UNIVERSITY OF DELHI

MASTER OF SCIENCE

(Biochemistry)

(Effective from Academic Year 2025-26)

PROGRAMME BROCHURE

Syllabus as approved by
Committee of Courses on 11 March 2025

I. About the Department

I.1 Historical Background and Department Highlights

The Department of Biochemistry, a vibrant and premiere unit of the University, was established in 1983. Initially, the Master's course in Biochemistry was offered as a guest course at the Vallabhbhai Patel Chest Institute (VPCI), University of Delhi. In 1986, under the pioneering leadership of its founding father Prof. B.K. Bachhawat, the course moved full-fledged to South Campus and research activities took wing, heralding a new beginning and glorious future. The activities of the department revolve around the central theme of "Development of molecular strategies to combat various human diseases". The Department has received Extramural grants from DBT, DST, ICMR, CSIR, and DRDO, as well as intramural grants from the University of Delhi for research and infrastructure. The Department has also been funded under the DST-FIST, UGC-SAP and DU-DST PURSE programs. Every faculty member has well-equipped laboratory for research. The department has the Central Instrumentation Facility that houses high-end equipment as well as equipment routinely used for dissertation and research work.

One of the commendable contributions of the department has been the creation and sustenance of rigorous, dynamic and vibrant teaching and research programme that imparts conventional and new knowledge in an innovative manner, which ensures that fresh, young minds are trained and oriented to create newer knowledge in turn. In the department, teaching over the years has reached impeccable standards and research attained world-class quality. We boast of a world class faculty equipped with state-of-the art facilities that constantly churn out productivity – be it extremely well-trained students who find placement in various spheres of the professional world; research publications that are well cited; patents or technology that have reached the market (diagnostic kits); or technologies that have shown great potential for the near future (vaccine, gene therapy, drug, drug delivery). Our faculties have carved out a niche for themselves on the scientific arena and have won several awards, accolades and honors. Our students are equally productive and attain success regularly in all possible ways.

I.2 About the Programme

The M.Sc. programme in Biochemistry endeavours to provide students with excellent training in Biochemistry emphasizing on solid background of basic concepts as well as rapid advancement in the field. As per the NEP-2020 guidelines, the M.Sc. programme can be of two years full time or one-year full time depending upon the student's choice and his B.Sc. course duration. Hence, the course curriculum is designed accordingly for both the options as elaborated later. In addition to theoretical knowledge, considerable emphasis is given on hands on experience in the forefront areas of Biochemistry and Biotechnology through practical training in masters' laboratory. The second year of the two-year programme or the only one-year programme has three tracks which are i) only coursework, ii) coursework and research and iii) coursework with emphasis on research. To augment hands on research training in the research track programmes, an important feature pertains to the inclusion of project work and dissertation, that will allow students to get hands-on-experience in tools and methods used in Biochemistry and Biotechnology in specific labs allotted to students under the supervision of a mentor. The emphasis is to expose students to various aspects pertaining to research including the habit of scientific reading, research methodology, analytical ability, organizational capability, independent thinking, experimental design and execution capability and scientific

writing. Another outstanding feature that defines the programme and inculcates self-learning is the two courses (one in each semester of the first year in two-year programme), in which students are required to present in open forum for collective evaluation by the departmental faculty members. In the first year, students will be required to present seminars on important scientific topics and concepts after critical review of the scientific literature. In the second year of the two-year programme or in the only one-year programme with research, they are required to present update on the area of their dissertation research. This aspect of the programme helps students learn how to critically assess research papers, distil the best of the information and present the same in a concise and clear manner. The enlightening exercise will give them experience of public speaking and instil confidence. Students can also take advantage of the various elective courses on human diseases (infectious diseases and life-style disorders) to align themselves with the central theme of the department and equip better for future research in aspects of human diseases and disorders, the need of the hour in the country. Students who join the programme from non-biochemistry background in life sciences can take advantage by opting for the courses on Intermediary Metabolism or Developmental biology. The course also offers generic elective courses in Enzymes and metabolic pathways and Food and nutritional biochemistry that will also provide students, especially from other programmes in the University, an overview of the biochemical principles and concepts in various aspects of the subject.

In addition, the department regularly organizes seminars by national and international researchers to expose the students to a repertoire of scientific areas and scientific methodology to complement the courses in the programme. Although summer training is not a compulsory part of the curriculum, students are encouraged to undergo summer training in the department or other institutions during summer vacation, especially through national fellowships like those provided by the three Indian academies of Sciences. The department has separately allocated funds for educational tours to support their visits to various institutions / universities / industries. Students are encouraged to attend national conferences to expose them to the scientific community to learn the latest developments in science. Students are also encouraged to present posters and co-author papers and reviews. The department also organizes symposiums and conferences inviting eminent scientists across the country. For a holistic development, several cultural and sports activities are also organized round the year.

