

B.Sc. (H) BIOCHEMISTRY
Generic Elective Papers UGCF-NEP2020

Generic Elective (GE)			
1-VIII	BCH-GE-1	Public Health Biology	2T, 2P
	BCH-GE-2	Nutrition and Food Science	2T, 2P
	BCH-GE-3	Physiology of Sports and exercise	2T, 2P
	BCH-GE-4	Molecules of Life	2T, 2P
	BCH-GE-5	Techniques in Biochemistry	2T, 2P
	BCH-GE-6	Basics of Cell biology	3T, 1P
	BCH-GE-7	Protein and Enzymes	2T, 2P
	BCH-GE-8	Intermediary Metabolism	3T, 1P
	BCH-GE-9	Gene Organization, Expression and Regulation	3T, 1P
	BCH-GE-10	Tools of Genetic Engineering	2T, 2P
	BCH-GE-11	Basics of Immunology	3T, 1P
	BCH-GE-12	Biochemical Correlation of Diseases	2T, 2P

SEMESTER WISE DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES

S.No.	Course	Prerequisites of the Course
Semester I/II- Level 100		
1	Public Health Biology	Class XII
2	Nutrition and Food Science	Class XII
3	Physiology of Sports and Exercise	Class XII
4^{\$}	Molecules of Life	Science in Class XII
5	Techniques in Biochemistry	Science in Class XII
Semester III /IV/V/VI- Level 200/300		
6*	Basics of Cell Biology	Molecules of Life/ Biology in Class XII
7	Proteins and Enzymes	Molecules of Life/ Biology in Class XII
8*	Intermediary Metabolism	Molecules of Life/ Biology in Class XII
9*	Gene Organization, Expression and Regulation	Molecules of Life/ Biology in Class XII
Semester VII/ VIII- Level 400		
10	Tools of Genetic Engineering	Gene Organization, Expression and Regulation / Molecular Biology
11*	Basics Concepts in Immunology	Cell Biology
12	Biochemical Correlation of Diseases	Metabolism, Cell Biology

***Courses are mandatory** to be studied for a minor in Biochemistry.

\$ This course is advised mandatory for students who have not studied Biology in Class XI and XII.

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-4: MOLECULES OF LIFE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
BCH-GE-1: MOLECULES OF LIFE	04	02	00	02	Class XII with science	Science in Class XII

1. Learning Objectives

The objective of the course is to provide students with an understanding of biomolecules, the basic building blocks that are vital for various life forms. The course emphasizes on studying the different types of biomolecules focusing on their key properties, biological roles and functions. The course also aims to outline chemical and physical aspects of biomolecules by hands on approach through laboratory experiments.

2.1 Learning Outcomes

1. The course will provide an understanding of how the structure of biomolecules determine their chemical properties and functions.
2. Students will develop understanding of biochemistry at atomic level and appreciate the biological importance of each biomolecule.
3. Students will gain insight into basic structures, classification, chemistry and properties of amino acids, carbohydrates, lipids and nucleic acid along with their biological role.
4. Students will learn about the nutritional roles of water soluble and lipid soluble vitamins in the body along with their occurrence.

2.2. Course Contents

Theory Credits: 2

Total Hours: 30

Unit I: Amino acids and proteins

(No. of hours: 10)

Introduction, classification of amino acids, standard and non-standard amino acids, essential and non-essential, peptide bond, acid-base properties; zwitterions, Isoelectric point, optical properties of amino acids. Organization of protein structure - primary, secondary, tertiary and quaternary structures. Bonds in protein structures - covalent and non-covalent. Secondary structure - alpha-helices, beta-strands, beta-sheets and turns; tertiary and quaternary structures. Structure-function relationship in proteins. Concept of proteins as enzymes.

Unit II: Carbohydrate**(No. of hours: 6)**

Introduction, classification and importance of carbohydrates. Monosaccharides, disaccharides, polysaccharides; homopolysaccharides (glycogen, starch, cellulose, chitin) heteropolysaccharides (hyaluronic acid and Heparin) D-and L- isomerism, Fisher and Haworth structure, optical isomerism, epimerism, anomerism, mutarotation

Unit III: Lipids**(No. of hours: 6)**

Introduction, classification and function of lipids, fatty acids, essential fatty acids, storage lipids (triacylglycerol); structural lipids (phospholipids, sphingolipids, glycolipids, cholesterol); eicosanoids.

Unit IV: Nucleic acids**(No. of hours: 6)**

Introduction, Purine and pyrimidine bases, nucleosides, nucleotides, nucleic acid. DNA structure and function, types of DNA, RNA structure and function, Biologically important nucleotides, Chargaff's rule.

Unit V: Vitamins and Coenzymes**(No. of hours: 2)**

Definition, classification and active forms of vitamins.

2.3 Practical:**Credits: 2****Total Hours: 60**

1. Laboratory safety and standards (precision, accuracy and sensitivity). Preparation of solutions.
2. Estimation of proteins by Biuret/ Lowry method.
3. Preparation of acetate buffer/phosphate buffer
4. Qualitative analysis of Amino acids (Ninhydrin, Xanthoproteic, Millon's)
5. Qualitative test for Carbohydrates: monosaccharides, disaccharides, and polysaccharides by Mohlisch, Fehling/ Benedict, and Iodine test
6. To determine the Iodine Number of oil/fat.
7. Qualitative test for Nucleic acids (orcinol and DPA)

2.4 Essential readings:

1. Nelson, D.L. and Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7th ed.). W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
2. Jain J L, Jain S, Jain N (2016) *Fundamentals of Biochemistry*, S Chand Publishers, ISBN-13- 978-8121924535.
3. Satyanarayana, U. and Chakrapani, U. (2021) *Biochemistry* (6th Edition), Elsevier Health Sciences, ISBN 978-81-312-6435-5.
4. Lippincott's Illustrated Reviews - *Biochemistry South Asian Edition* Paperback – 1 October 2020 by Ritu Singh (Author), Rajeev Goyal (Author)

- Naik P (2015) *Biochemistry* 4th Edition by: ISBN 978-9351529897, Jaypee Brothers Medical Publishers (P) Ltd.
- Sundararaj, P. and Siddhu, A. (2020) *Qualitative tests and Quantitative procedures in biochemistry - A Practical Manual* (Third Edition), Elite Publishing. ISBN: 978-8188901197.

Suggested readings:

- Berg, J.M., Tymoczko J.L. and Stryer L. (2011) *Biochemistry*, 7th edition. New York, USA: W. H. Freeman and Co. ISBN-13: 978142927635.
- Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations*. 7th edition John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
- Campbell, M. K. and Farrel, S.O. (2017) *Biochemistry*, 9th edition. Boston, USA: Brooks/Cole Cengage Learning. ISBN-13: 978-1305961135.
- Plummer D.T. (1998) *An Introduction to Practical Biochemistry*, 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.
- Sawhney, S. K., & Singh, R. (2017) *Introductory Practical biochemistry* (12th Edition), Nerosa Publishing House, ISBN: 978-817319-302-6.

3. Teaching Learning Process and Assessment Methods

Facilitating the achievements of Course Learning Objectives**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Ability to comprehend the structure, function, optical and acid base properties of amino acids.	Classroom teaching of structures and properties of amino acids and laboratory experiments on titration curves and identification of functional groups.	Quiz on amino acid properties and structure. Students will be shown three-dimensional structures of amino acids in power points, which they will identify and relate to properties
II	Introduction to the structure, properties, stereoisomerism and roles of carbohydrates.	Traditional chalk and board teaching; learning properties of carbohydrates through laboratory-based identification	Test on structure and functions of carbohydrates
III	Appreciation of the varied roles of lipids such as distribution in different biological membranes, storage lipids, and signaling lipids.	Traditional teaching of structures of lipids and video presentation of membrane lipids: learning structure and function of lipids and membranes through discussion and powerpoint presentations learning properties of lipids through	Test and MCQ on lipids

		laboratory-based examination.	
IV	Understanding nucleic acid chemistry, physical properties and structure.	Chalk and board teaching and presentation on double helix model of nucleic acid structure. Qualitative identification of nucleic acid through laboratory-based experiments	Test and quiz on nucleic acids. Discussion on the history of discovery of double helix of DNA
V	Understanding of the biochemical importance of vitamins and their active forms	Classroom teaching of nutritional roles of vitamins and their active forms. Nutritional importance can be studied by their associated deficiency symptoms and diseases	Quiz on vitamins, their active forms and deficiency diseases. Revision of the entire course

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Carbohydrates; Lipids; Nucleic acids; Amino acids; Proteins; Vitamins

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH GE-6: Basics of Cell Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
BCH GE- 5 Basic Cell Biology	04	03	00	01	Class XII with science	Molecules of Life/ Biology in Class XII

1. Course Objectives

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

2. Course Learning Outcomes

On successful completion of the course, students will have:

1. Insights into the basic structure and function of the cell and cellular organelles.
2. Knowledge of various techniques used in cell biology
3. Understanding of the concept of cell-to-cell interaction and cell division
4. Understanding of the cytoskeletal elements and motor proteins

2.1 Course Content

2.2 THEORY

CREDITS: 3

TOTAL HOURS: 45

UNIT I: Introduction to Cell Biology

(No. of Hours: 6)

Structure of prokaryotic and eukaryotic cell, mycoplasma, viruses, viroid, prions. Basic tools of cell biology: Light microscopy and Electron microscopy.

UNIT II: Cellular Organelles

(No. of Hours: 12)

Structure and functions of the Nucleus: Nuclear envelope, Nuclear pore complex. Nuclear Import and Export of proteins. Mitochondria; Chloroplasts and peroxisomes.

Overview of the endomembrane system: Protein sorting to Endoplasmic Reticulum; Golgi complex and Lysosomes; vesicular transport; Exocytosis and endocytosis.

UNIT III: Cytoskeleton, Extracellular matrix and Cell Junctions (No. of Hours: 8)

Structure and function of cytoskeletal elements- Microtubule, Microfilament and Intermediate filament. Introduction to motor proteins - Myosin, Kinesin and Dynein. Cell-matrix and cell-cell interactions. Cell Junctions.

UNIT IV: Cell Cycle and Cell Death (No. of Hours: 6)

Eukaryotic cell cycle; Cell Division (mitosis and meiosis); Introduction to cell cycle regulation; Overview of apoptosis, necrosis and autophagy.

2.3 CELL BIOLOGY (PRACTICALS)**TOTAL HOURS: 30****CREDITS: 1**

1. To learn the handling of a light microscope.
2. Visualization of prokaryotic and eukaryotic (plant and animal) cells.
3. Preparation of a squash mount of onion root tips and identification of different stages of mitosis.
4. To study the effect of isotonic, hypotonic and hypertonic solutions on cells.

2.5 ESSENTIAL READINGS

1. Cooper, G.M. and Hausman, R.E. (2013) *The Cell: A Molecular Approach*, 6th ed., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
2. Karp, G, Iwasa, J and Marshall, W (2016) *Cell and Molecular Biology: Concepts and Experimentation*, 8th Edition, John Wiley and Sons, Singapore, ISBN: 978-1-118-88384-6.
3. Powar CB (2010) *Cell Biology*, Himalaya Publishing House, ISBN-13: 978-9350246696.
4. Dr. P S Verma and Dr. V K Agarwal (2020), *CELL BIOLOGY: (Cytology, Biomolecules and Molecular Biology) LPSPE*, S Chand Publishing, ISBN: 9789355011022

SUGGESTED READINGS

1. Alberts, B., Johnson, A., Lewis, J., and Enlarge, M. (2008) *Molecular Biology of the Cell* (2008) 5th ed., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.
2. Ferrier D R, Singh R & Goyal R (2020). Lippincott's Illustrated Reviews - Biochemistry South Asian Edition, Publisher: Wolters Kluwer (India) Pvt. Ltd., ISBN: 9789389859751.

3. Teaching Learning Process and Assessment Methods Facilitating the Achievement of Course Learning Outcomes**

Unit No	Learning Outcomes	Teaching Methods	Assessment Method
I	Students will be able to distinguish between prokaryotic and eukaryotic cells. They will also learn about the principle and functioning of light and electron microscopy.	Traditional chalk & board method with PowerPoint presentations and Video tutorials for improved understanding of concept.	Group discussion and class tests. Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students' understanding of previous lecture.
II	Students will learn about the structure and function of the cellular organelles.	Traditional chalk & board method with PowerPoint presentations and Video tutorials for improved understanding of concept.	Group discussion and class tests. Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students' understanding of previous lecture.
III	Students will be able to understand the cytoskeletal framework of the cell, and the structure and function of the cytoskeletal elements. They will also learn about the composition of the cell matrix, and cell junctions.	Traditional chalk & board method with PowerPoint presentations and Video tutorials for improved understanding of concept.	Group discussion and class tests. Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students' understanding of previous lecture.
IV	The students will learn about the eukaryotic cell cycle, cell division and cell cycle regulation.	Traditional chalk & board method with PowerPoint presentations and Video tutorials for improved understanding of concept.	Group discussion and class tests. Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Pre-lecture quiz to evaluate students' understanding of previous lecture.

4. Keywords:

Cell Organelles, Mitosis, Meiosis, Prokaryote, Eukaryote, Cell Wall, Cell Matrix, Cell Junctions, Cytoskeleton Proteins, Cell Cycle, Microscopy.

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-9: GENE ORGANIZATION, EXPRESSION AND REGULATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
GENE ORGANIZATION, EXPRESSION AND REGULATION	04	03	00	01	Class XII with Science	Molecules of Life/ Biology in Class XII

1. Course Objectives

This course is designed to introduce the concepts of the structure of the genetic material, of genes and the different architecture of the genome in various organisms. It deals with replication of the genetic material in prokaryotes and eukaryotes as well as the expression of genes into RNA as well as proteins; all being crucial life processes required for the perpetuity and successful functioning of living organisms. It also throws light on the regulation of gene expression in prokaryotes.

2.1 Course Learning Outcomes

At the end of this course, students shall be able to:

1. Understand the structure of the DNA double helix and organization of genomes in prokaryotes and eukaryotes.
2. Understand the details of DNA replication in prokaryotes and eukaryotes.
3. Discern the processes of conversion of the information stored in the genetic code into mRNA as well as proteins.
4. Learn the basic concept of operons that exist in prokaryotic systems and the control of gene expression.

2.2 Course Contents Theory

Credits: 03

Total Hours: 45

Unit 1: Structure of genes and chromosomes

(No. of Hours: 8)

Watson and Crick model of DNA, features of the double helix, definition of a gene, organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA, linking number, topoisomerases.

Unit 2: Replication of genomes

(No. of Hours: 12)

General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Three stages of DNA replication, end replication problem, telomerase, Inhibitors of DNA replication and applications in medicine, DNA Repair mechanisms.

Unit 3: Transcription**(No. of Hours: 10)**

Transcription in prokaryotes, RNA polymerase, 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. Eukaryotic RNA polymerase, post-transcriptional processing of RNA, splicing, Inhibitors of transcription and applications in medicine.

Unit 4: Translation**(No. of Hours: 8)**

Features of the genetic code, structure of ribosomes, charging of tRNAs, amino acyl tRNA synthetases; three stages of protein synthesis - initiation, elongation and termination. Inhibitors of protein synthesis.

Unit 5: Regulation of gene expression**(No. of Hours: 7)**

Regulation of transcription in prokaryotes and eukaryotes, concept of operons. Lac operon - control by negative and positive regulatory proteins, Trp operon - control by attenuation.

2.3 Practical:**Credits: 1****Total Hours: 30**

1. Quantitative determination of DNA and RNA by absorbance at 260 nm and using A260/A280 ratio to distinguish between them.
2. Isolation of chromosomal DNA from *E. coli*.
3. Isolation of total RNA from yeast cells.

2.4 Essential readings:

1. Nelson, D.L. and Cox, M.M (2013) *Lehninger: Principles of Biochemistry* (6th ed.,) W.H. Freeman & Company (New York), ISBN-13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L., (2012) *Biochemistry* (7th ed.,) W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.
3. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008) *Watson: Molecular Biology of the Gene* (7th ed.), Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN-13: 9780321762436.
4. Rastogi V B (2016) *Principles of Molecular Biology*, 2nd edition, Publisher Medtech ISBN-13: 978-9384007478.
5. Rastogi S C (2023), *Cell and Molecular Biology*, Publisher New Age International Private Limited; Fifth edition, ISBN-10, 9395161868. ISBN-13, 978-9395161862.

Suggested readings:

1. Pierce, B.A (2012) *Genetics - A Conceptual Approach* (6th ed.,) W.H. Freeman & Co. (New York), ISBN: 13:978-1-4292-7606-1.
2. Lewin, B., Krebs, J.E., Kilpatrick, S.T., Goldstein, E.S. (2018) *Lewin's Gene X* (10th ed.,) Bartlett Learning publishers, LLC (Burlington, MA), ISBN: 978-0-7637-6632-0.

3. Teaching Learning Process and Assessment Methods Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Students will learn about the complexity of DNA double helix structure, understand the importance of supercoiling of DNA, linking number and topoisomerases.	Teaching using traditional chalk and board method, Power point presentations, and discussion sessions in the class.	Oral questions will be asked in the class. Problems will be assigned to test student's analytical ability.
2.	Understand the details of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases, stages of DNA replication, inhibitors and applications in medicine.	Teaching will be carried out by displaying colorful models for steps of replication using slides and the rest using chalk and board method. Discussion sessions in the class will be regularly conducted.	Students will be challenged with analytical problems, puzzles and assignments related to replication of DNA. Class tests will be conducted for internal assessment.
3.	Understand the process of transcription in prokaryotes, various stages of RNA synthesis, transcription inhibitors and applications as antimicrobial drugs.	Power point presentations will be used to explain transcription process and interactive discussion sessions in the class will be scheduled.	Regular question-answer and quiz sessions in the class, demonstration by students with the help of models to test and improve their understanding.
4.	Students will learn about the features of genetic code structure of ribosomes, tRNAs, amino acyl tRNA synthetases, stages and inhibitors of protein synthesis.	Classroom teaching of discoveries from research papers, chalk and board method of teaching and use of Power point presentation. Practical demonstration of translation inhibitor and audio visual to demonstrate the experimental strategies used to decipher the genetic code.	Students will be challenged with analytical problems, puzzles and assignments related to genetic code and other topics covered in the class.
5.	Will be familiarized with regulation of transcription in prokaryotes and concept of lac and trp operon.	Traditional chalk and board method of teaching, audio visual presentation and regular class room discussion.	Various analytical problems will be assigned to students related to prokaryotic gene expression. Oral question answer sessions will be held in the class.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords:

DNA double helix, Replication, Transcription, Translation, Genetic code, Protein synthesis, Operons.

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH GE 11: Basic Concepts in Immunology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts of Immunology BCH-GE 10	04	03	00	01	Class XII with science	Basics in Cell Biology

1. Learning Objectives

- Explain the importance of innate Immunity in providing protection against pathogen.
- To understand the structure of the cells and organs associated with the immune system
- To understand the concept of antigen, the structure & function of antibody and the generation of humoral & cell mediate immune responses in the body.
- To know how antigen is recognized by B and T cells and the role of Major Histocompatibility complex in generation of immune response.

2.1 Learning Outcomes

At the end of the course the students will know:

1. The structure and function of cells and organs of the immune system
2. The concept of antigenicity and immunogenicity
3. Isotypes of antibodies-structure and functions
4. The concept of innate and adaptive immunity
5. Generation of antibodies and mechanisms to generate antibody diversity
6. Antigen presentation pathways and generation of cell mediated immunity

2.2 Theory (Credits 3)

Total Hours: 45

Unit 1. Introduction to the Immune System

(No. of Hours: 10)

Overview of the immune system, Historical Perspective, Hematopoiesis, Cells of the Immune System, Primary and Secondary lymphoid organs, Antigens, Properties of Immunogen, Haptens, Structure and Effector Functions of Different Types of Antibodies, Antigenic Determinants on Immunoglobulins, Antigen- antibody interactions, precipitation and agglutination reactions, Enzyme-linked immunosorbent assay.

Unit 2. Innate Immune Response

(No. of Hours: 8)

Anatomical Barriers, Inflammation, Phagocytic cells, Natural Killer Cells, Toll like receptors, Activation Pathways (Classical, Alternate, Mannose Binding Lectin) of Complement System, Biological Consequences of Complement Activation.

Unit 3. Humoral Immunity**(No. of Hours: 8)**

Primary and secondary immune response, B Cell Development, Maturation, Activation and Proliferation, role of T helper cell in B cell activation, Generation of Antibody Diversity, Class switching.

Unit 4. Cell mediated Immunity**(No. of Hours: 9)**

Structure and function of Class I & Class II Major Histocompatibility Complex molecules, Antigen Presenting Cells, Processing and Presentation of Antigen by the endocytic and cytosolic pathways, Structure & function of T cell receptor and co-receptors (CD3/CD4/CD8), Cytotoxic T cell and killing mechanisms.

Unit 5. Transplantation, Immunotherapy, Vaccines**(No. of Hours: 10)**

Transplantation, Rejection, Tissue typing; immunotherapy for cancer; vaccines and adjuvants; different types of vaccines.

2.3 Practical**Credits: 1****Total Hours: 30**

1. Double immuno-diffusion
2. Differential/Total Leukocyte Count
3. Isolation of lymphocytes from blood/spleen
4. Active agglutination Blood group typing
5. Indirect ELISA/DOT ELISA

2.4 Essential Readings:

1. 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.
2. Immunology: A Short Course (2009) 6th ed., Coico, R. And Sunshine, G., John Wiley & Sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
3. Singh I K and Sharma P (2022) *Essentials of Immunology: Laboratory Manual (A Laboratory Manual For Students Of Biological And Allied Sciences)* (As Per National Education Policy (Nep) Syllabus), Prestige Publishers, ISBN-10: 8195805744, ISBN-13 : 978-8195805747.

Suggested Readings:

1. Abbas AK, Lichtman AH, Pillai S ·(2021) *Cellular and Molecular Immunology*, 10e, South Asia Edition Publisher: Elsevier Health Sciences, India, ISBN: 9788131264577.

3. Teaching Learning Process and Assessment Methods
Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Outcomes	Learning Activity	Assessment Tasks
1	Students will study the fundamentals of immunology, including what an antigen and an antibody are, their related antigenic determinants, and about cells and organs of the immune system.	Teaching will be conducted both through black board mode and power point presentation mode.	Students will be asked questions related to the topic and class discussion will be held
2	Students will gain knowledge about the several ways in which innate immunity may defend individuals against illnesses including the complement systems' roles in innate and adaptive immunity.	Teaching will be conducted both through black board mode and power point presentation mode.	Assignment will be given and class discussion will be held
3	Students will learn as to how humoral response is generated and mechanisms responsible for generation of antibody diversity	Teaching will be conducted both through black board mode and power point presentation mode. The students will perform some practical to determine micronutrients in food	Quiz and classroom discussions will be held
4	They will learn about MHC Class I and Class II molecules and their role in antigen presentation, How cell mediated immune response controls infection will be discussed	Power point presentations and black board teaching will be done	Mid semester test will be held and assignments will be given

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords:

Immunity, innate, adaptive, antibody, Humoral and Cell mediated immune response, Processing of antigens