instrumentation in Life Sciences (2012) Bisen, P.S. and Sharma, A., CRCPress/Taylor and Francis Group (California), ISBN: 978-1-4665-1240-5.

Molecular Cloning: A Laboratory Manual (2012) Vol. 1-3, 4th ed., Green M.R. and Sambrook J., Cold Spring Harbour Laboratory Press (New York). ISBN: 978-1-936113-41-5 / ISBN: 978-1-936113-42-2.

Biophysical Chemistry (2013), Schimmel, C.R.C., Macmillan Higher Education, ISBN : 0716738619, 9780716738619.

Current Protocols in Protein Science (2013) Coligan, J.E., Dunn, B.M., Speicher,

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)

GENERIC ELECTIVE (GE) COURSES

B.Sc. (HONOURS) BIOCHEMISTRY
GENERIC ELECTIVE (GE) COURSES
GE-1
Biomolecules (1Y3BCH104)
Semester - I

Course Objective

The objective of the course is to teach students about important biomolecules essential to life. The course also aims to teach organic inorganic, and physical aspects of biomolecules

2.1 Course Learning Outcomes

Students have knowledge of structure and function of protein, RNA, DNA, Carbohydrates, Coenzymes
How structure of biomolecule determine their chemical properties
To have understanding of biochemistry at atomic level
Biological importance of each biomolecule

2.2Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Biomolecules in their cellular environment **No. of hours : 7**

The cellular basis of life, Structure and function of a cell and its subcellular components(eukaryotes, prokaryotes)

Physical properties and structure of water molecule, pH, Buffers, biological buffer systems(body fluids and their principal buffers)

UNIT II: Amino Acid and Peptides **No. of hours : 11**

Introduction, general nature of amino acids, classification of amino acids importance of amino acids, modified and standard amino acids, physical, optical properties of amino acids, Ionization of amino acids, buffering of amino acids, peptide bond, biologically important peptide

Introduction to chromatography, separation of amino acid by paper chromatography

UNIT III: Carbohydrate Chemistry **No. of hours : 11**

Introduction, Definition classification and functions of carbohydrates monosaccharides Disaccharides polysaccharides homopolysaccacharides, heteropolysaccaharides structure of glucose, isomerism; keto aldo, D and L isomerism, optical isomerism, epimerism, anomerism, Mutarotation chemical properties of monosaccharides action of strong acids, alkalies, oxidation, reduction, osazone formation glycoside formation

Derivatives of monosaccharides phosphoric acid ester, amino sugar, deoxy sugar, sugar acids, sugar alcohols, Disaccharides maltose, lactose, sucrose Homopolysaccarides starch, glycogen, cellulose, dextrin Heteropoly-saccaharides types of glycosoaminoglycans and functions glycoproteins

UNIT IV: Chemistry of Lipids **No. of hours: 11**

Introduction; Definition, classification and functions of lipids; Fatty acids; Essential fatty; acids; Reactions of lipids; Triacylglycerol or neutral fat; phospholipids glycolipids; cholesterol; Eicosaanoids; prosatglandins; lipoprotein

UNIT V:Chemistry of Nucleic Acid **No. of hours : 11**

Introduction Nucleic Acid Nucleotide biologically important Nucleotides Synthectic analogues of Nucleotides or Anti metabolites DNA structure and function Types ofDNA Organisation of DNA RNA Structure and function

UNIT VI:Vitamins and Coenzymes **No. of hours : 8**

Definition and classification of vitamins water soluble vitamins, fat soluble vitamins Occurrence and nutritional role Coenzymes and their role in metabolism Metal ion containing biomoleculeus (heme, porhurins and cyanocobalamine; their biological role

GENERIC ELECTIVE (GE) COURSES
GE-1 Practical
Course Code – 1Y3BCH104P

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

1 Safety measures in laboratories.
Preparation of normal and molar solution
Preparation of buffers.
Determination of pKa of acetic acid and glycine.
Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids. Separation of amino acids/ sugars/ bases by thin layer chromatography Estimation of ascorbic acid in fruit juices

2.3 References

Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 /ISBN:10:1-4292-3414-8.

Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., JohnWiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
GENERIC ELECTIVE (GE) COURSES
GE-2
Techniques in Biochemistry (1Y3BCH102)
Semester - I

Course Objective

The objective of the course is to introduce various techniques to the students, which are used in biological research as well as to provide them with an understanding of the underlying principles of these techniques and experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject and better execution of these techniques.

2.1 Course Learning Outcomes

Students will acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.Students will learn about the principle and application of electrophoresis, centrifugation techniques, cell culture and microscopic techniques.

It will also give them an opportunity to get hands on experience to develop theirexperimental skills expected from any biochemist working in a research lab.

THEORY

CREDITS: 4 **TOTAL HOURS:60**

UNIT I: Spectroscopic Techniques **No. of hours: 15**

Electromagnetic radiation, interaction of radiation with biomolecules, principle of UV-visible absorption spectrophotometry, Lambert's Law, Beer's Law, working of a spectrophotometer. Applications of UV-visible absorption spectrophotometry in biochemistry. Fluorescence spectrophotometry: Phenomena of fluorescence, intrinsic and extrinsic fluorescence, applications of fluorescence in biochemistry.

UNIT II: Chromatography **No. of hours: 15**

Preparation of sample, different methods of cell lysis, salting out, dialysis. Introduction to chromatography. Different modes of chromatography: paper, thin layer and column. Preparative and analytical applications. Principles and applications of: Paper Chromatography, Thin Layer Chromatography, Ion Exchange Chromatography, Molecular Sieve Chromatography, Affinity Chromatography.

UNIT III: Electrophoresis **No. of hours: 12**

Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis, buffer systems in electrophoresis, electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification (staining procedures), molecular weight determination, isoelectric focusing of proteins.

UNIT IV: Centrifugation **No. of hours: 8**

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient. Various types of centrifuges, low speed centrifuge, high speed centrifuge and ultracentrifuge, types of rotors. Application of centrifugation, differential centrifugation, density gradientcentrifugation- zonal and isopycnic.

UNIT V: Microbiological/Cell culture techniques **No. of hours: 5**

Types of media, selective and enrichment media, sterilization methods, bacterial culturing, CFU determination, growth curves, Generation/doubling times, cell counting, viable and non- viable. Growth and maintenance of cultures, biosafety cabinets, CO2incubator. Staining procedures, plating and microtony.

UNIT VI: Microscopy **No. of hours: 5**

Principle of light microscopy, phase contrast microscopy, fluorescence microscopy.Permanent and temporary slide preparation, histology and staining.

GENERIC ELECTIVE (GE) COURSES
GE-2 Practical
Techniques in Biochemistry (1Y3BCH102)

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Verification of Beer's Law
Estimation of proteins by Biuret/Lowry method
Separation of amino acid acids by TLC/paper chromatographyTo perform agarose gel electrophoresis
To isolate mitochondria by differential centrifugation
Visualization of cells by methylene blue

2.3 References

Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques, 6th ed., Boston, Mass: Prentice Hall, 2012, ISBN-13: 9780136043027.

Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), 1998, ISBN: 13: 9780070994874 / ISBN:10: 0070994870.

Wilson K. and Walker J., Principles and Techniques of Biochemistry and MolecularBiology, 7th ed., Cambridge University Press, 2010, ISBN 9780521516358.

Wiley, J.M., Sherwood, L.M. and Woolverton, C.J.. Prescott's Microbiology 10th edition. McGraw Hill Higher Education 2017, ISBN13: 9781259657573.

Additional Resources:

Cooper T G, The Tools of Biochemistry 2nd ed., Wiley-Interscience Publication (NewDelhi), 2011, ISBN: 13:9788126530168.

Freifelder, D., Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York), 1982, ISBN:0716713152 / ISBN:0716714442.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
GENERIC ELECTIVE (GE)
COURSES GE-3
Proteins and Enzymes (1Y3BCH204)
Semester - II

Course Objectives

The objective of this course is to provide overview of protein biochemistry and enzymology to undergraduate students with diverse science backgrounds, since proteins and enzymes are the most versatile functional entities in life with applications in various life sciences research as well as in industry and biomedicine. The biochemical, structural, functional and aspects of interaction of proteins and enzymes will be introduced in this course.

Course Learning Outcomes

On successful completion of the course students will be:

Familiar with unique features and characteristics of proteins and enzymes and their applications in research, medicine and industry.
Aware of the relationship between three-dimensional structure of proteins and enzymes and their functions.
Able to comprehend the basic mechanism of action of enzymes and their remarkable regulation
Aware of the principles of protein isolation, purification and characterization
Able to gain hands-on-experience in handling proteins and enzymes from various sources, thus improving their ability of learning and imbibing the basic concepts.

Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to proteins and their structural organization **No. of hours :10**

Amino acids and their properties. Peptides and their biological significance - hormones, antibiotics and growth factors. Diversity of proteins and their functions. Protein sequence - Edman degradation. Solid phase peptide synthesis. Organization of protein structure - primary, secondary, tertiary and quaternary structures. Conjugated proteins, multimeric proteins and metalloproteins. Bonds in protein structures - covalent and non-covalent. Dihedral angles. Ramachandran map, Secondary structure - helices, sheets and turns.

UNIT II: Three-dimensional structures and protein folding **No. of hours: 12**

Characteristics of tertiary and quaternary structures. Motifs and domains. Structure-function relationship in proteins. 3D structures of myoglobin and hemoglobin. Oxygen binding curves, influence of pH and effector molecules. Concerted and sequential models for allosteric proteins. Hemoglobin disorders. Protein folding - denaturation and renaturation. Role of chaperones.Proteinmisfolding and aggregation diseases.

UNIT III: Isolation, purification and analysis of proteins **No. of hours: 8**

Ammonium sulphate fractionation, centrifugation dialysis. Ion-exchange chromatography, molecular sieve chromatography, affinity chromatography. HPLC and FPLC. Gel electrophoresis: SDS-PAGE, IEF and 2-D electrophoresis.

UNIT IV: Introduction to enzymes, their characteristics and kinetics **No. of hours: 12**

Nature of enzymes - protein and non-protein (ribozyme, abzymes). Cofactor and prosthetic group, apo- and holo-enzymes. Features of enzyme catalysis. Classification of enzymes and nomenclature. Fischer's lock & key and Koshland's induced fit hypothesis. Enzyme specificity. Enzyme kinetics- Michaelis-Menten equation, Lineweaver-Burk plot. Determination of Km, Vmax, Kcat. Factors affecting enzyme activity. Enzyme inhibition- Reversible (competitive, uncompetitive, non-competitive) and irreversible inhibition. Mechanism based inhibitors.

UNIT V: Mechanism of enzyme action and enzyme regulation **No. of hours: 10**

General mechanisms of action. Acid-base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes. Allosteric regulation and feedback inhibition (ATCase). Reversible covalent modification (glycogen phosphorylase). Proteolytic cleavage- zymogen. Multienzyme complex. Coenzymes.

UNIT VI: Applications of enzymes **No. of hours: 8**

Isoenzymes. Applications of enzymes in research. Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase), Enzyme immunoassay (HRP), Enzyme therapy (Streptokinase). Enzyme immobilization and its applications. Industrial applications.

GENERICELECTIVE (GE) COURSES

GE-3 Practical

Proteins and Enzymes (1Y3BCH204P)

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Estimation of proteins by Biuret / Lowry / Bradford method and UV absorbance measurements.
Ammonium sulphate fractionation of crude homogenate from germinated mung beans
Enzyme activity assay (acid phosphatase)
Progress curve of enzyme
Effect of pH / temperature on enzyme activity
Determination of Km and Vmax using Lineweaver-Burk plot.
SDS-PAGE analysis of proteins

References

Nelson, D. L. and Cox, M.M. Lehninger, Principles of Biochemistry, 5th Ed., W.H. Freeman and Company (N.Y., USA.), 2008.

Voet, D. and Voet, J.G. Biochemistry, 3rd Ed., John Wiley & Sons, Inc. USA, 2004.Physical

Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.

Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd.(New Delhi), ISBN: 978-81-265-3016-8.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
GENERIC ELECTIVE (GE) COURSES
GE-4
Biochemical Correlations of Disease (1Y3BCH205)

Course Objective

This course provides students with knowledge and understanding of various human diseases. They will understand the concepts of a well-balanced diet, healthy lifestyle, biochemical basis of diseases, treatment strategies, mechanism of action of drugs and drug resistance mechanisms against various antimicrobials. Students will also learn various strategies that are employed for preventing infectious and non-infectious diseases

2.1 Course Learning Outcomes

Develop understanding about the importance of balanced diet, regular exercises andhealthy lifestyle.
Gain insight into various disorders associated with imbalanced diet and poor lifestyle.

Learn various strategies employed for preventing various human diseases.
Understand the molecular basis of microbial pathogenicity, drug resistance andimplications on public health management.
Should be able to handle and solve analytical problems related to theory classes.

2.2Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Inherited metabolic diseases **No. of hours:8**

Alkaptonuria, Phenylketonuria, Glycogen storage diseases: Von Gierke, Cori and McArdle, Lipid storage diseases: Gauchers diseases, Niemann-Pick disease, SCID: Adenosine Deaminase deficiency.

UNIT II:Nutritional deficiency and lifestyle based diseases **No. of hours: 16**

Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindness, Rickets, Osteomalacia, Osteoporosis, Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes Mellitus-II, Inflammatory Bowel Disease (IBD).

UNIT III: Hormonal Imbalances **No. of hours : 8**

Hormonal imbalances leading to disease: Diabetes Insipidus, Acromegaly, Gigantism, Dwarfism, Goitre, Cretinism, Cushing and Conn's syndrome, Addison's disease.

UNIT IV: Autoimmune diseases **No. of hours: 8**

Concepts in immune recognition-self and non-self-discrimination, organ specific autoimmune diseases- Hashimoto's thyroiditis, Graves' disease, Myasthenia Gravis, Diabetes Melitus-I, Systemic diseases: Systemic Lupus Erythropoesis (SLE), Rheumatoid arthritis.

UNIT V:Diseases caused due to misfolded proteins **No. of hours: 6**

Alzheimer's, Huntington's diseases, Kuru, Creutzfeldt-Jakob disease, Sickle Cell anaemia, Thalessemia.

UNIT VI: Infectious diseases **No. of hours: 16**

Viral infection: Polio, Measles, Mumps, influenza, HIV. Bacterial infections: Tetanus, Diphtheria, Tuberculosis, Typhoid, Cholera. Protozoan: Malaria and Trypanosomiasis. Parasitic infections: Leishmania.

GENERIC ELECTIVE (GE) COURSES

GE-4 Practical
Biochemical Correlations of Disease (1Y3BCH205P)

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Lipid Profile: Triglyceride, Cholesterol
Anthrompometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area(MAMA), Mid Arm Area (MAA).
Haemoglobin Estimation Blood
pressure measurementCalcium
Estimation

2.3 References

Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John WileySons, Inc.(New York), ISBN: 978-0-4710-28173-4
Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John WileySons, Inc (New Jersey), ISBN; 978-0-470-08158-7
Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J. L. and Stryer, L., W.H Freemanand Company (New York)
Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons.(Singapore) ISBN: 978-1-118-09242-2
Klein's Microbiology, (2008) 7 ed., Prescott, Harley, Wiley, J.M. Sherwood, L.M. Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007- 126727

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks

B.Sc. (HONOURS) BIOCHEMISTRY
GENERIC ELECTIVE (GE) COURSES
GE-5
Intermediary Metabolism (1Y3BCH305)
Semester - III

Course Objectives

The objective of this course is:

To provide the students an understanding about the major metabolic pathways of different types of metabolism such as carbohydrates, lipids, amino acids and nucleic acid with their regulation
To provide the students knowledge about the possible correlation between all metabolicpathways.

2.1 Course Learning outcomes

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

Understand the basics of metabolic pathways
Understand the pathways involved in catabolism and biosynthesis of Glucose.
Understand the mechanism of ATP synthesis. Understand the
biosynthesis and degradation of glycogen
Understand the metabolism of fatty acids, amino acids, and nucleotidesDevelop the
understanding of metabolic integration

2.2Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Glycolysis and gluconeogenesis **No. of hours: 12**

Nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency. Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis. Pentose phosphate pathway, importance of various pathways and theirregulation

UNIT II: Citric acid cycle and Oxidative phosphorylation **No. of hours: 12**

Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway. The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3-phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.

UNIT III: Glycogen metabolism **No. of hours: 8**

Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis. Diseases associated with the abnormal carbohydrate metabolism.

UNIT IV: Fatty acid and amino acid degradation **No. of hours: 12**

TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Fatty acids activation, regulation of fatty acid oxidation, Protein degradation to amino acids, Role of essential and non-essential amino acids in growth and development. Protein calorie malnutrition - Kwashiorkar and Marasmus, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation. Diseases associated with the abnormal metabolism.

UNIT V: Nucleotide metabolism10 **No. of hours:**

Biosynthesis - de novo and salvage pathways, regulation of nucleotide synthesis by feedbackinhibition, degradation and excretion. Diseases associated with the abnormal metabolism

UNIT VI: Integration of metabolism **No. of hours: 6**

Brief role of hormones - insulin, glucagon; metabolic shifts to provide fuel to brain duringfasting and starvation, Increase in gluconeogenesis and muscle protein breakdown.

GENERIC ELECTIVE (GE) COURSES
GE-5 Practical
Intermediary Metabolism (1Y3BCH305P)

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Estimation of glucose
Alcohol fermentation by yeast.
H2S production, indole production and ammonia production by bacteria.
Urea estimation.
Uric acid estimation.
Estimation of creatinine

2.3 References

Biochemistry (2012) 7th ed., Campbell, M.K. and Farrel, S.O. Brooks/Cole, CengageLearning (Boston), ISBN: 13:978-1-111-42564-7.

Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freemanand Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
GENERIC ELECTIVE (GE) COURSES
GE-6
Biochemical Applications in Forensics (1Y3BCH306)
Semester - III

Course Objectives

The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidences, which will help students develop analytical and problem solving skills for real life situation. The course will keep abreast with all recent developments and emerging trends in forensic science thus helping interested students takeup forensic science as future course of study.

Course Learning Outcomes

Students will learn the fundamental concepts and principles of forensic science andtheir significance.
Students will understand how a forensic investigation is initiated through preservationof evidences, as well as chemical, physical and biological methods of their analysis including analysis of DNA and other bodily fluids.
Students will learn how to establish identity of an individual by document evaluation,fingerprints, footprints, DNA analysis etc.
Students will obtain hands-on-experience in some of the basic biochemical processesinvolved in forensic investigation.

2.2 Course Contents

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to forensic sciences **No. of hours: 10**

Basic Principles and Significance; History and Development of Forensic Science; Defining the scene of investigation; Collection, Packaging, Labelling and Forwarding of biological exhibits to forensic laboratories; Preservation of biological evidence; Importance of Health and Safety Protocols in sample collection and analysis.

UNIT II: Biological science and its application in investigation **No. of hours: 20**

Biochemical analysis of various biological evidence like blood, semen & other biological fluids, viscera, bite marks, hair (animal and human), fibres & fabrics, pollen and soil; Establishment of identity of individuals - fingerprints, footprints, blood and DNA analysis, anthropology – skeletal remains, Odontology; Time of death- rigor mortis, liver mortis, algor mortis, forensic entomology. Biochemical basis for determination of cause death case studies.

UNIT III: Chemical science and its application in investigation **No. of hours: 15**

Detection of drugs of abuse and narcotics in biological samples; Toxicological examination of viscera, detection of petroleum products, food adulteration; Analysis of inks and their use in questioned document identification, blood splatter analysis, stain analysis, case studies.

UNIT IV: Recent advances in forensics. **No. of hours: 15**

Narco analysis: theory, forensic significance, future prospect; *Brain mapping:* introduction, EEG, P-3000 wave, forensic applications, limitation of technique; *Polygraph*: Principle and technique, polygraph as forensic investigative tool, use of psychoactive drugs in forensic analysis. NHRC guidelines for polygraph test; *Facial reconstruction*: Method and technique, facial reconstruction in forensic identification; DNA Finger Printing; DNA-Introduction, source of DNA in Forensic case work, Extraction of DNA, Techniques of DNA fingerprinting-RFLP, STR, PCR. DNA fingerprinting in paternity disputes, mass disaster and other forensic case work, case studies.

GENERIC ELECTIVE (GE) COURSES

GE-6 Practical
Biochemical Applications in Forensics (1Y3BCH306P)

PRACTICALS

CREDITS: 2

TOTAL HOURS: 60
Full Marks: 30
Time: $1^1/2$ Hrs

TLC method for differentiation of ink/drugs Fingerprint
development from various surfaces
Handwriting identification based on class characteristic and individual characteristics
Microscopic examination of Hair/Fibre/Pollen/diatom
Examination of blood samples: Blood grouping, DNA finger printing, Blood splatteranalysis.
Examination of urine samples: Identification of drugs.Field trip
to a forensic laboratory.

References

Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology by Parikh C.K. Henry Lee's Crime Scene Handbook by Henry C Lee
Forensic Biology by Shrikant H. Lade Crime Scene Processing and Laboratory Work Book by Patric Jones
Forensic Science: An Introduction to Scientific and Investigative Techniques 3rd ed. By Stuart H. James
Criminalistics: An Introduction to Foresnic Science, 9th ed. By Richard Saferstein
Compute Crime and Computer Forensic by Dr. R.K. Tiwari Handbook of Forensic Psychology Dr. Veerraghavan
Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology by Parikh C.K.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
GENERIC ELECTIVE (GE) COURSES
GE-7
Recombinant DNA Technology (1Y3BCH404)
Semester - IV

Course objectives:

The objective of the course is to teach:

Basics of theory and practical aspects of recombinant DNA technology.
Various techniques for DNA manipulation in prokaryotes and eukaryotes.
Applications of this knowledge for the development of Diagnostics, Therapeutics, Vaccines, etc.

2.1 Course learning outcomes:

The students after completing this course will be able to understand:

Principles and importance of gene cloning
Various methods for screening of recombinants and identification of cloned gene.
Polymerase chain reaction and DNA sequencing
Recombinant gene expression system.
Application of recombinant technology in the production of Biopharmaceutical processes and products such as Insulin, Vaccines and DNA finger printing.

THEORY

CREDITS: 4 **TOTAL HOURS: 60**

UNIT I: Introduction to recombinant DNA technology **No. of hours: 08**

Overview of gene cloning. Restriction, modification systems and DNA modifying enzymes, DNA analysis by electrophoresis.

UNIT II: Cloning vectors for prokaryotes and eukaryotes **No. of hours: 12**

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors for *E. coli* like pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage.Ti plasmid, BAC and YAC.

UNIT III: Introduction of DNA into cells and selection of recombinants No. of hours: 12

Ligation of DNA molecules. Introduction of DNA into cells, Transformation, selection for transformed cells. Identification of recombinants, blue-white selection. Identification of recombinant phages. cDNA and Genomic libraries.

UNIT IV: Polymerase chain reaction and DNA sequencing **No. of hours: 08**

Fundamentals of polymerase chain reaction, designing primers for PCR. DNA sequencing by Sanger's method and automated DNA sequencing.

UNIT V: Expression of cloned genes **No. of hours: 12**

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

UNIT VI: Applications of genetic engineering in biotechnology **No. of hours: 12**

Production of recombinant proteins such as insulin and factor VIII. Gene therapy. Genetically modified herbicide glyphosate resistant crops. Ethics concerns.

GENERIC ELECTIVE (GE) COURSES
GE- 7 Practical
Recombinant DNA Technology (1Y3BCH404P)

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

DNA estimation by UV spectrophotometry.Isolation of plasmid DNA from *E. coli.*
Restriction digestion and agarose gel electrophoresis.
Amplification of a DNA fragment by PCR.

2.3 References

Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell Publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.

Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN:978-1-55581-498-4 (HC).

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)

SKILL ENHANCEMENT ELECTIVE (SEC) COURSES

B.Sc. (HONOURS) BIOCHEMISTRY
SKILLENHANCEMENT ELECTIVE (SEC) COURSES
SEC-1
Biochemical Techniques (1Y3BCH304)
Semester - III

Course Objectives

The objective of the course is to introduce to the students, various techniques that are used in a biochemistry lab and to provide them with an understanding of the principle underlying these techniques and laboratory skills in the form of practical exercises so that students can apply this knowledge to pursue research.

2.1 Course Learning Outcomes

The course is designed for undergraduate students to know the basic concepts of various techniques used in Biochemistry. The course will enable students to:

Acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.
Learn about the principle and applications of electrophoresis and centrifugation techniques.
It will also give them an opportunity to get hands on experience to develop their laboratory skills expected of any biochemist working in a research lab.

THEORY

CREDITS: 2 **TOTAL HOURS:30**

UNIT I: Spectroscopic Techniques **No. of hours: 6**

Electromagnetic radiation, interaction of radiation with biomolecules, principle of UV-visible absorption spectrophotometry, Lambert's Law, Beer's Law, working of a spectrophotometer. Applications of UV-visible absorption spectrophotometry in biochemistry. Fluorescence spectrophotometry and its applications in biochemistry.

UNIT II: Chromatography **No. of hours: 10**

Introduction to chromatography. Principle and applications of Paper Chromatography, Thin Layer Chromatography, Ion Exchange Chromatography, Gel filtration and Affinity Chromatography.

UNIT III: Electrophoresis **No. of hours: 8**

Principle of electrophoresis, Polyacrylamide gel electrophoresis (native and denaturing) for proteins and nucleic acids. Agarose gel electrophoresis, Isoelectric focusing of proteins, two- dimensional. Detection and identification of proteins and nucleic acids and determination of molecular weight.

UNIT IV: Centrifugation **No. of hours: 6**

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient. Various types of centrifuges, types of rotors. Application of centrifugation, differential centrifugation, density gradient centrifugation (zonal and isopycnic).

SKILL ENHANCEMENT ELECTIVE (SEC) COURSES
SEC-1 Practical
Biochemical Techniques (1Y3BCH304P)

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Determination of absorption maxima (λmax) of small molecules and macromolecules.
Verification of Beer's Law.
Determination of molar extinction coefficient.
Separation of amino acid acids/sugars by thin layer chromatography (TLC)
Separation of proteins by gel filtration chromatography
Separation of protein by Ion exchange chromatography
Separation of nucleic acids using agarose gel electrophoresis
Separation of protein by SDS PAGE.

2.3 References

Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques 6th ed,. Botson,Mass Prentice Hall, 2012, ISBN-13: 978-0136043027.
Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), 1998, ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0- 07-099487-0.
Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7 th ed., Cambridge University Press, 2010, ISBN 978-0-521-51635-8.

Additional Reading

Cooper T G, The Tools of Biochemistry 2nd ed., Wiley-Interscience Publication (New Delhi), 2011, ISBN: 13:9788126530168.
Freifelder, D., Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd W. H. Freeman and Company (New York), 1982, ISBN:0-7167- 1315-2 / ISBN:0-7167-1444-2.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
SKILL ENHANCEMENT ELECTIVE (SEC) COURSES
SEC-2
Biostatistics (1Y3BCH305)
Semester - III

Course Objective

The primary objective of this course being offered as an elective skill enhancement course is to:

Provide understanding about the principles of biological data collection, statistical analysis and presentation.
Provide a hands-on-experience by performing practicals that are well correlated with the theory topics and are designed to support skill oriented learning outcomes in the management of biological data.

2.1 Course Learning Outcomes

Learners will be able to:

Understand the principles of biological data collection, statistical analysis and presentation.
Learn and appreciate various factors that influence type of sample collected and sample size.
Collect, analyze and interpret biological data using appropriate statistical tools
Apply the principles of biological data management in real life situations
Improvise their computational, mathematical and computer skills, which would increase their eligibility to pursue research based higher education.

THEORY

CREDITS: 2 **TOTAL HOURS: 30**

UNIT I: Data Collection and Presentation **No. of hours: 4**

Importance of statistical analysis in biological data management. Sampling schemes – SimpleRandom sampling, systemic sampling, Stratified sampling, Cluster sampling, Non probabilitysampling; Types of numerical data – Nominal data, Ordinal Data, Ranked data, discrete data, continuous data; Modes of presenting data: Frequency distributions, Relative frequency.

UNIT II: Measures of central tendency and analysis of variance **No. of hours: 12**

Mean, median, mode; Co-efficient of variation and standard deviation; Range and interquartile range; Grouped mean and grouped variance; Frequency distributions; One way ANOVA; Two-way ANOVA; AMOVA; student's t test

UNIT III: Probability **No. of hours: 4**

Operations on events, Venn diagrams, Conditional Probability; Probability distributions.

UNIT IV: Hypothesis Testing **No. of hours: 4**

General concepts – Null hypothesis, alternative hypothesis, Rejection of hypothesis; Type I and Type II errors; P value and sample size estimation.

UNIT V: Regression and Correlation **No. of hours: 6**

Chi Square Test – Observed and expected frequencies, Calculating p values, assumptions of a chi square goodness of fit; Correlation –Two-way scatter plot, Pearson's correlation coefficient; Regression – regression concepts, simple linear regression; Calculation of R2 and ρ.

SKILL ENHANCEMENT ELECTIVE (SEC) COURSES
SEC-2 Practical
Biostatistics (1Y3BCH305P)

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Exercise 1. Collection of data

Random sampling method
Stratified sampling method
Cluster sampling method

Exercise 2. Data representation

Frequency and relative frequency distribution table, Plotting different biological data in a best representative graphical format.

Exercise 3. Data analysis

Calculating Mean, median, mode, variance, standard deviation and standard error for a givendata set.
Standard t-test for grouped samples.
Analysis of 2 way variance
Chi square goodness of fit test
Regression analysis and calculating regression coefficient

Exercise 4

Learning to analyze data using SPSS or R software

Exercise 5

Project assignment.

2.3 References

Analysis of biological data, M. Whitlock and D. Schluter (2009); Roberts and company publishers; ISBN- 978-0-9815194-0-1
Principles of biostatistics, M. Pagano and K. Gauvreau (2000); Duxbury Thomasl earnings; ISBN- 0-574-22902-6.

Additional Resources:

Biostatisticalanlysis, J.H. Zar (2010); 5th Ed; Pearsons Int. Edition; ISBN- 978-0-13-206502-3.

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
SKILL ENHANCEMENT (SEC) COURSE
SEC-3
Research Methodology (1Y3BCH306)
Semester III

Course Objective:

The main objective of this paper is to provide students with:

A general introduction to the methodological foundations and tools used in research for an understanding of the ways to identify problems, develop hypotheses and research questions and design research projects.
An exposure to the broad range of designs used in research in laboratory, field experiments, surveys and content analysis.
An introduction to the concept of controls, statistical tools and computer applications used in research.
Knowledge of scientific writing, oral presentation and the various associated ethical issues.

2. 1 Course Learning Outcomes:

By studying this paper students will be able to:

Define research, learn the importance of research and its link with theoretical knowledge
Describe the research process and the principle activities, skills and ethics associated with the research process
Describe and compare the major quantitative and qualitative research methods construct an effective research proposal
Understand the importance of research ethics use the computer software for organization and analysis of data.
Develop skills in the art of scientific writing and oral presentation

2.2Course Contents

THEORY

CREDITS: 2 **TOTAL HOURS: 30**

UNIT I: Objectives of research **No. of hours: 4**

Definition, objectives, types of research, classification, various phases of research.

UNIT II: Research proposals and literature survey **No. of hours: 6**

Research proposal and aspects, Review of literature using appropriate sources – reviews,patents, research papers, books.

UNIT III: Basic principles of research design **No. of hours: 6**

Types of research designs – exploratory, descriptive, experimental, survey and case study. **UNIT IV:**

Experimental, sampling design and data collection **No. of hours: 6**

Sample - types, criteria, characteristics and steps; Tools and techniques to execute experiments; Observation, questionnaire, interview

UNIT V: Interpretation, report writing and the art of oral presentation

No. of hours: 4

Report writing, format of publications in research journals, how to present papers andresearch findings

UNIT VI: Bioethics and Plagiarism in Research **No. of hours: 4**

Biosafety and Ethics - compliance and concerns; Plagiarism; Citation and acknowledgement

SKILL ENHANCEMENT (SEC) COURSE
SEC-3 Practical
Research Methodology (1Y3BCH306P)

PRACTICALS
CREDITS: 2

TOTAL HOURS: 60
Full Marks:30
Time: $1^1/2$ Hrs

Writing of a Mini-Review paper
Design of a research survey on a specific problem Idea presentations in small groups

2.3 References

Research Methodology: Methods and Techniques (2004) 2nd ed., Kothari C.R., New Age International Publishers.
Research Methodology: A Step-by-Step Guide for Beginners (2005) 2nd ed., Kumar R., Pearson Education.
Research Methods The Basics -Nicholas Walliman
WHO (2001) Health Research Methodology – A Guide for Training in Research Methods.
Cresswell J : Research Design : Qualitative and quantitative Approaches Thousand Oaks CA, Sage Publications

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.

B.Sc. (HONOURS) BIOCHEMISTRY
SKILL ENHANCEMENT ELECTIVE (SEC) COURSES
SEC-4
Bioinformatics (1Y3BCH404)
Semester - IV

Course Objectives

The objective of this course is to impart basic understanding of bioinformatics and computational biology. The course will introduce the broad scope of bioinformatics bydiscussions on the theory and practices of computational methods in biology. This course also aims to provide students with a practical hands-on experience with common bioinformatics tools and databases. Students will be trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein structures.

Course Learning Outcomes

After completion of the course, a student will

Understand the basics of bioinformatics and computational biology and develop awareness of the interdisciplinary nature of this field.
Demonstrate the use of several softwares/tools in biology
Discuss, access and use biological databases in public domain
Understand protein structure using visualization softwares
Be able to gain understanding of sequence alignmentsAnalyze phylogeny using alignment tools
Comprehend the fundamental aspects of in-silico protein structure prediction
Understand how theoretical approaches can be used to analyze biological systems
Obtain knowledge on applications of bioinformatics from genomes to personalizedmedicine.

Content for each course

CREDITS: 2 **TOTAL HOURS: 15 hrs theory + 30 hrs practical**

UNIT I: Introduction to bioinformatics **No. of hours: 2**

Introduction to Bioinformatics, Computer fundamentals – Operating Systems, Hardware, Software, Programming languages in bioinformatics - PERL/R programming, role of supercomputers in biology, Historical background. Scope of bioinformatics - Genomics, Proteomics, Computer aided drug design (CADD) and Systems Biology.

UNIT II: Biological databases and data retrieval **No. of hours: 4**

Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Organism specific databases (E. coli, yeast, Arabidopsis, mouse, Drosophila Melanogaster), Structure viewers (Ras Mol, J mol) and File formats.

UNIT III: Sequence alignment & Phylogeny **No. of hours: 4**

Similarity, identity and homology. Concept of Alignment – local and global alignment, pairwise and multiple sequence alignments, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTALW, Definition of phylogeny and its importance, Methods of Phylogenetic tree generation, Phylip

UNIT IV: Genomics **No. of hours: 2**

Introduction to genomics, comparative and functional genomics, gene structure inprokaryotes and eukaryotes, Genome annotation, gene prediction approaches and tools.

UNIT V: Protein sequence, structure prediction and analysis **No. of hours: 3**

Protein Structure - Primary, Secondary and Tertiary structure, Protein structure prediction methods: Homology modeling, Fold recognition and *ab-initio* methods, Ramachandran plot.

SKILL ENHANCEMENT ELECTIVE (SEC) COURSES
SEC-4 Practical
Bioinformatics (1Y3BCH404P)

EXERCISES

Sequence retrieval (protein and gene) from NCBI and Molecular file formats - FASTA, GenBank/Genpept.
Structure download (protein and DNA) from PDB and Molecular viewer by visualizationsoftware (Pymol / Rasmol/Jmol)
BLAST suite of tools for pairwise alignment
Multiple sequence alignment (CLUSTALW/TCoffee) and construction of guide treesGene prediction using GENSCAN/GLIMMER
Primary sequence analyses (Protparam) and Secondary structure prediction (GOR,nnPredict).
Tertiary structure prediction (SWISSMODEL) and Protein structure evaluation -Ramachandran map (PROCHECK

References

Bioinformatics – Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B.,Oxford University Press (India), ISBN: 9780195692303.
M. Michael Gromiha, Protein Bioinformatics: From Sequence to Function, AcademicPress, 2010
Bioinformatics: Sequence and Genome Analysis (2001), 1st ed., Mount, D.W. Cold Spring Harbor Laborator Press (New York), ISBN: 0-87969-608-7.
Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2005), 3rded., Baxevanis, A.D. and Ouellette, B.F., John Wiley & Sons, Inc. (New Jersey),ISBN: 0-47147878-4.

Additional Reading

D.E. Krane and M.L. Raymer, Fundamental concepts of bioinformatics, PearsonEducation Inc. 2006
Bioinformatics and Functional Genomics (2003), 1st ed., Pevsner, J., John Wiley & Sons,Inc. (New Jersey), ISBN: 0-47121004-8.

B.Sc. (HONOURS) BIOCHEMISTRY
SKILL ENHANCEMENT ELECTIVE (SEC)
SEC- 5
Microbial Techniques (1Y3BCH405)

Course Objective

To impart basic understanding of microbial techniques by hands on experience onworking with microorganisms.
To teach students about various control methods for the growth of microbes. To make students aware about the characteristic features of different microbes

2.1 Course Learning Outcomes

After completion of this course, a student will be able:
To visualize and identify various microorganisms
To culture microorganisms in aseptic conditions
To prepare and sterilize different types of media To maintain different types of cultures
To carry out research using microorganisms.
To learn the principles behind and importance of sterilization while working in varied areas of biology in various laboratories.

2.2Course Contents

THEORY

CREDITS: 2 **TOTAL HOURS: 60**

UNIT I: Introduction **No. of hours: 2**

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Alexander Fleming. Development of various microbiological techniques and golden era of microbiology.

UNIT II: Microbial Nutrition and Growth **No. of hours: 4**

The common nutrient requirements. Nutritional types of microorganisms. Culture media and its components, Synthetic or defined media, Complex media, Enriched media, Selective media, Differential media. Isolation of Pure culture: Streaking, Serial dilution and Plating methods, cultivation, maintenance of pure cultures. Microbial Growth: phases of growth, measurement of microbial growth

UNIT III: Control of microorganisms by physical and chemical methods
No. of hours: 3

Mechanism of Dry Heat, Moist Heat, Hot air oven, Filtration and Radiations, Use of Phenolics, alcoholics, halogens, heavy metals, aldehydes and gases for sterilization.

UNIT IV: Bacterial, Fungal and Algal cell organization and staining
No. of hours: 4

Overview of characteristic features of bacterial, fungal and algal cell. Composition and detailed structure of gram- positive and gram- negative cell wall. Simple staining and negative staining of bacteria. Mechanism of gram staining.

UNIT V: Introduction to Viruses **No. of hours: 2**

General characteristic features of viruses. Nacked and envelop viruses. Examples of RNA and DNA viruses. Subviral particles: viroids, prions, virusoids and their importance. Isolation and cultivation of viruses. Virus purification and assays

SKILL ENHANCEMENT ELECTIVE (SEC)
SEC- 5 Practical
Microbial Techniques (1Y3BCH405)

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**
Full Marks: 30
Time: $1^1/2$ Hrs

Microbiology Laboratory: Basic rules and requirements.
To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
Preparation of glassware for microbiological work, cotton plugs, medium and theirsterilization.
Sterilization of heat sensitive material by filtration.
Demonstration of presence of microflora in the environment by exposing nutrient agarplates to air.
Study of different shapes of bacteria, fungi and algae using permanentslides/pictographs
To stain bacteria using crystal violet/methylene blue.
To perform Gram's staining.
To prepare temporary mount of algae.
To prepare temporary mount of fungi.
Isolation of pure cultures of bacteria by streaking method.
Enumeration of colony forming units (CFU) count by spread plate method/pour plate
Study the morphological structures of viruses (DNA and RNA) and their importantcharacters using electron micrographs.
Isolation and enumeration of bacteriophages (PFU) from water sample.

2.3 References

Willey JM, Sherwood LM, and Woolverton CJ. (2017). Prescott's Microbiology. 10th edition. McGraw Hill Higher Education. ISBN13: 9781259657573

PelczarJr MJ, Chan ECS, and Krieg NR.(2004). Microbiology.5th edition Tata McGrawHill. ISBN13: 9780074623206

Cappucino J and Sherman N. (2013). Microbiology: A Laboratory Manual. 10th edition. Pearson Education Limited. ISBN13: 9780321840226

Additional Resources:

Madigan MT, Martinko JM, Dunlap PV and Clark DP (2010).Brock Biology of Micro-organisms.13thedition. Pearson Education, Inc. ISBN 13: 9780321649638

Dubey R.C and Maheshwari D.K. (2010). Practical Microbiology. First Edition. S.Chand. ISBN: 81-219-2153-8

Practical-1: 20 Marks, Note Book: 5 Marks, Viva: 5 Marks.