I.3 About Post Graduate Attributes

It is expected that at the end of the programme, each student is independent in their thought processes and can make an informed choice about their subsequent career. The program is expected to motivate students for higher education, especially research, while providing trained manpower for biotechnology industry as well. The students are expected to be able to apply biochemical principles to understand various complex processes in life sciences and provide biotechnological solutions to combat various human diseases. They are expected to be ethically sound and ready for the next phase of their development.

I. 4 About the process of course development involving various stakeholders at different stages

For the design of curriculum, selection of courses and drafting of syllabus for each course, suggestions from stakeholders were obtained at each stage. The course structure was initially framed in a faculty meeting and suggestions were sought from stakeholders that included the current M.Sc. students of the department and students who passed out in the last few years.

Based on the suggestions, the course structure was re-framed and syllabus for each course was drafted. Subsequently, the drafts went through multiple rounds of revisions. The revised draft was deliberated in a meeting of the Committee of Courses, their suggestions were incorporated and the final draft was prepared.

II. M.Sc. Programme Details:

Programme Objectives (POs):

The proposed programme shall be governed by the Department of Biochemistry, Faculty of Interdisciplinary and Applied Sciences, University of Delhi South Campus, New Delhi-110021. The specified program will lead to the award of a M.Sc. degree in Biochemistry. Students will be offered advanced level theory and practical courses in subjects like proteins and enzymes, cellular signals, immunology and immune-techniques, molecular biology, recombinant DNA technology, advanced techniques in biochemistry and multi-omics technology. The emphasis is on hands-on training of students. The research track programmes include work by students in research laboratories to carry out projects under the supervision of faculty members in addition to two practical courses in the first year. Before students initiate dissertation research projects, they will also be trained adequately in the various basic tools, techniques and instrumentation in specific research laboratories. Students are also required to present critical reviews on various current and significant topics in seminars. In the process they develop oratory and writing skills. In keeping with the objectives of the department, elective courses have also been included to impart knowledge in infectious diseases and life style disorders, in intermediary metabolism and developmental biology. The department also offers a generic elective course on enzymes and metabolic pathways and food and nutritional biochemistry for interested students across the University.

The department strives to achieve the following programme objectives:

- The foremost objective of the programme is to empower students with clear understanding of the basic concepts of biochemistry and provide them knowledge of the recent advances so that they can independently assess the vast scope in the field.
- The programme aims to train students to enable them to apply biochemical principles, theoretically and experimentally, to understand various complex life processes, while providing biotechnological solutions to combat various human diseases.
- It is expected that at the time of completion of the programme each student is confident and independent in their thought processes and can make an informed choice about their subsequent career.
- The program is expected to motivate students for higher education, especially research and provide trained manpower for biotechnology industry.
- They are expected to be ethically sound and ready for the next phase of their development, skilled in the art of self-reading, oration and scientific writing.

Programme Specific Outcomes (PSOs):

A post-graduate student upon completion of the programme is expected to gain the following attributes:

- In-depth knowledge of Biochemistry with inter-disciplinary perspective of other branches of life sciences.
- Competence for research and innovation in Biochemistry as a skilled experimentalist.
- Analytical and problem-solving skills with regard to biochemical principles of life processes and technologies for combating human diseases.
- Critical thinking about the concepts in Biochemistry and ability to critically review scientific literature for development of new theories and testable hypothesis.
- Capacity for decision making with regard to scientific progress, personal development and career choice.
- Ability to work independently, while still promoting teamwork and collaboration skills.
- Oratory (public speaking), scientific conversation and writing skills.
- Leadership and organizational skills.
- Demonstration of integrity, honesty, ethical behavior and sense of responsibility.
- Appreciation of diversity in scientific community and responsibility towards society and nation.
- Environmental awareness vis-à-vis bio-waste generation, disposal and management and safety and security issues.

Programme Structure:

As per the NEP-2020 guidelines, the M.Sc. programme will be offered as either a two-year programme or a one-year programme depending on the duration of the B.Sc. course of the student and the choice of the student. A student who has pursued 4-year Undergraduate degree in Biochemistry and allied subjects will be eligible to opt for a one-year M.Sc. programme while a student with 3-year undergraduate degree in Biochemistry and allied subjects will be eligible only to opt for a two-year M.Sc. programme.

Two-year M.Sc. programme will have a total of 88 credits with 22 credits in each semester. The second year of the programme will have three options and the student will have to opt for any of the options out of i) PG with only coursework, ii) PG with coursework and research and iii) PG with coursework and more emphasis on research. The credit scheme for the course is tabulated below.

The one-year M.Sc. programme will have a total of 44 credits with 22 credits in each semester. The programme will have three options and the student will have to opt for any of the options out of i) PG with only coursework, ii) PG with coursework and research and iii) PG with coursework and more emphasis on research. However, the third option (PG with coursework and more emphasis on research) will only be offered to the students with B.Sc. (H) Biochemistry degree. The credit scheme for the course is tabulated below.

SEMESTER-WISE PROGRAM STRUCTURE of M.Sc. BIOCHEMISTRY COURSE (NEP-PGCF)

First year (common in Program Structure 1, 2 and 3)

Semester-1

	Credits in each course			
	Theory	Practical	Tutorial	Credits
Discipline Specific Core (DSC) courses				
DSC-01: Proteins and Enzymes	3	1	0	4
DSC-02: Basic Techniques in Biochemistry	0	4	0	4
DSC-03: Emerging areas in Biochemistry	3	1	0	4
Discipline Specific Elective (DSE) courses*				
DSE-01: Developmental Biology	3	1	0	4
DSE-02: Intermediary Metabolism	3	1	0	4
Generic Elective (GE) courses*				
GE-01: Enzymes and metabolic pathways	3	1	0	4
Skill enhancement course (SEC)/ workshop/ Specialized laboratory/ Hands-on Learning				
SEC-01: ICT tools for Biochemistry	0	2	0	2
Research Methods/ Tools/ Writing	-	-	-	-
Dissertation/ Academic Project/ Entrepreneurship/ Intensive problem-based research				
-	-	-	-	-
Total credits				22

***** *(a student can opt for either two DSE courses, or one DSE with one GE)*

Semester-2

	Credits in each course			
Course	Theory	Practical	Tutorial	Credits
Discipline Specific Core (DSC) courses				
DSC-04: Cellular signals and their decoding	3	1	0	4
DSC-05: Bioanalytical techniques	0	4	0	4
DSC-06: Classical to future innovation in Biochemistry	3	1	0	4
Discipline Specific Elective (DSE) courses*				
DSE-03: Infectious Disease Biology	3	1	0	4
DSE-04: Lifestyle Disorders	3	1	0	4
Generic Elective (GE) courses*				
GE-02: Food and Nutritional Biochemistry	3	1	0	4
Skill enhancement course (SEC)/ workshop/ Specialized laboratory/ Hands-on Learning				
SEC-02: Artificial Intelligence and its Applications in Biochemistry	0	2	0	2
Research Methods/ Tools/ Writing	-	-	-	-
Dissertation/ Academic Project/ Entrepreneurship/ Intensive problem-based research				
-	-	-	-	-
Total credits				22

***** *(a student can opt for either two DSE courses, or one DSE with one GE)*

DSE

1. Developmental Biology DSE-1
2. Intermediary Metabolism DSE-2
3. Infectious Disease Biology DSE-3
4. Lifestyle Disorders DSE-4

GE

1. Enzymes and metabolic pathways GE-1
2. Food and Nutritional Biochemistry GE-2

DISCIPLINE SPECIFIC CORE COURSE – DSC-01: PROTEINS AND ENZYMES

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		
DSC-01 PROTEINS AND ENZYMES	**04**	**03**		**01**	-	**-**

Number of weeks: 15
Number of hours: 45 (T) + 30 (P)

Learning Objectives:

The main objective of this course is to introduce basic concepts of protein structure and function, mechanism of protein folding, and methods to engineer proteins for various applications. Another objective is to offer detailed knowledge about enzymes, providing basic concepts of their mechanism of action, kinetics, regulation, inhibition, purification, and diverse applications.

Learning Outcomes:

1. Students will be able to describe levels of protein structures – their basic constituents, forces that stabilize protein structures, and their various modules and arrangements.
2. Students will be able to evaluate how proteins fold during and following translation and the consequences of improper folding.
3. Students will be able to analyse enzyme assays, kinetics, structure, regulation, mechanism of action, and reaction intermediates and inhibition.
4. Students will be able to apply this knowledge for developing novel proteins and enzymes for industrial applications.

Contents

Unit I: Amino acids: Ways of representation, Classification, Stereochemistry, Chemical and structural features, Covalent & non-covalent interactions, Importance of weak interactions in protein structures. Levels of protein structure: *Primary structure*: Flexibility and conformational restrictions, Characteristics of peptide bond, Ramachandran plot. *Secondary structure*: H- bonding scheme, Diversity in alpha-helices, Beta-stand and sheet, Turns and loops, *Supersecondary structure*: Domains and motifs. *Tertiary structure*: General properties and characteristics, Structure prediction (modeling). *Quaternary structure*: Concept of subunits

and promoters and their association, Importance of quaternary structure; Various examples, Fibrous and Globular proteins, Structural Features of Membrane proteins.

12 hours

Unit II: Protein Folding and its biotechnological applications: The "protein folding problem" and problems in protein folding; Anfinsen's classical experiment; Folding curves and transitions; Models of protein folding; Assisted protein folding (Chaperones); Protein Engineering: Basic principles; Types and Methods; Strategies in protein engineering (Directed evolution, Comparative design, Rational design); Applications and case studies. Solvent Engineering: Physical basis for protein denaturation/ stability; Preferential binding and preferential hydration models; Various stabilizers and their applications.

11 hours

Unit III : Enzymology: Activation energy, Coupled reactions, Active site and its importance, Enzyme activity; Specific activity and Units; Ribozymes; Abzymes; Classification and nomenclature of enzymes. Enzyme assays: Optimization of enzyme assays. Factors influencing catalytic efficiency and the mechanisms employed. Mechanism of catalysis of various key enzymes at the molecular level. Enzyme kinetics: Significance; Rapid Equilibrium and Steady State approach, Henry- Michaelis-Menten's and Haldane equations, Significance of Km, Catalytic efficiency and turnover number; Kinetic perfection. Order of kinetics. Methods of plotting enzyme kinetics data: Lineweaver-Burk, Hanes-Woolf, Woolf-Augustinsson-Hofstee, Eadie-Scatchard; Direct linear plot; Advantages and disadvantages; Integrated form of the Henry-Michaelis-Menten equation.

11 hours

Unit IV: Enzyme Inhibition, Reversible and Irreversible inhibition, Models and types of inhibition; Kinetics and diagnostic plots related to enzyme inhibition, Dixon plots, Multisubstrate enzymes; Multisite and Allosteric enzymes; Models and examples. Regulation and control of enzyme activity: Isozymes, Zymogens, reversible covalent modification, irreversible covalent modification, Half-site reactivity; Bifunctional enzymes. Enzyme purification & Chromatography.

11 hours

Practical **30 Hours**

1. *In silico* protein sequence and structure analysis. Mining and retrieval of sequences and structures from PDB; Sequence alignment.
2. Prediction of physical and intrinsic parameters; Ramachandran Plot and its application.
3. Structure prediction and Homology modelling, Introduction to AlphaFold and other software
4. Seminal discoveries in the field of protein structure and folding, methodologies and interpretations- a discussion.

Suggested Readings:

1. C. Branden, T. Tooze. 1999. Introduction to Protein Structure (2nd Ed.), Garland Science, Taylor and Francis Group, New York, USA. ISBN: 978-0-8153-2305-1.
2. T.E. Creighton. 2002. Proteins: Structures and Molecular Properties (3rd Ed.), W.H. Freeman and Company, New York, USA. ISBN 978-0716770305.

3. R. H. Pain. 2000. Mechanisms of Protein Folding (2nd edition), Oxford University Press, Oxford, England. ISBN 978-0716770305.
4. S. Lutz, U. T. Bornscheuer. 2012. Protein Engineering Handbook, Volume-3, Wiley-VCH, Weinheim, Germany. ISBN: 978-3-527-31850-6.

Teaching Learning Process and Assessment methods

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I.	Students will learn about the significance of proteins in life; their classification; Key features of proteins that help them acquire diverse function; Properties of each of the proteinogenic amino acids along with their functional significance in protein structures; Characteristics of various physico-chemical interactions and importance of non-covalent interactions in providing proteins their shape and stability.	Outlining the history of development of knowledge about proteins through Powerpoint presentations and landmark publications; Use of stereochemical models; Question and answer sessions in the class; Amino acid characteristics will be explained using chalk and board; Two and three- dimensional pictures of the interactions in protein structures.	Structures of amino acids will be shown in ball and stick representation, and students will need to identify them along with their stereochemical identity; numerical problems relating to their pKa and pI, and how such knowledge is used in industry. A host of characteristics and features will be provided to students and they will need to match them with the type of non- covalent interactions.
II.	Students will learn about the characteristics of peptide bonds and how torsional angles are measured; Ramachandran plot and its use in validating protein structures. They will learn about the characteristics of interactions and nature of H-bonding that lead to secondary structures; Features of domains and motifs; General features of tertiary structures and arrangement of side chains; Concepts of subunits and their organization and consequences to protein structure and function	Chalk and Board for teaching the basic concepts; Power point presentations for 3D structure demonstration; Teaching module on protein structure-function (with myoglobin/ haemoglobin as a prototype), created for E- Pathshala (UGC, MHRD) will also be used.	Sequence of small sized proteins will be given and students will be asked to identify the protein and model their three-dimensional structure and predict their secondary structures. They will be assigned the task of retrieving PDB coordinates of any given protein and use the structure to plot Ramachandran maps. The domains in a given protein can be predicted and visualized along with the subunits and their interface.

III.	Importance of investigating enzyme kinetics; the important kinetic parameters like Km, Vmax, Kcat, etc.; derivation of Michaelis-Menten equation; Order of kinetics; Students will learn how to plot experimental data into various forms to calculate the various kinetic parameters and advantages and disadvantages of each such method. Students will learn how to measure fast kinetics.	The basic concepts will be explained using chalk and board; Original paper by Michaelis-Menten will be discussed. Powerpoint presentations for better representations. Student interaction in class.	Students will be asked to derive MM equation without help. Numerical problems to estimate kinetic parameters. Students will be asked to rearrange MM equation to derive the various equations which underlie each linear plot. Experimental data will be provided to plot data and derive parameters using graph papers. Students will read papers on fast kinetics and discuss about the principles in class in groups of 3.
IV	Students will learn about the various types of enzyme inhibitors; their mode of action and their influence on enzyme kinetic parameters. They will learn to plot experimental data.	Concepts will be taught using chalk and board and notes; Powerpoint presentations for images for clarity of concepts; Research papers will be provided for applications; Numerical problems will be solved.	Numerical problems on various types of inhibitors. Identification of types of inhibition from kinetic schemes and diagnostics plots

DISCIPLINE SPECIFIC CORE COURSE – DSC-02: BASIC TECHNIQUES IN BIOCHEMISTRY

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		
DSC-02 BASIC TECHNIQUES IN BIOCHEMISTRY	**04**	**-**		**04**	-	**-**

Number of weeks: 15
Number of hours: 120 (P)

Learning Objectives:

- The objective of this course is to develop a clear understanding with hands-on-experience in preparing basic reagents for biochemistry experiments,
- Students will learn different methods for quantitation and characterization of biomolecules.
- The students will develop the knowledge and skills to carry out various biochemical techniques.

Learning Outcomes:

1. Students will learn about various good lab practices, working in labs and use of instruments.
2. Students will be able to make various buffers and stock solutions as well as will be able to perform protein and DNA estimation using various methods.
3. The course will provide better understanding of controls in experiments and the art of design, execution and analysis of experiments.
4. Students will be able to perform ELISA and immunoblotting and differentiate various staining and detection methods.
5. Students will also learn the method of record keeping and presentation of data.

Contents:

Unit I: Buffers: theory and practice. Preparation and storage of buffers and protein stock solutions: Concept of pH, buffers and pKa; Preparation of buffers in the laboratory over a pH range (2 to 11); Use of pH meters. Handling of buffers and storage concerns. Physiological buffers in human body.

30 Hours

Unit II: DNA and Protein quantitation and characterization: DNA and protein estimation by UV spectroscopy (denaturation and renaturation experiments), storage and concentration; Spectrophotometry, Lambert-Beer Law, Concept of extinction coefficient and λmax.

30 Hours

Unit III: Electrophoresis and Immunoblotting: Analysis of proteins - Native PAGE and SDS-PAGE for multimeric and disulfide bonded proteins, Visualization of protein bands by Coomassie staining and Silver staining, concept of sensitivity of detection. Determination of molecular weight of a protein using standards, semi-log graph plotting and interpretation, Western blot / Immunoblotting analysis of the proteins using western blot. Primary and secondary antibodies, conjugates, application of different conjugates.

30 Hours

Unit IV: ELISA- a qualitative and quantitative method for estimation of analytes, Indirect ELISA and estimation of antibody titres, sandwich ELISA for quantitation of antigen levels in samples. Applications of ELISA in diagnostics.

30 Hours

Suggested Readings:

1. J. Owen, J. Punt, S. Stranford, (2018) Kuby Immunology (8th Edition), WH Freeman and Company, USA.
2. J.M. Berg, J.L. Tymoczko, L. Stryer. (2023) Biochemistry (10th Edition), WH Freeman and Company, USA.
3. M.R. Green and J. Sambrook (2012) Molecular cloning, A Laboratory Manual Vol. I-III. (Fourth edition) Cold Spring Harbor Laboratory Press
4. Hofmann, A., Clokie, S. (2018) Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8th Edition), Cambridge University Press, UK.

Teaching Learning process and Assessment methods

Unit No.	Course learning outcome	Teaching and learning activity	Assessment task
Unit I	Students will understand the fundamental concepts of pH, pKa, and buffer systems. They will develop practical skills in preparing buffers across a pH range and using pH meters efficiently.	Interactive lectures on buffer theory, hands-on laboratory sessions for buffer preparation, and demonstrations on pH meter calibration and troubleshooting. Discussions on real-	Mid-term and end-term tests on buffer calculations and concepts. Practical assessments on buffer preparation and pH measurement. Submission of lab

	Additionally, they will gain expertise in handling and storing buffers to maintain their stability.	world applications of buffers in biochemical processes.	reports on buffer stability and handling techniques.
Unit II	Students will gain knowledge of different techniques for estimating DNA and protein concentrations using UV spectroscopy. They will learn about protein storage and concentration techniques. Additionally, they will understand the spectroscopic characterization of proteins and protein stability analysis.	Lectures on the principles of UV spectroscopy, extinction coefficients, and protein quantification methods. Laboratory demonstrations on DNA and protein estimation techniques. Hands-on sessions on protein handling and storage.	Mid-term and end-term tests on UV spectroscopy principles. Practical assessments on DNA and protein estimation. Lab reports on protein quantification and stability measurements.
Unit III	Students will develop expertise in analysing proteins using electrophoretic techniques such as Native PAGE and SDS-PAGE. They will learn methods for visualizing proteins using Coomassie and Silver staining. Additionally, they will gain knowledge of molecular weight determination and Western blot analysis.	Lectures on electrophoretic separation principles and gel composition. Hands-on training in sample preparation, gel running, and staining techniques. Demonstrations on Western blot transfer and antibody-based detection.	Practical assessments on gel electrophoresis and staining techniques. Mid-term and end-term tests on electrophoresis principles and interpretation of results. Submission of lab reports on protein analysis and Western blotting.
Unit IV	Students will understand the principles of ELISA for qualitative and quantitative detection of biomolecules. They will gain expertise in performing indirect and sandwich ELISA for antibody and antigen quantification. They will also explore the clinical and research applications of ELISA.	Lectures on ELISA principles and types. Hands-on sessions on indirect and sandwich ELISA techniques. Data analysis workshops on interpreting ELISA results.	Mid-term and end-term tests on ELISA principles and applications. Practical assessments on ELISA procedures and data interpretation. Submission of lab reports on antibody titre estimation and antigen quantification.

DISCIPLINE SPECIFIC CORE COURSE – DSC-03: EMERGING AREAS IN BIOCHEMISTRY

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		
DSC-03 EMERGING AREAS IN BIOCHEMISTRY	04	03		01	-	-

Number of weeks: 15
Number of hours: 45 (T) + 30 (P)

Learning Objectives:

The course intends to inculcate the skills in students to explore an important and current scientific topic and present collated information that reflects their understanding of the topic.

Learning Outcomes:

1. Upon successful completion of the course, students will learn how to survey scientific literature, screen relevant information, apply their knowledge of biochemistry to understand research findings and analyse the results reported in literature.
2. Students will learn how to collate scientific findings and prepare a scientific document on the analysis.
3. Students will learn how to prepare bibliography in scientific text, check for plagiarism and be aware of the softwares to avoid plagiarism.
4. Students will learn to present their results orally and in written form.

Contents:

Unit I: Emerging areas relevant to human health and biochemistry, assignment of a particular area, use of online search engines and scientific websites to survey available literature on the area / topic assigned. In-depth study of review and research activities to understand the current state of work in the particular area.

16 hours

Unit II: Identify and understand basic concepts, techniques, methodologies employed in the area of research through published literature, analyse the results obtained and identify key achievement and findings, identify gap areas for further research.

12 hour

Unit III: Compilation of the analysis into a detailed oral presentation. Incorporation of background information, current status in the area, detailed explanation of the research articles, experimental findings, area and scope of further work.

8 hours

Unit IV: Preparation of a scientific document on the analysis, introduction to appropriate softwares for referring and plagiarism and their use for the preparation of the document.

9 hours

Practical: **30 hours**

1. Designing slide decks to enhance the quality of scientific presentations
2. How to use and add animations, graphics and flowcharts in presentations
3. How to deliver scientific presentations in a clear and engaging manner
4. Use of narrative techniques to communicate research
5. Drafting scientific document and use of bibliographic software.

Suggested Readings:

1. Review articles in scientific journals.
2. Research articles in scientific journals.
3. Standard textbooks of Biochemistry as appropriate.

Teaching Learning process and Assessment methods

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will know how to search for research papers using combination of key words; They will learn how to download references and save them in appropriate softwares like EndNote; Students will learn to differentiate review articles from research articles; Students will learn how to make Powerpoint presentation file.	A Powerpoint presentation on the art of presentation will be utilized initially to train students; Interactions with students will be conducted to answer their queries.	Topic on current and important research areas will be assigned individually to students and they will be asked to retrieve literature and show them to teachers for verification. They will be shown review and research articles and asked to identify them. They will be motivated to make short presentations as journal club seminars for the practice of oration.

II	Students will learn how to analyse and interpret research findings. They will also learn to identify research gap areas.	Teachers will assist the students in understanding the experiments and analyse the research findings in published literature.	Students will be assessed for their understanding of research findings in the presentation.
III	The students will learn how to make presentations in public and will also learn to answer questions related to their presentation.	Previous presentations by students will be shown. Interactions on how to deliver seminars and answer the questions will be conducted	Students will be evaluated for their presenting skills and handling of questions at the end of the semester. Questions will be asked based on the topics presented and the students will be assessed based on their performance.
IV	Students will learn how to prepare a write-up to summarize their understanding of a research topic; They will have advanced learning or MS Word, MS Excel and other softwares. They will learn how to cite references in text and how to organize them in a bibliographic section either manually or using softwares like EndNote. Students will learn about the softwares for plagiarism and how to use them.	Teachers will describe how to prepare write-up and what are the points to keep in mind while doing so. Student queries will be entertained by teachers. They will be shown previous term papers for better understanding. Students will be informed about the issues related plagiarism.	Students will need to write term paper on the topic assigned. If needed, they will be asked to write short essays on simpler topics for practice of writing. Department also often organizes essay writing competition to allow students the opportunity to improve their writing. They will be asked to run their write-up through plagiarism software and show the outcome to teachers.

DISCIPLINE SPECIFIC CORE COURSE – DSC-04: CELLULAR SIGNALS AND THEIR DECODING

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		
DSC-04 CELLULAR SIGNALS AND THEIR DECODING	04	03		01	-	-

Number of weeks: 15
Number of hours: 45 (T) + 30 (P)

Learning Objectives:

The objective is to offer detailed knowledge about various cellular signals and the processes through which these signals are decoded, various signal transduction pathways associated with the cellular processes of the cells. The course also aims to provide insights into how classical cellular pathways were experimentally discovered.

Learning Outcomes:

1. Students will acquire insights into transport processes across cell membranes, process of endocytosis and protein sorting/translocation to various organelles.
2. Students will gain knowledge about the concepts of various cellular signal transduction pathways
3. Students will acquire insights into the mechanisms of cellular responses under varying conditions
4. Students will learn the association of the defects in the signalling processes to various diseases.

Contents:

Unit I: Role of signal sequences in protein sorting and localisation: Historical background, Protein translocation across ER- signal sequence and SRP. Co-translational and post-translational translocation into ER. Signals for insertion of proteins into ER membrane - positive-inside rule, protein modification (glycosylation and GPI anchor) and quality control of protein and UPR in ER. Retrograde signals and pathways, Golgi vesicular traffic, protein import in mitochondria, peroxisomes, chloroplasts. Signal for Import and Export of

Macromolecules from Nucleus. Glycosylation in mammalian cells, origin, nature and types of Glycosylation. Role of Glycosylation in protein stability and folding with reference to ER exit. Introduction to post-translational modifications.

12 hours

Unit II: Short Term and Long-Term Cellular Signalling: General principles of signalling by cell surface receptors, endocrine, paracrine and autocrine signalling. Components of intracellular signal-transduction pathways. G- protein coupled receptor system, General mechanism of the activation of effector molecules associated with GPCRs, GPCRs that activate or inhibit adenylate cyclase, activate phospholipase C, or that regulate ion channels. Receptor tyrosine kinases - their discovery, signalling of growth factors (EGF and Insulin) via activation of receptor tyrosine kinases. Non-receptor tyrosine kinases, Nuclear receptor superfamily, signalling responses by NO, peptide hormones, eicosanoids and brief introduction to plant hormones.

11 hours

Unit III: Types of signalling pathways: MAP kinase pathway, role of Ras oncogene, cytokine signalling via JAK/STAT pathway, signalling of TGFβ by direct activating Smad proteins, NF-kB pathway, cAMP pathway and PKA signalling (fight and flight response), cGMP pathway, role of phospholipids and calcium signalling, PI3 kinase and AKT pathway, Hedgehog, Wnt and Notch signalling pathways. Two-component systems. Signaling pathway involved in exocytosis (insulin secretion as an example).

11 hours

Unit IV: Cell cycle, Cell Survival and Death Signal: Cell cycle and regulation, Restriction point of cell cycle and Quiescent cells. Control of cell cycle in yeast and mammalian cells. Role of various cycle-CDK complexes in the transition of various checkpoint of cell cycle. Role of ubiquitin-protein ligase –SCF and APC/C in the control of cell cycle. Cytokinesis. Programmed cell death and role of Caspase protein in apoptosis. Various pro-apoptotic and anti-apoptotic regulators and pathways. Autophagy and its mechanisms. Ferroptosis.

11 hours

Practicals: **30 hours**

1. Case studies to discuss the importance of signalling processes in various diseases
2. Video demonstrations on cellular architecture, transport mechanisms
3. Assays to distinguish apoptotic cells from normal and necrotic cells
4. The role of checkpoints as therapy targets in cancer management

Suggested readings

1. H. Lodish, A. Berk, C.A. Kaiser, M. Kreiger, M. P. Scott, A. Bretscher, H. Ploegh, P. Matsudaria. 2021. Molecular Cell Biology, 9th edition, W.H. Freeman and Company, New York., USA.
2. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P Walter. 2020. Molecular Biology of the Cell 7th edition, Garland Publishing, Inc. New York. USA.
3. G.M. Cooper. 2023. The Cell: Molecular Approach 9th edition, ASM Press, Washington, D.C. USA.

4. L. Harvey, B. Arnold, Z.S. Lawrence, M. Paul, D. Baltimore, J.E. Darnell. 2021. Molecular Cell Biology 9th edition, W. H. Freeman & Co, New York, USA.

Teaching Learning process and Assessment methods

Unit No.	Course learning outcome	Teaching and learning activity	Assessment task
Unit I	Students will gain knowledge about the process of protein sorting, role of ER in quality control and various post-translational modifications.	Board and powerpoint teaching methods will be employed for taking the lectures. Classes will be held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	Mid-term internal assessment test will be conducted. Regular class revisions and oral questions will be asked on the previously taught questions.
Unit II	Students will gain knowledge about the concepts of various cellular signal transduction pathways – about the types of receptors and intracellular messengers	Board and powerpoint teaching methods will be employed for taking the lectures. Classes will be held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	Mid-term internal assessment test will be conducted. Students will be asked to prepare and Present research/ review articles related on various topics assigned to them.
Unit III	Students will acquire insight into the mechanisms of cellular responses under varying conditions. Students will learn the association of the defects in the signaling processes to various diseases	Board and powerpoint teaching methods will be employed for taking the lectures. Scientific research articles will be discussed in the class. Students will be encouraged to ask questions and have discussions on the topics taught.	End-term internal assessment test will be conducted. Regular class revisions and oral questions will be asked on the previously taught questions.
Unit IV	Students will be able to learn about the concepts of cell cycle, apoptosis and autophagy. They will also learn about the role of these processes in cancer and other diseases.	Board and powerpoint teaching methods will be employed for taking the lectures. Scientific research articles will be discussed in the class. Students will be encouraged to ask questions and have discussions on the topics taught.	End-term internal assessment test will be conducted. Regular class revisions and oral questions will be asked on the previously taught questions.

DISCIPLINE SPECIFIC CORE COURSE – DSC-05: BIOANALYTICAL TECHNIQUES

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		
DSC-05 BIOANALYTICAL TECHNIQUES	**04**		**-**	**04**	-	**-**

Number of weeks: 15
Number of hours: 120 (P)

Learning Objectives:

The objective of this course is to provide in depth knowledge with hands-on-experience in bacterial cell culture, immuno-techniques, animal cell culture, cloning, gene expression in *E. coli*, protein purification, enzyme kinetics and bioinformatics.

Learning Outcomes:

1. Students will get hands-on training for bacterial cell culture, molecular biology techniques, gene cloning and protein purification.
2. Students will obtain hands-on training for animal cell culture, transfection of foreign genes and their expression analysis.
3. The course will provide better understanding of controls in experiments and the art of design, execution and analysis of experiments.
4. Students will learn the tools to analyse DNA and protein sequences.

Contents

Unit I: Growth of Bacterial culture, preparation and sterilization of growth medium, Streaking of culture and inoculation, Competent cell preparation and Transformation. Plasmid DNA isolation, amplification of gene by PCR, insertion of gene into expression vector to produce recombinant protein (Isolation of Vector, Restriction digestion, extraction of DNA from gel, Ligation, Transformation). Screening of positive clones by colony PCR and restriction digestion analysis.

30 hours

Unit II: Expression, localization and purification of recombinant protein. Various methods to optimize expression, techniques to improve the solubility of the recombinant protein, protein purification by chromatographic methods. Measurement of kinetic parameters and factors influencing enzyme activity.

35 hours

Unit III: Introduction to animal tissue culture, media compositions and learning about aseptic conditions. Growing mammalian cells, trypsinization, plating, cryofreezing and general maintenance of cells. Harvesting of cells and counting using Hemocytometer; Investigation of the effect of various harsh conditions on cell viability using Trypan blue. Preparation of transfection-grade plasmid DNA using commercial columns, analysis of its quality and yield, Transfection of plasmids into mammalian cells. Visualization of the fluorescent proteins in live cells and calculation of transfection efficiency. Assessment of localization (nuclear or cytoplasm) and co-localization of the proteins. Preparation of transfected cell lysates and Western Blot analysis of the overexpressed proteins.

40 hours

Unit IV: Pairwise alignment to identify homologous sequences and interpret alignment scores. Multiple sequence alignment (MSA) using Clustal Omega, MUSCLE, and MAFFT to analyze alignment quality and conserved regions. Phylogenetic analysis using MEGA, PhyML, and FastTree, comparing different tree-building methods such as Neighbor-Joining and Maximum Likelihood. Web-based phylogenetic analysis using Phylogeny.fr and MEGA for constructing and interpreting evolutionary relationships. Sequence editing and visualization using BioEdit, AliView, and Geneious for sequence preparation and alignment evaluation.

15 hours

Suggested Readings:

1. D.L. Nelson, M.M. Cox. (2021). Lehninger Principles of Biochemistry (8th Edition), W.H. Freeman and Company, New York, USA.
2. M.R. Green and J. Sambrook (2012) Molecular cloning, A Laboratory Manual Vol. I-III. (Fourth edition) Cold Spring Harbor Laboratory Press.
3. Fred M. Ausubel *et al.* editors (2017) Current Protocols in Molecular Biology. John Wiley and Sons, Inc.
4. John E. Coligan *et al.* editors (2017) Current Protocols in Protein Science. John Wiley and Sons, Inc.
5. T.A. Brown. (2020) Gene Cloning and DNA Analysis. (8th Edition). Wiley-Blackwell publishing (Oxford, UK).
6. L. Wolpert, R. Beddington, T. Jessell. 2019. Principles of Development (6th Edition), Oxford University Press, New York, USA.

Teaching Learning process and Assessment methods

Unit No.	Course learning outcome	Teaching and learning activity	Assessment task
Unit I	Students will be able to do bacterial culturing, DNA isolation, restriction digestion and cloning of genes.	Students will be provided individual hands-on –training along with extensive theory classes for understanding the concepts. They will be taught various ways to clone a foreign gene, its various applications and	Students will be given assignment tasks related to gene cloning and PCR amplification, to design primers *in silico* and to devise

		troubleshooting. They will learn to make competent cells and perform gene cloning in an *E.coli* expression vector.	new cloning strategies.
Unit II	Students will be able to perform protein expression and purification and will learn how to troubleshoot the problems.	Extensive theory classes and discussion on protein expression and purification. