PONDICHERRY UNIVERSITY

(A CENTRAL UNIVERSITY)

CBCS REGULATIONS

&

COURSES OF STUDIES FOR

B.Sc. PROGRAMME

in

Biochemistry

(2021-22 onwards)

REGULATIONS

Choice Based Credit System

ADMISSION PROCESS

Selection of students to B. Sc. Biochemistry Programs is based on merit (12^{th} mark) and follows the Government reservation policy.

CURRICULUM GOALS/OBJECTIVES

The curriculum of this Department incorporates classical to recent concepts within different areas of each subject offered, and updates syllabus with periodic revision exercises, ensured by the Board of Studies and ratified through the School Board. The curriculum is made with a view to impart fundamental knowledge in the field of Biochemistry. The theory and practical sessions augment their ability to understand the implications of the scientific and technical approaches involved in this domain of knowledge, enabling to mold them into prospective skillful scientific workforce for the future.

EVALUATION

The student assessment followed in this department is as per the regulations notified by the Office of the Controller of Exams, Pondicherry University.

All subjects in the UG program carry an Internal assessment component. Students are expected to secure 25 % in the internal evaluation and 75% in end Semester external evaluation modes. Each teacher is expected to organize continuous assessment modes for each course assigned to him/her. The internal assessment is categorized into 15 marks for internal assessment tests/Term papers/Quizzes and 5 marks for Seminars/Assignment/Presentation/Write ups/Viva, and 5 marks for attendance. A failed student who fulfils the required attendance 75% shall have a minimum 40% in internal assessment for being permitted to register for the end semester exam. Students who have failed due to insufficient attendance (below 75%) and / or less than 40% in internal assessment marks should repeat the course as when it is offered.

GRADING

Letter grades shall be used to assess the performance of students in each course by converting final marks (out of 100) into grades. In case of fractions the marks shall be rounded off to next integer. The following shall be used to convert marks into awarding grades:

Range of Marks	Letter Grade	Grade Point
96-100	0	10
86-95	A+	09
76-85	A	08
66-75	B+	07
56-65	B	06
46-55	C	05
40-45	P	04
Below 40	F	00
Lack of attendance	FA	00

The SGPA shall also be calculated by taking all courses taken by the student in the semester and CGPA shall also be calculated by taking all the courses taken by the studentin all the semesters.

CGPA	Class
9.00 – 10.00	First Class with Distinction (should not have failed in any course)
7.00 – 8.99	First Class
5.50 – 6.99	Second Class
4.00 – 5.49	Pass

The Grade card shall be issued to the students containing grades obtained by the student in the previous semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA).

COMPUTATION OF SGPA AND CGPA

Following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) shall be followed:

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the numberof credits of all the courses undergone by a student, i.e.,

$$SGPA\ (Si) = \Sigma\ (Ci \times Gi) / \Sigma Ci$$

where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \Sigma\ (Ci \times Si) / \Sigma\ Ci$$

where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

ILLUSTRATION OF COMPUTATION OF SGPA AND CGPA AND FORMAT FOR TRANSCRIPTS

Computation of SGPA and CGPA

Illustration 1 for calculation of SGPA

The illustration is for a student who has taken six courses of given credits in a semesterand performance is given in grade letter which carry certain grade point.

Course	Credit	Grade letter	Grade point	Credit Point Credit x Grade
Course 1	3	A	08	3x08 = 24
Course 2	4	B+	07	4x07 = 28
Course 3	3	B	06	3x06 = 18
Course 4	3	O	10	3x10 = 30
Course 5	3	C	05	3x05 = 15
Course 6	4	B	06	4x06 = 24
	20			139

SGPA = 139/20 = 6.95

<u>Illustration 2 for calculation of SGPA</u>

A student registered for 6 (six) courses in a semester. At the end of the semester the student got A grade in a 4 credit course , A grade in 2 credit course B+ in a 3 creditcourse another B+ in a 3 credit course, B in a 3 credit course and F grade in a 3 credit course. Calculation of SGPA of this student is:

SGPA = (8x4+8x2+7x3+7x3+6x3+0x3)/(4+2+3+3+3+3) = (32+16+21+21 +18+00)/18= 108/18 = 6.00 0ut of 10.00.

SGPA of the student is 6.00.

Illustration for calculation of CGPA (Example)

The illustration is for calculation of CGPA of a student who studied six semesters in aUG program.

Semester	Credits	SGPA
Semester 1	20	6.95
Semester 2	22	7.80
Semester 3	18	5.65
Semester 4	21	6.04
Semester 5	19	7.21
Semester 6	20	7.85
	Total = 120	

CGPA =

(20 x 6.95 + 22 x 7.80 + 18 x 5.65 + 21 x 6.04 + 19 x 7.21 + 20 x 7.85) divided by 120	= 139.00 + 171.60 + 101.70 + 126.84 + 136.99 + 157.00 = 833.13/120 = 6.94275 Rounded off to 6.94

CGPA = 6.94. The student has passed in the program and is placed in 2nd Class.

PONDICHERRY UNIVERSITY
BACHELOR OF SCIENCE IN BIOCHEMISTRY

PROGRAMME OBJECTIVES

The B.Sc. programme in Biochemistry is intended to:

- impart basic biological and chemical knowledge for developing a strong foundation in the field of biochemistry
- make students familiar with essential scientific techniques and empower them with hands-on training to independently carry out scientific experiments
- inspire students to perform scientific enquiry, acquire horizontal knowledge and develop scientific temperament
- kindle interest in exploring the subject in depth, encouraging them to take up higher studies in life sciences
- provide the academic and professional skills required for a successful career

PROGRAMME OUTCOMES

Upon successful completion of this course, students:

- understand the fundamental chemical principles that govern biological systems
- attain critical thinking and the laboratory skills necessary to conduct and interpret basic scientific experiments
- acquire core knowledge in the basic areas of biochemistry, as well as horizontal knowledge in related life science fields
- use this knowledge to pursue either higher education or employment in various fields, or start their own businesses

STRUCTURE OF B.Sc. BIOCHEMISTRY UNDER CBCS

Discipline Specific Core Courses (DSC)

BBCT-1: Biological Science
BBCT-2: Cell Biology
BBCT-3: Molecules of Life
BBCT-4: Plant and Animal Physiology
BBCT-5: Enzymology and Carbohydrate Metabolism
BBCT-6: Human Physiology
BBCT-7: Intermediary Metabolism
BBCT-8: Molecular Biology
BBCT-9: Basic Immunology

Discipline Specific Elective Courses (DSE)

DSE-1: General Chemistry
DSE-2: Nutritional Biochemistry
DSE-3: Endocrinology
DSE-4: Clinical Biochemistry
DSE-5: Genetics

Skill Enhancement Elective Courses (SEC)

SEC-1: Basic Microbiology
SEC-2: Analytical Biochemistry
SEC-3: Entrepreneurial Skill Development
SEC-4: Genetic Engineering

Generic Elective Courses (GE)

GE-1: Biostatistics and Scientific Writing
GE-2: Bioinformatics

Ability Enhancement Compulsory Course (AECC)

AECC-1: English ×4 Semesters
AECC-2: MIL communication ×4 Semesters
AECC-3: Public Administration
AECC-4: Environmental Studies

B.Sc. Biochemistry

CBCS - Course Structure

2020–21 onwards

Course (Theory) / (Practical)	Subject Code	Subject	Credits	Page
FIRST SEMESTER				
MIL-1	LTAM 111	Language-I	3	
ENGLISH-1	ENGL 112	English-I	3	
DSC-1(T)	BBCT 111	Biological Science	4	1
DSE-1(T)	CHET 112	General Chemistry	4	35
AECC-I	XXXX 11X	Public Administration	2	
DSC-1(P)	BBCP 111	Lab in Biological Science	2	14
DSE-1(P)	CHEP 112	Lab in General Chemistry	1	37
SECOND SEMESTER				
MIL-2	LTAM 121	Language-II	3	
ENGLISH-2	ENGL 122	English-II	3	
DSC-2(T)	BBCT 121	Cell Biology	4	2
DSC-3(T)	BBCT 122	Molecules of Life	4	4
AECC –II	ENVS 12X	Environmental Studies	2	
DSC-2(P)	BBCP 121	Lab in Cell Biology	2	15
DSC-3(P)	BBCP 122	Lab in Molecules of Life	2	15
THIRD SEMESTER				
MIL-3	LTAM 231	Language-III	3	
ENGLISH-3	ENGL 232	English-III	3	
DSC-4(T)	BBCT 231	Plant and Animal Physiology	4	5
DSC-5(T)	BBCT 232	Enzymology & Carbohydrate Metabolism	4	7
SEC-1(T)	BMBT 233	Basic Microbiology	2	26
DSC-4(P)	BBCP 231	Lab in Plant and Animal Physiology	2	16
DSC-5(P)	BBCP 232	Lab in Enzymology & Carbohydrate Metabolism	2	16
SEC-1(P)	BMBP 233	Lab in Basic Microbiology	1	31

Course (Theory) / (Practical)	Subject Code	Subject	Credits	Page
FOURTH SEMESTER				
MIL-4	LTAM 241	Language-IV	3	
ENGLISH-4	ENGL 242	English-IV	3	
DSC-6(T)	BBCT 241	Human Physiology	4	8
DSC-7(T)	BBCT 242	Intermediary Metabolism	4	10
SEC-2(T)	ABCT 243	Analytical Biochemistry	2	27
DSC-6(P)	BBCP 241	Lab in Human Physiology	2	17
DSC-7(P)	BBCP 242	Lab in Intermediary Metabolism	2	17
SEC-2(P)	ABCP 243	Lab in Analytical Biochemistry	1	31
FIFTH SEMESTER				
DSC-8(T)	BBCT 351	Molecular Biology	4	11
DSE-2(T)	NBCT 352	Nutritional Biochemistry	4	19
DSE-3	ENDO 353	Endocrinology	4	20
SEC-3	EPSD 354	Entrepreneurial Skill Development	2	28
GE-1	BSSW 355	Biostatistics and Scientific Writing	3	33
DSC-8(P)	BBCP 351	Lab in Molecular Biology	2	18
DSE-2(P)	NBCP 352	Lab in Nutritional Biochemistry	1	25
SIXTH SEMESTER				
DSC-9(T)	BBCT 361	Basic Immunology	4	13
DSE-4(T)	CBCT 362	Clinical Biochemistry	4	22
DSE-5	GNTC 363	Genetics	4	23
SEC-4(T)	GENT 364	Genetic Engineering	2	30
GE-2	BINF 365	Bioinformatics	3	34
DSC-9(P)	BBCP 361	Lab in Basic Immunology	2	18
DSE-4(P)	CBCP 362	Lab in Clinical Biochemistry	1	25
SEC-4(P)	GENP 364	Lab in Genetic Engineering	1	32

EXAMINATION SCHEME
CBCS
B. Sc. BIOCHEMISTRY 2020–21 onwards

Papers	Subject code	Subjects	Theory Max	Theory Min	IA Max	IA Min	Practical Max	Practical Min	Total Max	Total Min
Semester-I										
MIL-1	LTAM 111	Language-I	75		25		-	-	100	40
ENGLISH-1	ENGL 112	English-I	75		25		-	-	100	40
DSC-1	BBCT/P 111	Biological Science	75		25		50	20	150	60
DSE-1	CHET/P 112	General Chemistry	75		25		50	20	150	60
AECC –I	XXXX 11X	Public Administration	75		25		-	-	100	40
Semester –II									**Total marks 600**	
MIL-2	LTAM 121	Language-II	75		25		-	-	100	40
ENGLISH-2	ENGL 122	English-II	75		25		-	-	100	40
DSC-2	BBCT/P121	Cell Biology	75		25		50	20	150	60
DSC-3	BBCT/P 122	Molecules of Life	75		25		50	20	150	60
AECC –II	ENVS 12X	Environmental Studies	75		25		-	-	100	40
Semester –III									**Total marks 600**	
MIL-3	LTAM 231	Language-III	75		25		-	-	100	40
ENGLISH-3	ENGL 232	English-III	75		25		-	-	100	40
DSC-4	BBCT/P 231	Plant and Animal Physiology	75		25		50	20	150	60
DSC-5	BBCT/P 232	Enzymology & Carbohydrate Metabolism	75		25		50	20	150	60
SEC-1	BMBT/P 233	Basic Microbiology	75		25		50	20	150	60
Semester –IV									**Total marks 650**	
MIL-4	LTAM 241	Language-IV	75		25		-	-	100	40
ENGLISH-4	ENGL 242	English-IV	75		25		-	-	100	40
DSC-6	BBCT/P241	Human Physiology	75		25		50	20	150	60
DSC-7	BBCT/P242	Intermediary Metabolism	75		25		50	20	150	60
SEC-2	ABCT/P243	Analytical Biochemistry	75		25		50	20	150	60
Semester –V									**Total marks 650**	
DSC-8	BBCT/P 351	Molecular Biology	75		25		50	20	150	60
DSE-2	NBCT/P 352	Nutritional Biochemistry	75		25		50	20	150	60
DSE-3	ENDO 353	Endocrinology	75		25		-	-	100	40
SEC-3	EPSD 354	Entrepreneurial Skill Development	75		25		-	-	100	40
GE-1	BSSW 355	Biostatistics and Scientific Writing	75		25		-	-	100	40
Semester –VI									**Total marks 600**	
DSC-9	BBCT/P361	Basic Immunology	75		25		50	20	150	60
DSE-4	CBCT/P 362	Clinical Biochemistry	75		25		50	20	150	60
DSE-5	GNTC 363	Genetics	75		25		-	-	100	40
SEC-4	GENT/P 364	Genetic Engineering	75		25		50	20	150	60
GE- 2	BINF 365	Bioinformatics	75		25		-	-	100	40
									Total marks 650	

DISCIPLINE SPECIFIC CORE COURSES

BBCT 111 - BIOLOGICAL SCIENCE

(DSC- 4 credits)

Course objectives:

- *This module serves as a bridge-course between the biology studied in school, and that relevant to the understanding of biochemistry to be studied in subsequent years*
- *This interdisciplinary paper is also aimed at providing wide horizontal knowledge so that the student can feel comfortable taking any life science major in higher studies*
- *This paper offers a competitive advantage in exams like GATE and NET, as it provides an overview of all topics in life sciences*

UNIT I: INTRODUCTION TO PLANT AND ANIMAL SCIENCES (10 hrs)

What is life?. Origin of life: Modern and cell theory. Abiogenesis experimental proof and evidences. Concepts of species and general classification of plants and animals. Overview of kingdom Animalia (Cnidaria, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata and Vertebrates) and Plantae (Bryophytes, Pteritophytes, and Spermatophytes: Gymnosperms and Angiosperms). General characteristics of each group up to class level with an example.

UNIT II: STRUCTURE & FUNCTIONS OF PLANT & ANIMAL TISSUES (7 hrs)

Structure, distribution and functions of parenchyma, collenchyma, sclerenchyma, secretory ducts, laticiferous tubules, merismatic tissue, xylem and phloem. Structure, distribution and functions of epithelial tissue (squamous), connective tissue (fibrous). Cellular basis of connective tissue. Structure and functions of smooth, striated and cardiac muscle tissue, and nervous tissue (neuron).

UNIT III: NUTRITION AND TRANSPORT IN PLANTS (10 hrs)

Grouping of organisms based on energy and carbon sources. Photosynthetic pigments and photosynthesis (light and dark reactions). Plant–water relations: movement of water through a flowering plant, transpiration and stomatal mechanism. Ascent of water in xylem: cohesion, adhesion and root pressure. Mechanism of movement of organic solutes in phloem: Munch's mass flow hypothesis. Significance of nutrients in plants: macronutrients (nitrogen, phosphorus and potassium) and micronutrients (magnesium, manganese, iron, zinc and sulphur).

UNIT IV: NUTRITION, TRANSPORT IN ANIMALS (8 hrs)

Different types of heterotrophic nutrition: holozoic, saprotrophic, parasitic and symbiotic. Feeding mechanisms: filter feeders, detritus feeders, biting and chewing, fluid feeders (sucking and piercing). Types of heart: two-, three- and four-chambered. Types of circulation: open, closed, single and double circulation. General characteristics of blood vessels (arteries, veins, capillaries). Brief introduction to vascular system, lymphatic organs and lymph in humans. Composition of blood and clotting mechanism.

UNIT V: GROWTH IN PLANTS AND ANIMALS (10 hrs)

Definition and types of growth**,** measurement of growth and patterns of growth. Growth and development in flowering plants. Plant growth regulators: phytohormones biological functions (auxin, gibberellin, cytokinin, abscisic acid and ethylene. Photoperioidism. Growth patterns and evidence of growth in animals. Sexually and asexually produced offspring, Regeneration, metamorphosis and neoteny.

REFERENCE BOOKS:

1. Freeman S, Quillin K, Allison L, Black M, Podgroski G, Taylor E and Carmichael J, *Biological sciences* (7th ed.), San Francisco: Pearson, 2019.
2. Tortora, GJ, Derrickson BH, *Principles of Anatomy & Physiology* (12th ed), John Wiley & sons, USA, 2008.

SUGGESTED READINGS:

1. Mader SS and Windelspecht M, *Biology* (13th ed.), New York: McGraw-Hill, 2018.
2. Dickison WC, *Integrative Plant Anatomy* (1st ed). Harcourt Academic Press, USA, 2000.

Course outcome:

Upon successful completion of the course, students are able to:

- *Understand the basics and feel comfortable in any life science subject from phenetics and cladistics to zoology, botany, plant and animal physiology*
- *Comprehend the basic physiology that occurs in all the diverse living organisms*
- *Appreciate the biodiversity of the world, and learn to conserve it by minimizing human impact on environment*

BBCT 121 - CELL BIOLOGY

Course objectives: (DSC- 4 credits

- *To study the structural and functional organization of the cell and its organelles*
- *To comprehend the phases of cell cycle and cell division*
- *To acquire knowledge about the components of microscope and the principles and applications of different microscopy techniques*

UNIT I: INTRODUCTION TO CELL BIOLOGY (7 hrs)

Historical aspects: Assembly and origin of macromolecules, cell theory, protoplasm theory and organizational theory. Broad classification of cell types: prokaryotic cell and eukaryotic cells structural organization and characteristics. Different cell types in tissues. Compartments and division of labour within organelles. Ultrastructure of virus, bacterial, plant and animal cells.

UNIT II: CELL WALL AND CELL MEMBRANE (8 hrs)

Bacterial and plant cell wall structure and functions. Plasma membrane: membrane models and composition. Types of junction: tight junction, gap junction and adherens junction. Transport mechanisms: simple diffusion, osmosis, facilitated diffusion, uniport, antiport, symport and bulk transport (ion channels, exocytosis, endocytosis, pinocytosis and phagocytosis). Cytoskeleton structure: microtubules and microfilaments. Basic aspects of intercellular communication: autocrine, paracrine, endocrine and neuronal signaling.

UNIT III: CELL ORGANELLES (12 hrs)

Structure and functions of: endoplasmic reticulum (rough endoplasmic reticulum and smooth endoplasmic reticulum), Golgi apparatus, lysosomes, centrioles, basal bodies, vacuoles, ribosomes and microbodies (peroxisomes and glyoxisomes). Mitochondria: structure, function and organization of the respiratory chain. Chloroplasts: structure, function and roles in photophosphorylation.

UNIT IV: THE NUCLEUS (8 hrs)

Structure and internal organization of the nucleus. Nuclear pore complex, the nuclear matrix and the nucleolus. Supercoiling and organization of genomic DNA: chromosomes and higher order chromatin structure, functional domains within the nucleus. Cell cycle: cell division (mitosis and meiosis), and its regulation: checkpoints in the cell cycle.

UNIT V: MICROSCOPY (10 hrs)

Principles and applications of microscopy: refraction, magnification, resolution, resolution limit and Ernst Abbe's equation. Components and applications of: light microscopy, dark field microscopy, phase contrast microscopy, differential interference contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy (transmission electron microscopy, scanning electron microscopy, scanning tunneling microscopy) and atomic force microscopy.

REFERENCE BOOKS:

1. Cooper GM, *The cell: a molecular approach* (8th ed.), London: Sinauer, 2018.
2. Alberts B, Johnson A, Lewis J, *et al*., *Molecular biology of the cell* (6th ed.), New York: Garland Science, Inc., 2014.

SUGGESTED READING:

1. De Robertis EDP and De Robertis EMF, *Cell and molecular biology* (8th ed.), New York: Lippincott Wilkins & Williams, 2011.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the structure and functions of the basic components of prokaryotic and eukaryotic cells, and also to gain insights about various types of membrane transport*
- *Comprehend the structure and functions of chromosomes and learn to independently prepare stained specimens and identify the phases of cell division*
- *Independently gain practical hands-on expertise in basic microscopy, simple staining and temporary mount preparations.*

BBCT 122 - MOLECULES OF LIFE

(DSC – 4 credits)

Course objectives:

- *This course is designed to serve as a bridge-course between the basics of chemistry and biology learnt in school, and those which will be taught in this degree program*
- *It emphasizes on the basic chemical foundations of life: water, carbohydrates, lipids, amino acids, proteins, and nucleic acids, and their unique structural, and physico-chemical properties*
- *It also aims to provide hands-on practical training for the qualitative analysis of different biomolecules*

UNIT I: FOUNDATIONS OF LIFE (7 hrs)

Introduction to cellular and chemical foundations of life. Elements found in living organisms. Biological significance of water, weak interactions in aqueous systems, ionization of water, pH, pK_a. Henderson–Hasselbalch equation, biological buffer systems: body fluids and their principal buffers.

UNIT II: CARBOHYDRATES (8 hrs)

Classification, chemical and physical properties. Monosaccharide: stereoisomers, enantiomers, epimers, mutarotation. Sugar derivatives: amino sugars, sugar alcohol, sugar acids, deoxysugar and glycosides. Disaccharides: sucrose, lactose and maltose. Polysaccharides: homo and hetero polysaccharides, mucopolysaccharides and glycoproteins.

UNIT III: LIPIDS (7 hrs)

Classification, chemical and physical properties. Fatty acids: saturated, unsaturated and essential fatty acids; rancidity, saponification number, iodine number, acid number and Reichert–Meissel number. Structure and biological functions of triacylglycerol, phospholipids, cholesterol and plant sterols.

UNIT IV: PROTEINS AND AMINO ACIDS (13 hrs)

Classification, chemical and physical properties of amino acids. Peptide bond: planarity and dihedral angles, Ramachandran plot. Structural hierarchy of proteins: primary, secondary, super-secondary, tertiary and quaternary structures. Classification of proteins, properties: isoelectric point, zwitterions, and precipitation reactions. Globular and fibrous proteins: structure and functions of hemoglobin, collagen, elastin, and keratin.

UNIT V: NUCLEIC ACIDS (10 hrs)

Chemistry of purine and pyrimidine, nucleosides and nucleotides. Types of DNA: structure and properties of A-, B- and Z-DNA. Denaturation, renaturation, T_m and hyperchromicity. Effect of acid and alkali on DNA and RNA. Types and functions of RNA: rRNA, mRNA, tRNA. Primary, secondary, and tertiary structures of tRNA.

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.

2. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.

SUGGESTED READING:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the chemical and molecular foundations of life and their roles in biological systems*
- *Comprehend the classification, structure, chemical properties and biological functions of carbohydrates, lipids, amino acids, proteins and nucleic acids*
- *Prepare biochemical solutions and analyze various biomolecules qualitatively in the laboratory.*

BBCT 231- PLANT & ANIMAL PHYSIOLOGY

(DSC – 4 credits)

Course objectives:

- *This module is intended to provide basic knowledge in realms of lifescience and to draw the attention of students to different arenas of life sciences suitable for their higher studies.*
- *This paper can also be useful for competitive advantage in exams like GATE and NET, as it provides an overview of all topics in life science*

UNIT I: HOMEOSTASIS (7 hrs)

Homeostasis concept. Control systems in biology: types and components of control system (block diagram of input unit, processing unit and responding unit), threshold level and steady state level. Temperature regulation in ectothermic and endothermic animals. Osmoregulation and water conservation: nitrogen and urea excretion in ammonotelic, ureotelic and uricotelic animals, blood pH regulation.

UNIT II: REPRODUCTION IN PLANTS AND ANIMALS (8 hrs)

Reproduction types in plants. Types of asexual reproduction in plants: cutting, grafting and layering. Roles of plants part involved in asexual reproduction: bulb, corn, rhizomes, tuber and stolen. Artificial propagation of plants, and tissue culture. Sexual reproduction: pollination and fertilization. Reproduction in animals: outline of asexual reproduction in animals. Sexual reproduction in animals: Humans male and female reproductive system.

UNIT III: BASIC CONCEPTS OF DEVELOPMENTAL BIOLOGY (10 hrs)

History, basic concepts and landmark experiments in developmental biology. Outline of organizers, gametogenesis, fertilization, cleavage, blastulation, gastrulation. Types of morphogenetic movements: epiboly, emboly, involution, ingression, invagination, intercalation and convergent extension. Cell fate and commitment. Differentiation and pattern formation.

Fates of the ecto- (epidermis, neural crest and neural tube), endo- and mesoderm. Somitogenesis: paraxial, caudal, lateral and intermediate.

UNIT IV: CONTROL AND CO-ORDINATION IN PLANTS AND ANIMALS (12hrs)

Plant movements: tropism, taxes, nastic and kinesis in brief. Types of stimuli and their applications. Types of plant movements with examples. Phloem calcium channels in plant co-ordination. Control and coordination in animals: stimuli, means of coordination: receptors and effectors. Parts of the nervous system: central, peripheral (sensory, motor and somatic) and autonomic. Reflex action and its importance.

UNIT V: EVOLUTION (8 hrs)

Theories of the origin of life. Evolution, and evidences for evolution: fossils, comparative anatomy, comparative embryology, biochemical and biogeographic evidence. Human evolution. Selection: definition, types (artificial and natural), and mechanisms. Concept of inbreeding and outbreeding: advantages and disadvantages. The peppered moth experiment (directional, stabilizing and disruptive selection). Definition of species, and types of speciation: inter- and intraspecific (allopatric and sympatric) speciation.

REFERENCE BOOKS:

1. Freeman S, Quillin K, Allison L, Black M, Podgroski G, Taylor E and Carmichael J, *Biological sciences* (7th ed.), San Francisco: Pearson, 2019.
2. Barresi MJF and Gilbert SF, *Developmental biology* (12th ed.), New York: Sinauer, 2019.
3. Taiz L, Zeiger E, Møller IM and Murphy A, *Plant physiology and development* (6th ed.), New York: Sinauer, 2015.

SUGGESTED READING:

1. Mader SS and Windelspecht M, *Biology* (13th ed.), New York: McGraw-Hill, 2018.

Course outcome:

Upon successful completion of the course, students are able to:

- *Understand the basics of most life science subjects from physiology to developmental and evolutionary biology*
- *Comprehend the basic physiology that occurs in all living organisms such as homeostasis, control and co-ordination*
- *Learn about the origin of life, and the narrow balance that exists within*

BBCT 232 - ENZYMOLOGY AND CARBOHYDRATE METABOLISM

(DSC – 4 credits)

Course objectives

- *The course is designed to provide an insight into the nomenclature and classification of enzymes, the mechanism and kinetics of an enzymatic reaction, and the types and kinetics of enzymeinhibition*
- *To understand the various pathways of carbohydrates metabolism, their regulations and energetics*
- *To practically determine the kinetics of enzymatic reactions and to study the effect of pH and temperature*

UNIT I: OVERVIEW AND CLASSIFICATION OF ENZYMES (8 hrs)

Historical perspective and definition of enzymes. Nomenclature of enzymes, enzyme classification and characteristics. Co-enzymes and cofactors. Isoenzymes, abzymes and ribozymes. Metalloenzymes and metal-activated enzymes. Proteolytic enzymes. Multienzyme complexes: pyruvate dehydrogenase and fatty acid synthase.

UNIT II: ENZYME KINETICS (10 hrs)

Units of enzyme activity. Factors affecting enzyme activity: pH, temperature and substrate concentration. Derivation of Michaelis–Menten equation. Limitations and transformation of the MM equation: Lineweaver–Burk plot and Hanes–Woolf plot. K_m, V_{max} and K_{cat}. Turnover number, catalytic efficiency and enzyme specificity. Enzyme inhibition: reversible (competitive, uncompetitive and non-competitive) and irreversible. Enzyme regulation: covalent modification, allosteric, end-product, and feedback regulation.

UNIT III: MECHANISM OF ENZYME CATALYSIS (7 hrs)

Enzyme active site and its general characteristics. Mechanism of enzyme action: lock-and-key model, induced- fit hypothesis. Mechanisms of enzyme catalysis: acid–base catalysis, covalent catalysis, substrate strain and entropy effect. Mechanisms of action of chymotrypsin, lysozyme and carboxypeptidase.

UNIT IV: CARBOHYDRATE METABOLISM (12 hrs)

Introduction to metabolism. Types of metabolic pathways: anabolic, catabolic and amphibolic pathways**.** The glycolytic pathway, TCA cycle and their regulations. Mitochondrial transport systems: malate and glycerophosphate shuttles. Significance of substrate level phosphorylation. Gluconeogenesis, Glycogenesis, Glycogenolysis and their regulations. The Luebering–Rapoport pathway, Cori cycle, Glucose–alanine cycle and the utilization of lactose and fructose. HMP shunt and the Uronic acid pathways.

UNIT V: BIOLOGICAL OXIDATION AND ENERGETICS (8 hrs)

Introduction to bioenergetics and free energy concept. Thermodynamics of ATP hydrolysis, and other high energy compounds. The electon transport chain (ETC): components and reactions of the ETC. Mechanism of oxidative phosphorylation: ATP synthase complex and Mitchell's chemiosmotic theory. P/O ratio, uncouplers and inhibitors of the ETC.

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
2. Rodwell VW, Bender DA, Botham KM, *et al*., *Harper's illustrated biochemistry* (31st ed.), London: McGraw Hill, 2018.
3. Palmer T and Bonner PL, *Enzymes* (2nd ed.), Cambridge: Woodhead Publishing, 2007.

SUGGESTED READINGS:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.
2. Devlin TM, Textbook of biochemistry with clinical correlations (7th ed.), New York: John Wiley & Sons, 2010.

Course outcome: *Upon successful completion of the course, students are able:*

- *to understand the concepts of enzymes, and the mechanics and kinetics of enzymatic reactions*
- *to comprehend the basic types of metabolic pathways, the metabolics and energetic of carbohydrates*
- *to independently perform enzymology experiments and learn to calculate enzyme activity and kinetics.*

BBCT 241- HUMAN PHYSIOLOGY

(DSC – 4 credits)

Course objectives

- *This course provides an overview on physiology, an insight into the processes responsible for sustaining life*
- *It serves as a bridge between medicine and chemistry by explaining the chemistry behind physiological processes like digestion, muscle contraction, nerve conduction, heart pumping,etc.*
- *The course also describes the alterations in normal physiology, which occur during disease, thus, providing a molecular perspective of several disease states*

UNIT I: THE DIGESTIVE SYSTEM (7 hrs)

The anatomy of the human alimentary canal. Accessory glands of the digestive system. The biochemistry of digestion of carbohydrates, protein and fats in various regions of the alimentary canal in humans. Absorption, and fates of ingested carbohydrates, protein and dietary lipids. Storage and detoxification.

UNIT II: THE CARDIOVASCULAR AND CIRCULATORY SYSTEM (8hrs)

Structure and functions of heart, conductive system of heart, origin and conduction of the heartbeat. Cardiac cycle, and electrocardiogram (ECG). Structure of the endothelium. Anatomy of the human vascular and lymphatic systems. Composition of blood and its functions. Common diseases of the blood, blood vessels and heart.

UNIT III: THE RESPIRATORY AND MUSCULAR SYSTEMS (10hrs)

Structure and functions of lung. Mechanism of pulmonary ventilation: exchange of gases between lung and blood, and transport of gases between blood and tissues. Disorders associated with the lungs: occupational and habitual diseases. Ultra-structure and chemical composition of skeletal muscle, sliding filament theory, physico-chemical changes during muscle contraction and muscular dystrophy.

UNIT IV: THE NERVOUS SYSTEM (12hrs)

Concept of nerve and nerve cells. Transmission of nerve impulse. Action potential, neurotransmitters. Synaptic conduction: neuromuscular synapse, adrenergic and cholinergic neurotransmission. The anatomy of the human brain. Functions of different parts of the human brain. The blood–brain barrier. Structure and functions of the spinal cord. Parts of the nervous system: central, peripheral and autonomic. Reflex action: importance of reflexes, sympathetic and parasympathetic nervous systems. CSF and its composition. Neurodegenerative diseases.

UNIT V: THE EXCRETORY SYSTEM (7hrs)

Structure and functions of kidney and nephron. Composition and formation of urine. Principle of ultrafiltration. Fluid and electrolyte balance, acid–base dynamics. Role of the lungs in excretion. Metabolic and respiratory acidosis and alkalosis.

REFERENCE BOOKS:

1. Hall JE, *Guyton and Hall textbook of medical physiology* (13th ed.), Philadelphia: Saunders, 2015.
2. Waugh A and Grant A, *Ross and Wilson anatomy and physiology in health and illness* (13th ed.), New York: Churchill Livingstone, 2018.

SUGGESTED READING:

1. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, *Ganong's review of medical physiology* (26th ed.), New York: McGraw-Hill Education, 2019.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the chemical reactions involved in digestion, absorption and assimilation, as well as the electrochemical and ionic changes that power the heart, neurons and muscle functions*
- *Comprehend the applications of gas laws and buffer systems in the transport of gases by the circulatory system, and the alterations in disease states*
- *Independently perform complete blood count, and be competent in hematology.*

BBCT 242 - INTERMEDIARY METABOLISM

(DSC – 4 credits)

Course objectives:

- *The course provides a detailed overview of lipid and amino acid metabolism, and the disorders associated with them*
- *It provides an understanding of the integration of metabolism and the inter-conversion of metabolites*
- *To provide hands-on training in metabolism based reactions, as well as in estimation of metabolites involved like glucose, urea and cholesterol.*

UNIT I: LIPID METABOLISM (12 hrs)

Fatty acid biosynthesis and its regulation. Biosynthesis of triacylglycerol and phospholipids. Metabolism of cholesterol: synthesis, transport, degradation and excretion. Fatty acid oxidation: β-oxidation, its energetics and regulation. Ketone bodies: formation, utilization and excretion. Transport of lipid: VLDL, LDL, HDL and chylomicrons.

UNIT II: AMINO ACID METABOLISM (10 hrs)

Amino acid pool, glycogenic and ketogenic amino acids. Transamination, deamination, decarboxylation and catabolism of amino acids. Biosynthesis and catabolism of tyrosine, methionine and lysine. Urea cycle and its regulation, interrelationship between urea cycle and the TCA cycle. Inborn errors of amino acid metabolism: alkaptonuria, phenylketonuria, cystinuria, BCAA, hyperhomocysteinemia, Fanconi's syndrome and albinism.

UNIT III: NUCLEIC ACID METABOLISM (8 hrs)

Nucleosides and nucleotides. Biosynthesis of purine and pyrimidine nucleotides: sources of nitrogen and carbon atoms of purine and pyrimidine ring. *De novo* and salvage pathways significance and regulation. Degradation of purines and pyrimidines. Abnormalities in nucleic acid metabolism: orotic aciduria and gout.

UNIT IV: HEME METABOLISM (9 hrs)

Structure and functions of hemoglobin: chemistry of porphyrins, biosynthesis and degradation of heme. Bile pigment formation, conjugated and unconjugated bilirubin. Abnormalities in heme metabolism: metabolic consequences in sickle cell anemia, thalassemia, porphyria and jaundice (hemolytic, hepatic and obstructive).

UNIT V: INTEGRATION OF METABOLISM (6 hrs)

Metabolic fluxes, energy demand and supply. Integration of Metabolic fluxes and energy requirement. Major organs involved in metabolic integration and metabolism during starvation: liver, adipose tissue, skeletal muscle and brain.

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
2. Rodwell VW, Bender DA, Botham KM, *et al*., *Harper's illustrated biochemistry* (31st ed.),

London: McGraw Hill, 2018.
3. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.

SUGGESTED READINGS:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.
2. Devlin TM, *Textbook of biochemistry with clinical correlations* (7th ed.), New York: John Wiley & Sons, 2010.

Course outcome:

Upon successful completion of this course, students are able to

- *understand important metabolic pathways of major classes of biomolecules, and their associated diseases*
- *appreciate the integrated nature of metabolism and metabolic fluxes. Independently they can perform enzyme assays, as well as functional tests for the major organs*

BBCT 351 - MOLECULAR BIOLOGY

(DSC – 4 credits)

Course objectives:

- *The course describes the central role of the information molecule – the DNA, in controlling all physiological and cellular processes*
- *It describes the flow of information from nucleic acids to proteins, and the significance of the central dogma*
- *It explains the molecular mechanisms and regulation of DNA replication, repair, transcription, post-transcriptional processing and protein synthesis*

UNIT I: INTRODUCTION AND HISTORY OF MOLECULAR BIOLOGY (9 hrs)

Discovery of DNA as genetic material: experiments of Griffith, Avery, McLeod and McCarty, Hershey and Chase experiment, Lederberg and Tatum's conjugation experiment and Friedrich Miescher's experiment. Types of DNA and RNA. Chromosomal organization in prokaryotes and eukaryotes. Chemical nature of the gene. Gene and gene concept: cistron, muton, replicon and recon. Central dogma of molecular biology.

UNIT II: DNA REPLICATION (9 hrs)

Messelson–Stahl experiment of semiconservative DNA replication. DNA replication in prokaryotes: enzymes and proteins involved in replication. DNA mutation and repair: types of mutation (mismatch, base-excision, nucleotide excision and direct repair). Replication of plasmids and mitochondrial DNA.

UNIT III: TRANSCRIPTION **(9 hrs)**

Transcription in prokaryotes: types of RNA polymerases. DNA elements in transcription: promoters, enhancers, silencers, transcription factors and inhibitors of transcription. Structure of mRNA in prokaryotes and eukaryotes. Post-transcriptional processing in eukaryotes: splicing, capping and polyadenylation. Codon, characteristics of genetic code and wobble hypothesis. Reverse transcription, transposons and retrotransposons.

UNIT IV: TRANSLATION **(9 hrs)**

Mechanism of translation in prokaryotes: amino acid activation, initiation, elongation, and termination. Posttranslational modification in eukaryotes. Inhibition of protein synthesis by antibiotics.

UNIT V: REGULATION OF GENE EXPRESSION **(9 hrs)**

Positive and negative control: *lac* and *trp* operon. Gene regulation in eukaryotes, enzyme induction and repression. Positive control of gene expression by steroid hormones.

REFERENCE BOOKS:

1. Watson JD, Baker TA, Stephen PB, *et al*., *Molecular biology of the gene* (7th ed.), San Francisco: Pearson Education, 2017.
2. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.

SUGGESTED READING:

1. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the central dogma of molecular biology: replication, transcription, translation, together with their regulation*
- *Appreciate the importance of biochemical reactions that result in molecular processes, which ultimately help a cell assemble another cell*
- *Independently perform molecular biology based experiments such as isolation and analysis of DNA, RNA and proteins*

BBCT 361 - BASIC IMMUNOLOGY

(DSC – 4 credits)

Course objectives:

- *To compare and contrast the innate and the adaptive immune systems, as well as humoral and cell-mediated immune responses*
- *To distinguish various cell types, antibody isotypes, and cytokines involved in immune responses and associated functions*
- *To understand the significance of the Major Histocompatibility Complexes in immune surveillance and transplantation*

UNIT I: OVERVIEW AND HISTORICAL PERSPECTIVE (8 hrs)

Immunity and types of immunity: innate and adaptive, active and passive, natural and acquired immunity. Overview of immune system, cells of the immune system and their functions. Organs of the immune systems and their functions: primary and secondary lymphoid organs.

UNIT II: ANTIGEN AND ANTIBODY (10 hrs)

Nature and types of antigens, specificity, epitope, haptens, adjuvants. Immunogenicity and factors affecting immunogenicity. Immunoglobulins: structure, classes and functions. Antigen– antibody reactions: agglutination, precipitation, flocculation, complement fixation, neutralization.

UNIT III: HUMORAL AND CELL-MEDIATED IMMUNITY (9 hrs)

Functions of T_H, T_C, T_S and B lymphocytes. Primary and secondary immune responses and the role of memory cells. Polyclonal and monoclonal antibody generation and their applications.

UNIT IV: IMMUNODIAGNOSTIC TECHNIQUES (10 hrs)

Single immunodiffusion: 1D and radial, double immunodiffusion: 1D and radial. Immunoelectrophoresis, immunofluorescence, rocket electrophoresis, haemagglutination, bacterial agglutination, CFT, ELISA, RIA.

UNIT V: HYPERSENSITIVITY REACTIONS (8 hrs)

Types of hypersensitive reactions: type I, II, III and IV, allergy and inflammation. Fundamentals of autoimmune disorders, immunodeficiency and immune suppression. Transplantation immunology: graft acceptance and rejection.

REFERENCE BOOKS:

1. Punt J, Stranford S, Jones P and Owen J, *Kuby immunology* (8th ed.), New York: W.H. Freeman, 2018.
2. Murphy K, Mowat A, Weaver CT, *Janeway's Immunobiology* (8th ed), Garland Science, London & New York, 2012.

SUGGESTED READING:

1. Delves PJ, Martin, SJ, Burton RD and Roitt IM, *Roitt's essential immunology* (13th ed.), London: Wiley-Blackwell, 2017.

Course outcome:

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

- *Understand the components of different cells and organs involved in humoral and cell-mediated immunity*
- *Comprehend the role of over-activation of immune system in hypersensitivity and its consequences*
- *Gain knowledge about autoimmunity, graft rejection and therapeutic modalities for immunosuppression during transplantation*

BBCP 111 - LAB IN BIOLOGICAL SCIENCE

(DSC – 2 credits)

1. Study of morphological characteristics of plants
2. Examination of cross sections of stem, root, leaf of dicots and monocots
3. Effect of CO_2 concentration on photosynthesis in *Hydrilla*
4. Transpiration index: measurement of transpiration by cobalt chloride method in dry and moist conditions
5. Observation of stomata in dicot leaf
6. Study of histological slides of various animal tissues: epithelial tissue (columnar and squamous epithelium), connective tissue (adipose and cartilage tissue), muscle (cardiac, skeletal and smooth muscle), and blood vessels (arteries and veins)

REFERENCE BOOKS:

1. Hardin J and Bertoni GP, *Becker's world of the cell* (9th ed.), Madison: Pearson, 2016.
2. Kardong KV. *Vertebrates' Comparative Anatomy, Function and Evolution* (4th ed), McGraw-Hill Higher Education, 2005.
3. Eroschenko VP. *diFiore's Atlas of Histology with Functional correlations*(12th ed.), Lippincott W. & Wilkins, 2008.

BBCP 121 - LAB IN CELL BIOLOGY

(DSC – 2 credits)

1. Study of parts of compound microscope
2. Micrometry
3. Examination of prokaryotic and eukaryotic cell
4. Study of salivary gland chromosomes
5. Staining of nuclei in cheek epithelium
6. Examination of Barr body
7. Study of mitosis in onion root tip squash preparation

REFERENCE BOOK:

1. Hardin J and Bertoni GP, *Becker's world of the cell* (9th ed.), Madison: Pearson, 2016.

BBCP 122 - LAB IN MOLECULES OF LIFE

(DSC – 2 credits)

1. Safety measures in laboratories
2. Preparation of normal and molar solutions
3. Determination of pK_a of acetic acid and glycine
4. Qualitative tests for carbohydrates:
   - Monosaccharides: hexoses (glucose and fructose), pentose (ribose)
   - Disaccharides: reducing (maltose and lactose) and non-reducing (sucrose)
   - Polysaccharides: starch
5. Qualitative tests for lipids.
6. Qualitative tests for amino acids
7. Detection of proteins and nucleic acids

REFERENCE BOOKS:

1. Hofman A and Clokie S, *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.), London: Cambridge University Press, 2018.
2. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.

BBCP 231 - LAB IN PLANT & ANIMAL PHYSIOLOGY

(DSC – 2 credits)

1. Preservation of embryo
2. Transverse sectioning, staining and temporary mounting of root
3. Transverse sectioning, staining and temporary mounting of leaf
4. Transverse sectioning, staining and temporary mounting of stem
5. RBC fragility test
6. Extraction and isolation of chlorophyll
7. Assay of starch hydrolysis in germinating seeds

REFERENCE BOOKS:

1. Lea PJ and Leegood RC, *Plant biochemistry and molecular biology* (2nd ed.), New York: John Wiley & Sons, 2001.
2. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, *Ganong's review of medical physiology* (26th ed.), New York: McGraw-Hill Education, 2019.

BBCP 232 - LAB IN ENZYMOLOGY AND CARBOHYDRATE METABOLISM

(DSC – 2 credits)

1. Isolation and quantification of starch from potatoes
2. Isolation and quantification of casein and lactalbumin from milk
3. Estimation of glucose by Benedict's method
4. Estimation of enzyme activity by end-point and continuous monitoring assay
5. Effect of pH and temperature on enzyme activity
6. Determination of enzyme activity in the presence of activators and inhibitors

REFERENCE BOOKS:

1. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.
2. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.

BBCP 241 - LAB IN HUMAN PHYSIOLOGY

(DSC – 2 credits)

1. Determination of blood pressure
2. Determination of hemoglobin
3. RBC count
4. WBC count
5. Determination of PCV and ESR
6. Measurement of PT and PTT
7. Determination of Ankle Brachial Index

REFERENCE BOOK:

1. Bell GH, Emslie-Smith D and Paterson CR, *Textbook of physiology and biochemistry* (9th ed.), London: Churchill Livingstone, 1976.

BBCP 242 - LAB IN INTERMEDIARY METABOLISM

(DSC – 2 credits)

1. Determination of acid number
2. Extraction of urease from jack bean
3. Extraction of pectinase
4. Isolation of lipids from egg yolk and separation by TLC.
5. Isolation and quantification of ovalbumin from egg
6. Estimation of protein by Biuret method
7. Spectrophotometric estimation of protein by A_{280} method

REFERENCE BOOKS:

1. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.
2. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.

BBCP 351 - LAB IN MOLECULAR BIOLOGY

(DSC – 2 credits)

1. Hydrolysis of DNA and separation of nucleotide bases by paper chromatography
2. Ultraviolet absorption spectrum of DNA and estimation of concentration by A_{260} method
3. Colorimetric estimation by DNA by diphenylamine (DPA) method
4. Isolation of microbial DNA
5. Isolation of plant and animal DNA
6. Agarose gel electrophoresis
7. Estimation of RNA by Orcinol method

REFERENCE BOOK:

1. Green MR and Sambrook J, *Molecular cloning: a laboratory manual* (4th ed.), Cold Spring Harbor: Cold Spring Harbor Laboratory Press, 2012.

BBCP 361 - LAB IN BASIC IMMUNOLOGY

(DSC – 2 credits)

1. Blood grouping
2. Identification of immune cells in blood smears
3. Single and double immunodiffusion
4. Radial immunoassay
5. Dot ELISA
6. Widal's test
7. Complement Fixation Test

REFERENCE BOOKS:

1. Gordon JR, *A practical guide to cellular and molecular research methods in immunology* (4th ed.), Saskatoon: University of Saskatchewan, 2002.
2. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.

DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES

NBCT 352 - NUTRITIONAL BIOCHEMISTRY

(DSE – 4 credits)

Course objectives:

- *This course is an introduction to the importance of nutrition in human health*
- *It includes the requirements and roles of macro- and micronutrients in the body, and the biochemical bases of deficiency diseases*
- *The course also provides practical, hands-on training in the biochemical methods and analyses used in nutritional research*

UNIT I: NUTRITION AND ENERGY METABOLISM (9 hrs)

Nutrition and the role of nutrition in maintaining health. Energy, unit of energy and measurements of energy. Energy requirement for different categories of people, body mass index (BMI) and basic metabolism. Basal metabolic rate (BMR): determination. factors affecting BMR, SDA, RQ.

UNIT II: MACRONUTRIENTS (9 hrs)

Role of food and classification of foods. Macronutrients: functions, and dietary sources of carbohydrates, fats, proteins and dietary fibre. Caloric value and recommended daily allowances (RDA). Malnutrition: deficiencies and over-consumption.

UNIT III: MICRONUTRIENTS (9 hrs)

Vitamins, classification of vitamins, dietary sources, RDA and deficiency of vitamins A, D, E, K, C and B-complex. Hypervitaminosis, and the biochemical bases of deficiency symptoms. Minerals, classification of minerals. Distribution in the body, dietary sources, RDA, digestion, mechanism of absorption, utilization, transport, storage, excretion, balance, deficiency and toxicity of calcium, iron and phosphorus. Distribution in the body, dietary sources, physiological function, deficiency and toxicity of iodine, fluoride, magnesium, copper, zinc, selenium and manganese.

UNIT IV: DIFFERENT DIMENSIONS FOR FITNESS (9 hrs)

Balanced diet, Different criteria for health and well-being: physical, intellectual, emotional, social, spiritual, environmental and occupational. Special nutritional concerns: pregnancy, lactation and aging. Special nutritional requirements of working women, female athletes and post-pregnancy weight management. Eating disorders: anorexia, bulimia, binge-eating and obesity.

UNIT V: PRESERVATION OF FOOD AND ADULTERATION (9 hrs)

Preservation of nutrients, safe food handling and toxicity. Storage of food, food preservation, food additives and its principles. Food adulteration: definition, detection and prevention. Adulterants in commonly consumed food items. Accidental contamination: botulism and staphylococcal intoxication. Importance of food labels in processed food: nutritional labelling and food standards.

REFERENCE BOOKS:

1. Mahan LK and Raymond J, *Krause's food and nutrition care process* (14th ed.), St. Louis: Elsevier, 2017.
2. Gibson R, *Principles of nutritional assessment*, London: Oxford University Press, 2005.
3. Coombs GF and McClung JP, The vitamins: fundamental aspects in nutrition and health (5th ed.), London: Academic Press, 2017.

SUGGESTED READINGS:

1. Brody T, *Nutritional biochemistry* (2nd ed.), San Diego: Academic Press, 1999.
2. Devlin TM, *Textbook of biochemistry with clinical correlations* (7th ed.), New York: John Wiley & Sons, 2010.

Course outcome:

Upon successful completion of this course, students are able to:

- *Describe the biochemical roles of macro- and micronutrients in human health and diseases*
- *Calculate the recommended metabolic requirements in normal humans, athletes and pregnant women*
- *Capable of independently estimating the vitamin and nutrition content in various food stuff in a laboratory*

ENDO 353 - ENDOCRINOLOGY

(DSE – 4 credits)

Course objectives:

- *The course provides an overview of the process of cell–cell communication through hormones*
- *It will help understand and appreciate the delicate network and balance of hormones required for the healthy functioning of the human body, and the hormonal imbalances that result in human diseases*
- *It is also intended to prepare a student for postgraduate studies in any course related to molecular medicine*

UNIT I: INTRODUCTION TO ENDOCRINOLOGY (9 hrs)

Historical perspective, comparative endocrinology and its roles in homeostasis. Definition of hormones. Mojor endocrine glands: Anatomy, structure and functions. Concept of secondary messenger system- Sautherland experiment. Chemical nature and types of hormones. Hormones regulations and feedback mechanisms.

UNIT II: BRAIN AND PITUITARY GLAND HORMONES (7 hrs)

Hormones of the hypothalamus: Structure and functions. Control of hypothalamic–hypophyseal hormone secretion. Pituitary gland: anatomy, hormones, their biological roles and associated disorders.

UNIT III: THE THYROID AND PARATHYROID GLANDS HORMONES (8 hrs)

Structure and functions of the thyroid gland. Thyroid hormones: biosynthesis and biological functions. Diseases associated with the thyroid gland: hypo- and hyperthyroidism. Structure and functions of the parathyroid gland. Parathyroid hormone: biological functions. Hypo- and hyperparathyroidism. Regulation of calcium and phosphorus metabolism by calcitriol.

UNIT IV: THE PANCREAS AND ADRENAL GLAND HORMONES (9 hrs)

Endocrine regions of the pancreas. Synthesis, regulation, secretion, biological actions and disorders associated with the pancreatic hormones: glucagon, insulin and somatostatin. Hormones of the adrenal gland: adrenal cortex (glucocorticoids and mineralocorticoids) and adrenal medulla (epinephrine and norepinephrine).

UNIT-V: THE REPRODUCTIVE AND ADIPOSE HORMONES (12 hrs)

Structure and cell types of the testis. Spermatogenesis, steroidogenensis and endocrine control of testicular function. Biological actions of androgens and associated disorders. Structure and cell types of the ovaries. The ovarian cycle, ovarian steroid hormones, their physiological roles and associated disorders. Hormones of the adipose tissue, their biological functions, and roles in diseases.

TEXT BOOKS:

1. Hall JE, *Guyton and Hall textbook of medical physiology* (13th ed.), Philadelphia: Saunders, 2016.
2. Rodwell VW, Bender DA, Botham KM, Kennelly PJ and Weil PA, *Harper's illustrated biochemistry* (31st ed.), Blacklick: McGraw-Hill Education, 2018.

SUGGESTED READING:

1. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, *Ganong's review of medical physiology* (26th ed.), New York: McGraw-Hill Education, 2019.

***Couse outcome*:** *Upon successful completion of the course, students are able to:*

- *Understand the different cognate and non-cognate modes of communication between cells in a multi-cellular organism*
- *Comprehend the roles of the different endocrine factors that regulate metabolism, growth, ionic homeostasis, glucose homeostasis and reproductive function*
- *Describe the molecular, biochemical and physiological roles of all hormone, as well as the integrative regulations of their secretions in health and disease*

CBCT 362 - CLINICAL BIOCHEMISTRY

(DSE – 4 credits)

Course objectives:

- *This course translates the knowledge learned in multiple courses such as intermediary metabolism and physiology into the diagnosis of human health and disease.*
- *It serves as a rational guide on how to employ biochemical investigations systematically in clinical diagnosis and prognosis.*
- *It also provides practical, hands-on training in the estimation of clinically relevant biomolecules in body fluids*

UNIT I: APPROACHES TO CLINICAL BIOCHEMISTRY (7 hrs)

Concepts of accuracy, precision, sensitivity and reproducibility. Quality control and determination of normal range. Collection and processing of blood and urine samples, anticoagulants, preservatives for blood and urine, and transport of biological samples.

UNIT II: DISORDERS OF CARBOHYDRATE METABOLISM (8 hrs)

Introduction: normal fasting and post-prandial blood glucose level, mechanism of blood glucose homeostasis: hypo- and hyperglycemia, renal threshold value. Diabetes mellitus: types, diagnosis, clinical features, metabolic defects and complications. GTT, galactosemia, fructosuria and glycogen storage diseases.

UNIT III: DISORDERS OF PROTEIN METABOLISM (10 hrs)

Introduction: clinical significance and variation of plasma and serum proteins. Clinical features of phenylketonuria, alkaptonuria, albinism and tyrosinosis. Disorders of the urea cycle. Clinical significance of non-protein nitrogen: BUN and creatinine (normal and abnormal levels). Clinical importance of clearance determination. Abnormal constituents of urine and their significances.

UNIT IV: DISORDERS OF LIPID AND NUCLEIC ACID METABOLISM (8 hrs)

Introduction, hypertriglyceridemia, hypo- and hyperlipoproteinemia. Atherosclerosis: clinical features and complications. Lipid storage diseases and fatty liver. Gout: types, aetilogy and clinical features. Brief overview of lysosomal storage diseases.

UNIT V: LIVER AND GASTRIC FUNCTION TESTS (12 hrs)

Functions of the liver and classification of LFTs. Abnormalities in bile pigment metabolism: differential diagnosis of jaundice (hemolytic, hepatic and obstructive). Changes in plasma proteins, clotting factors and prothrombin time. Serum enzymes in liver diseases: ALP, SGOT, SGPT and γ-GTP. Bile pigment levels in urine and faeces. Gastric function tests: collection and examination of gastric contents after stimulation. Errors in collection of samples. Fractional test meal analysis and its interpretation, and tubeless gastric analysis.

REFERENCE BOOKS:

1. Murphy MJ, Srivastava R and Deans K, *Clinical biochemistry: an illustrated color text* (6th ed.), Edinburgh: Elsevier, 2019.

2. Devlin TM, *Textbook of biochemistry with clinical correlations* (7th ed.), New York: John Wiley & Sons, 2010.

Course outcome:

Upon successful completion of the course, students are able to:

- *Acquire knowledge on diagnosis, prognosis and treatment of disorders of carbohydrate, protein, lipid and nucleic acid metabolism.*
- *Comprehend renal, liver and gastric function tests, and how they are employed in systematic diagnosis of diseases*

Acquire hands-on clinical laboratory training in estimating glucose, cholesterol, urea, creatinine and total protein from blood and urine.

GNTC 363 – GENETICS

(DSE – 4 credits)

- *The course addresses the question of the mechanism of inheritance of traits from one generation to the next*
- *It begins with the Mendelian concepts and the emergence of the science of genetics, and comprehensively covers current topics including population genetics*
- *It also demonstrates how the principles of genetics can be used as a powerful experimental tool to unravel the molecular function of genes, and study human diseases*

UNIT I: INTRODUCTION AND MENDELIAN GENETICS (15 hrs)

A brief overview of the modern history of genetics: Mendelian theory and the chromosomal theory. Mendel's experiments, laws of segregation, dominance and independent assortment. Extensions to Mendelian genetics: genetic interactions (epistatic and non-epistatic interactions). Allelic variation and gene function: dominance relationships, multiple alleles, lethal alleles and null alleles. Muller's classification of mutant alleles (brief definitions). Penetrance and expressivity. Human pedigree analysis: pedigree conventions and applications of pedigree analysis.

UNIT II: **LINKAGE AND CROSSING OVER (8 hrs)**

Different theories of linkage: Boveri–Sutton, Bateson and Punnet, and Morgan's theory. Types of linkages: complete and incomplete. Coupling and repulsion, factors affecting linkage, and significance of linkage. Crossing over: mitotic and meiotic, types of crossing over, and significance of crossing over. Complementation and tetrad analysis. Gene mapping in *Drosophila*.

UNIT III: INHERTANCE AND NON-DISJUNCTION (7 hrs)

Types of inheritance: extrachromosomal, autosomal and sex-linked inheritance (X-linked and Y-linked). Sex-linked lethal, sex-limited and sex-influenced traits. Non disjunction: primary and secondary. Conditions associated with chromosomal non-disjunction: Down syndrome, Turner's syndrome and Klinefelter's syndrome.

UNIT IV: CYTOGENETICS (8 hrs)

Normal human karyotype, banding techniques. Sex chromosomes: X-linkage determination patterns. Dosage compensation in *Drosophila*. Changes in chromosome number and structure: aneuploidy, euploidy, and polyploidy. Types of mutations: point mutations (transversion, transition, insertion, deletion, missense, nonsense and frame shift), chromosomal aberrations and significance of mutations.

UNIT V: POPULATION GENETICS **(7 hrs)**

Mendelian population: gene pool, allele frequency, genotype frequency, Hardy–Weinberg equation. Factors influencing gene frequency or deviations from Hardy–Weinberg equilibrium: selection (directional and artificial selection), mutation, genetic load, genetic drift, meiotic drive and migration.

REFERENCE BOOKS:

1. Griffiths AJF, Doebley J, Peichel C and Wassarman D, *Introduction to genetic analysis* (12th ed.), New York: W.H. Freeman & Co., 2020.
2. Pierce BA, *Genetics: a conceptual approach* (7th ed.), New York: W.H. Freeman & Co., 2020.

SUGGESTED READING:

1. Snustad DP and Simmons MJ, Principles of genetics (7th ed.), Singapore: John Wiley & Sons, 2015.

Course outcome*:*

Upon successful completion of the course, students are able to:

- *Understanding and solve problems based on Mendelian and Morgan's genetics*
- *Demonstrate working knowledge in pedigree analysis*
- *Comprehend genetic map construction, cytogenetics and the mechanis ms of various geneticdiseases*

NBCP 352 - NUTRITIONAL BIOCHEMISTRY

(DSE – 1 credit)

1. Estimation of vitamins in food stuff
2. Estimation of vitamins in serum
3. Estimation of minerals in food stuff
4. Qualitative analysis of food adulteration.
5. Determination of nutritive value of foods
6. Case studies on nutritional disorders.

REFERENCE BOOK:

1. Brody T, *Nutritional biochemistry* (2nd ed.), San Diego: Academic Press, 1999.

CBCP 362 - LAB IN CLINICAL BIOCHEMISTRY

(DSE – 1 credit)

1. Blood glucose and urea analysis
2. Serum creatinine estimation
3. Serum uric acid estimation
4. Serum cholesterol estimation
5. Serum bilirubin estimation
6. Estimation of total protein and determination of A/G ratio
7. Urine analysis

REFERENCE BOOK:

1. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.

SKILL ENHANCEMENT ELECTIVE (SEC) COURSE

BMBT 233 - BASIC MICROBIOLOGY

(SEC – 2 credits)

Course objectives:

- *Microbes are omnipresent, including as symbionts and commensals. This course provides a brief but thorough overview of the types of microbes, their distribution, diseases and control, as well as their beneficial applications*
- *It provides hands-on training in the basic skills necessary for sterile practices and the handling and manipulation of cultures in the microbiology laboratory*

UNIT I: INTRODUCTION AND BACTERIAL CLASSIFICATION (6 hrs)

Definition, scope and history of microbiology. Germ theory of disease. Differences between prokaryotic and eukaryotic microorganisms. Classification of Bacteria: based on Gram's staining, temperature and oxygen requirement. Types of bacteria: chlamydia, rickettsia, mycoplasma, actinomycetes, cyanobacteria and eubacteria. Brief overview of Archea.

UNIT II: VIRUSES, FUNGI, ALGAE AND PROTOZOANS (6 hrs)

Classification and types of viruses: Baltimore classification. General characteristics of major groups of fungi: Oomycota, Zygomycota, Ascomycota and Basidiomycota. Classification of protozoa: Mastigophora, Sarcodina, Sporozoa and Ciliophora. General characteristics of major groups of algae: Chlorophyta, Phaeophyta, Rhodophyta, Pyrrophyta, Chrysophyta and Euglenophyta.

UNIT III: MICROBIAL GROWTH (5 hrs)

Microbial growth, growth rate, doubling time and exponential growth phases. Factors affecting microbial growth: nutrient factors (C, H, N, O, P, S and trace elements) and non-nutrients (temperature, hydrostatic pressure, pH, osmotic strength). Types of nutrient media and special nutrient media. Differential media, and examples to distinguish between different groups of bacteria using differential media.

UNIT IV: FOOD AND INDUSTRIAL MICROBIOLOGY (5 hrs)

Quality control of drinking water: total coliform count. Microorganisms in milk and milk products, and the preservation of milk. Role of microbes in industrial production of fermented foods: alcoholic beverages, dairy products, coffee and chocolate. Preservation of wine. Single-cell proteins, microbial biofuel and biofertilizers.

UNIT V: MICROBIAL DISEASES AND ANTIMICROBIAL AGENTS (8 hrs)

Diseases caused by bacteria, viruses, protozoa and fungi: airborne diseases, water-borne diseases and milk-borne diseases. Prion diseases. Principles and methods of sterilization and disinfection. History, and brief overview of antibiotics, their mechanisms of action, and antibiotic resistance.

REFERENCE BOOKS:

1. Willey JM, Sherwood LM and Woolverton CJ, *Prescott, Harley, and Klein's Microbiology* (7th ed.), Boston: McGraw Hill, 2007.Leboffe MJ and Pierce BE, *A photographic atlas for the microbiology laboratory* (4th ed.), Englewood: Morton Publishing, 2011.
2. Ananathanarayanan and Panikar, *Text book of microbiology* (10^{th} ed.), New Delhi: The Orient Blackswan, 2017.

Course outcome*:*

Upon successful completion of the course, students possess:

- *Foundational horizontal knowledge in microbiology*
- *Awareness of communicable diseases, their mode of transmission, preventive and control measures, for public health awareness*
- *The skill of handling microbial cultures, sterile practices and basic microbial techniques, which will be useful in handling diseased samples in the biochemistry laboratory*

ABCT 243 ANALYTICAL BIOCHEMISTRY

(SEC – 2 credits)

Course objectives:

- *The main objective of the course is the study of preparative and analytical separation techniques, and analysis of different biomolecules in a living system*
- *It includes the study of the principle behind the operation of different tools and methods for identification, analysis and examination of the physico-chemical properties of different biomolecules*
- *It helps biochemistry students understand the vast array of technologies and instruments at their disposal, and their applications*

UNIT I: CENTRIFUGATION (6 hrs)

Principle of centrifugation and Svedberg unit, analytical and preparative. Centrifugation rotors: vertical, fixed angle, swinging bucket. Subcellular fractionation by differential centrifugation, density gradient and principle of analytical ultracentrifuge.

UNIT II: CHROMATOGRAPHY (6 hrs)

Partition and adsorption chromatography. Types of chromatography: ion exchange, gel filtration and affinity chromatography. Principles and instrumentation of gas–liquid chromatography (GLC) and high performance liquid chromatography (HPLC).

UNIT III: ELECTROPHORESIS (6 hrs)

Principle and applications of agarose and native polyacrylamide gel electrophoresis. Denaturing SDS–PAGE: principle, reagents, instrumentation, protocol and applications.

UNIT IV: SPECTROSCOPIC TECHNIQUES (6 hrs)

Beer–Lambert's law, transmittance, absorbance, optical density and colorimetry. Types of spectroscopy, UV–Visible spectroscopy: principle, instrumentation and applications.

UNIT V: RADIOACTIVE TECHNIQUES (6 hrs)

Types of radiation, units of radioactivity and half-life. Measurement of radioactivity: GM and scintillation counters. Applications of radioactivity: autoradiography. Hazards of radioactivity and safety measures.

REFERENCE BOOKS:

1. Hofman A and Clokie S, *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.), London: Cambridge University Press, 2018.
2. Campbell I, *Biophysical techniques*, London: Oxford University Press, 2012.

SUGGESTED READING:

1. Upadhyay A, Upadhyay K and Nath N, *Biophysical techniques: principles and techniques* (4th ed.), Mumbai: Himalaya Publishing House, 2016.

EPSD 354 - ENTREPRENEURIAL SKILL DEVELOPMENT

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the criteria of choosing appropriate strategies and instrumentation for analysis of different biological sample types*
- *Know the applicability, advantages, limitations and sources of error of current analytical instruments through an understanding of the working principles of these instruments and the underlying biochemical basis*
- *Enable independent conduct of biochemical analyses and instrument evaluations in the laboratory and to link the practical applications to the learned theory.*

(SEC – 2 credits)

Course objectives:

- *The main objective of the course is to impart ability to turn ideas into action.*
- *It improves the skill and provides knowledge to make innovative food products and help the students to launch food based technology business with these tools*
- *It introduce the students to the field of entrepreneurship and to inculcate interest in creating start-up companies*

UNIT I: INTRODUCTION TO FOOD PREPARATION (5 hrs)

Importance of food and dairy microbiology. Cheese, bread, wine, fermented vegetables, methods and organisms used. Food and enzymes from microorganisms: single cell protein, production of enzymes.

UNIT II: SPOILAGE AND FOOD POISONING (8 hrs)

Spoilage different kinds of foods: Cereal products, sugar products, vegetable and fruits, meat products, fish and other sea foods, eggs and poultry, dairy and fermentative products (ice-cream/milk/bread/wine). Food borne infections and intoxications. Source, symptoms and management of the following: Bacterial, Fungal, Viral and Protozoa.

UNIT III: FOOD PRESERVATION (5 hrs)

Principles of food preservation. Methods of preservation: Physical (irradiation, drying, heat processing, chilling and freezing, high pressure and modification of atmosphere), Chemical preservation (Sodium benzoate Class I & II). Food Sanitation. Good manufacturing practices: HACCP, Personnel hygiene.

UNIT IV: ESTABLISHING AND FINANCING THE ENTERPRISE (7 hrs)

Project identification, selection, formulation and assessment of project feasibility. Inventory: direct and indirect raw materials and their management. Importance of finance, loans and repayments.

UNIT V: MARKETING MANAGEMENT (5 hrs)

Definition and importance of marketing management. Marketing mix and product management: product line, product mix and stages of product life cycle. Marketing research and importance of survey, physical distribution and stock management.

REFERENCE BOOKS:

1. Mahan LK and Raymond J, *Krause's food and nutrition care process* (14th ed.), St. Louis: Elsevier, 2017.
2. Gibson R, *Principles of nutritional assessment*, London: Oxford University Press, 2005.
3. Holt DH, *Entrepreneurship: new venture creation*, London: Pearson, 2016.
4. Kaplan JM and Warren AC, *Patterns of entrepreneurship management* (5th ed.), Hoboken: John Wiley & Sons, 2016.

SUGGESTED READINGS:

1. Brody T, *Nutritional biochemistry* (2nd ed.), San Diego: Academic Press, 1999.
2. Dubey RC and Maheswari DK, *Practical microbiology*, New Delhi: S Chand & Company P Ltd, 2012.

Course outcome:

Upon successful completion of this course, students are able to:

- *Understand the importance of food and the method of food preparation*
- *Know the method of food preservation and the use of various tools for preventing spoilage*
- *Analyse the marketing management in different business environments*

GENT-364 -GENETIC ENGINEERING

(2 Credits)

Course objectives:

- *The course outlines how molecular manipulation of DNA provides complete control of the Central Dogma of molecular biology, and the principles of the techniques used in gene identification, isolation and analysis*
- *It also lists applications of genetic engineering, such as the production of recombinant therapeutic proteins, vaccines, molecular farming and organ farming*
- *It provides hands-on, practical training in isolation and manipulation of DNA, which form the basis of molecular cloning*

UNIT I: INTRODUCTION TO GENETIC ENGINEERING (5 hrs)

Basic steps of gene cloning. Enzymes used in genetic engineering: restriction enzymes (types, target sites and nomenclature), DNA polymerases, ribonuclease, ligases, polynucleotide kinase, alkaline phosphatases, reverse transcriptase.

UNIT II: CLONING VECTORS AND GENE DELIVERY (8 hrs)

Essential elements in a plasmid vectors. Differences between cloning and expression vectors. Brief outline on bacteriophage, phagemid, cosmid and artificial chromosomes. Brief outline of gene transfer techniques: microinjection, electroporation and gene gun bombardment.

UNIT III: GENE ISOLATION AND ANALYSIS (7 hrs)

Selection and screening of recombinants. Isolation and purification of cellular and plasmid DNA, methods for labeling nucleic acids and probes, somatic cell hybrids, and *in situ* hybridization.

UNIT IV: GENE IDENTIFICATION AND SEQUENCING (5 hrs)

Amplification of DNA by PCR: technique and applications. Analysis of DNA, RNA and proteins by blotting techniques. DNA sequencing by Sanger's dideoxy chain-termination method.

UNIT V: APPLICATIONS OF GENETIC ENGINEERING (5 hrs)

Production of recombinant insulin, and vaccines. RAPD, RFLP and its applications. DNA fingerprinting, DNA foot printing.

REFERENCE BOOKS:

1. Primrose SB and Twyman RM, *Pinciples of gene manipulation and genomics* (7th ed.), Malden: Wiley Blackwell, 2014.
2. Brown TA, *Gene cloning and DNA analysis: an introduction* (7th ed.), Hoboken: Wiley-Blackwell, 2016.

Course outcome:

Upon successful completion of the course, students are able to:

- *Understanding the isolation of DNA using restriction enzymes, and its incorporation into suitable cloning and expression vectors*

- *Comprehend the methods and techniques used in the construction and analysis of genomic and cDNA libraries, and their applications*
- *Gain expertise in practical hands-on isolation of genomic DNA from mammalian tissue including its estimatation, manipulation as required in gene cloning.*

BMBP 233 – Lab in Basic Microbiology

(SEC – 1 credit)

1. Sterilization techniques
2. Identification of bacterial cells and the determination of antibacterial activity
3. Identification of fungal cells and the determination of antifungal activity
4. Pure culture techniques: streak plate, pour plate, spread plate and serial dilution
5. Methylene blue reductase test (MBRT)
6. Simple staining
7. Gram staining
8. Microbial growth curve

REFERENCE BOOK:

1. Sherman N and Cappuccino JG (2004) *Microbiology A Laboratory Manual*, Benjamin-Cummings Publishing Company, San Francisco, 2004.

ABCP 243 - LAB IN ANALYTICAL BIOCHEMISTRY

(SEC – 1 credit)

1. Calibration of pH meter
2. Verification of Beer'sLaw and estimation of sample concentration using spectrophotometer andcolorimeter
3. Separation of plant pigments using paper, thin layer, and column chromatography
4. Native and SDS–PAGE
5. Subcellular fractionation by differential centrifugation

REFERENCE BOOK:

1. Hofman A and Clokie S, *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.), London: Cambridge University Press, 2018.

GENP 364 - LAB IN GENETIC ENGINEERING

(SEC – 1 credit)

1. Isolation of plasmid DNA from bacterial culture
2. Restriction digestion analysis of DNA
3. Ligation of DNA fragments and bacterial transformation
4. Immobilization of cells
5. Recovery of DNA by low temperature-melting agarose gel method
6. Polymerase chain reaction (Only demonstration)

REFERENCE BOOK:

1. Green MR and Sambrook J, *Molecular cloning: a laboratory manual* (4th ed.), Cold Spring Harbor: Cold Spring Harbor Laboratory Press, 2012.

GENERIC ELECTIVE (GE) COURSES

BSSW 355 - BIOSTATISTICS AND SCIENTIFIC WRITING

(GE – 3 credits)

Course objectives:

- *The course is designed to help understand the statistical tools commonly used in biological research*
- *It helps to know the concept of hypothesis testing and the importance of statistical significance in interpreting research data*
- *To learn how to use software applications such as MS Office Excel to perform all statistical operations*

UNIT I: DIAGRAMMATIC REPRESENTATION OF DATA (4 hrs)

Collection of data and types of data. Data collection: types and methods. Tabulation and representation of data: histogram, frequency, line plots (polygon and ogive) and pie chart. Importance of correct choice of data representation for scientific interpretation

UNIT II: CENTRAL TENDENCY, DISPERSION AND CORRELATION (6 hrs)

Calculating the mean, median, and mode for grouped and ungrouped data. Merits and demerits of mean, mode and median. Measurements of dispersion: range, standard deviation and coefficient of variation. Correlation: types and methods for calculating correlation, and Karl Pearson's correlation coefficient.

UNIT III: TEST OF SIGNIFICANCE (8 hrs)

The null hypothesis, statistical significance and confidence interval. Methods of measuring statistical significance: Student's *t*-test, F-test, Chi-squared test and one-way ANOVA.

UNIT IV: LITERATURE REVIEW IN SCIENCE (8 hrs)

Introduction to literature review. Methods for literature search: use of library, books and journals, and the Internet (PubMed, Medline, Scopus and Elsevier) Search of patents and grant proposals. Purpose of literature review: selection of research problem and formulation of hypothesis.

UNIT V: BASICS OF SCIENTIFIC LITERTATURE (4 hrs)

Types of scientific literature: research articles, review articles, books, conference proceedings, grant proposal, project reports, theses and dissertations. Components of a scientific article: title, authors, affiliations, abstract, references, acknowledgements, tables, illustrations and footnotes, and rules and guidelines for writing each component. Methods to avoid plagiarism.

REFERENCE BOOKS:

1. Daniel WW and Cross CL, *Biostatistics: a foundation for analysis in the health sciences* (11th ed.), Hoboken: Wiley, 2019.
2. Zar JH, *Biostatistical analysis* (5th ed.), Upper Saddle River: Prentice-Hall, 2010.

SUGGESTED READINGS:

1. Lewis AE, *Biostatistics demystified*, New York: McGraw-Hill, 2013.
2. Sokal RR and Rohlf FJ, *Biometry* (4th ed.), New York: W.H. Freeman, 2012.

Course outcome:

Upon successful completion of this course, students are able to:

- *Recognize the importance of choosing proper diagrammatic representation for scientific data, and interpret whether results obtained are statistically significant*
- *Use the computer to present, analyse and interpret scientific data*
- *Access the Internet to retrieve information from biological databases.*

BINF 365 - BIOINFORMATICS

(GE – 3 credits)

Course objectives:

- *The course aims to provide students with an introduction to the basic practical techniques in bioinformatics*
- *It emphasizes on the application of bioinformatics and biological databases to solving real-world research problems including computer-aided drug design*
- *It aims to make students familiar with the use of a wide variety of internet applications, biological databases and publicly available biological software for solving fundamental biological problems*

UNIT I: BIOLOGICAL INFORMATION (6 hrs)

Introduction, scope and applications of bioinformatics. Types of biological data, and the growth of biological information. Computer algorithms in biological trend prediction. Roles of literature in aiding trend prediction in biology. Literature databases: PubMed, Medline, Scopus and Elsevier. Information retrieval: use of advanced search criteria and search strategies.

UNIT II: BIOLOGICAL DATABASES (6 hrs)

Introduction to biological sequence databases: primary, secondary and composite databases. Nucleotide sequence databases: GenBank, EMBL and DDBJ. Protein sequence databases: UniProt, SwissProt, TrEMBL and PIR. Protein structure databases: PDB, CATH and SCOP.

UNIT III: MOLECULAR SEQUENCE ANALYSIS (6 hrs)

Homology, analogy, orthology and paralogy. Introduction to sequence analysis software: DNASIS. Gene structure prediction: GENSCAN. Sequence alignment: local and global alignment, pairwise, and multiple sequence alignment. Tools for sequence alignment: BLAST, FASTA and CLUSTALW.

UNIT IV: PHYLOGENETIC ANALYSIS (6 hrs)

Construction of phylogenetic tree, dendrograms and cladogram. Methods for construction of phylogenetic trees: maximum parsimony, maximum likelihood and distance methods.

Phylogenetic analysis using PHYLIP. Amino acid substitution scoring matrices: PAM and BLOSUM.

UNIT V: PROTEIN STRUCTURE ANALYSIS AND THE OMICS ERA (6 hrs)

Protein structure analysis: visualization with RasMol, Swiss PDB viewer. Protein structure prediction: homology modelling with SWISS-MODEL. The Human Genome project, and its findings. Brief list of the different types of omics databases, and their applications.

REFERENCE BOOKS:

1. Parry-Smith DJ, Phukan S and Attwood TK, *Introduction to bioinformatics*, San Francisco: Pearson, 2007.
2. Baxevanis AD and Ouellette BF, *Bioinformatics: a practical guide to the analysis of genes and proteins* (3rd ed.), Hoboken: John Wiley & Sons, Inc., 2005.

Course outcome:

Upon successful completion of the course, students would possess knowledge about the following:

- *Scope of bioinformatics and applications of biological databases*
- *Mechanisms of molecular sequence analysis and phylogenetic analysis*
- *Types and methods of computer-aided drug design*

CHET 113- CHEMISTRY I

(DSE - 4 credits)

Course objectives:

- *This course is designed to refresh important basic concepts in chemistry learnt in school.*
- *It is also augmented with other concepts in chemistry, whose understanding is critical for proper and effective learning of biochemistry.*
- *To provide hands-on training in the basic techniques used in the chemistry laboratory.*
- *To provide hands-on practical training in chemical titration, redox titration and double salt preparation*

Learning outcomes:

Upon successful completion of this course, students are able to:

- *Understand the role of thermodynamics and kinetics for any reaction.*
- *Understand atomic structure, and the nature and types of chemical bonds, the types of isomers, and their importance in biology*
- *Have a basic comprehension of the structure and properties of aliphatic, aromatic and heterocyclic compounds*
- *Independently prepare standard solutions, and perform qualitative organic analysis in the lab*
- *Acquire practical hands-on expertise in acid–base and redox titrations, and also learn the preparation of inorganic salts.*

UNIT I: ATOMIC STRUCTURE (7 hrs)

Concept of atomic orbital, shapes of *s*, *p* and *d*-orbitals, radial and angular probability of *s*, *p* and *d* orbitals (qualitative idea). Multi-electron atoms, Pauli's exclusion principle, Hund's rule of maximum multiplicity, electronic energy levels and electronic configurations of hydrogen-like and

poly-electronic atoms and ions (concept only). Ground state term symbols of atoms and ions (concept only).

UNIT II: CHEMICAL BONDING (10 hrs)

Chemical bonding: nature and types, ionic/polar bond, covalent/non-polar bond, co-ordinate bond and non-covalent bonds (hydrophobic, dipole–dipole/ion–dipole interactions, London forces, hydrogen bonding). Bond properties: types of hybridization, geometry of organic molecules: methane, ethylene, acetylene and benzene, bond angle, bond length, bond order, bond strength. Electron displacement effects, inductive, resonance, hyperconjugative and steric effects, and their effect on the properties of compounds.

UNIT III: CHEMICAL EQUILIBRIUM (8 hrs)

State of equilibrium and thermodynamic condition of equilibrium (condition of minimum Gibbs' potential). Temperature dependence of equilibrium constant (brief introduction). Homogeneous and heterogeneous equilibria (concepts only). Chemical kinetics, Arrhenius equation, activation energy and rate constant.

UNIT IV: PRINCIPLES OF THERMODYNAMICS (10 hrs)

Definition of system and surroundings. Types of systems: isolated, closed and open. Extensive and intensive properties in thermodynamics. Concept of thermodynamic equilibrium, concept of temperature, heat and work, reversible work, irreversible work and maximum work. First and second laws of thermodynamics, and their implications. Absolute scale of temperature, concept of entropy as a state function, Helmholtz free energy, Gibbs free energy and their simple applications.

UNIT V: GENERAL ORGANIC CHEMISTRY (10 hrs)

Ionic and radical reactions: heterolytic and homolytic bond cleavage. Aliphatic substitution and elimination reactions. Aromatic compounds: electrophilic substitution in benzene, mechanisms of nitration, halogenation, alkylation and acylation. General introduction to rearrangement reactions. General introduction to stereochemistry: structural isomerism, stereo isomerism and optical isomerism. Heterocycles: structural aspects of five and six membered heterocycles containing hetero atoms (pyridine, pyrrole, furanose, pyranose, purines and pyrimidines).

TEXT BOOKS

1. Atkins PW, de Paula J and Keeler J, *Atkins' physical chemistry* (11th ed.), Oxford: Oxford University Press, 2018.
2. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
3. Elil EL and Wilen SH, *Stereochemistry of organic compounds*, New York: John Wiley & Sons, 2008.
4. Wade LG and Simek JW, *Organic chemistry* (9th ed.), Harlow: Pearson Education, 2017.
5. Finar IL, *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Sixth Edition, 2003.

CHEP 113 - CHEMISTRY LAB

(1 credit)

1. Safety measures in the laboratories
2. Preparation of normal, molar and percent solutions
3. Estimation of hydrochloric acid using oxalic acid standard
4. Flame test for qualitative detection of elements
5. Estimation of ferrous sulphate using Mohrs salt standard
6. Systematic analysis of functional groups: Detection of monofunctional

   organic compounds (-COOH, phenolic, aldehydic, ketonic, amide, nitro, 1^{o} amines)
7. Preparation of buffers of different ionic strength

REFERENCE BOOKS:

1. Mann FG and Saunders BC, *Practical Organic Chemistry*, Pearson Education, 2009.
2. Furniss BS, Hannaford AJ, Smith PWG, Tatchell AR, *Practical Organic Chemistry*, *5th Ed.*, Pearson, 2012.
3. Ahluwalia VK and Aggarwal R, *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press, 2000.
4. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.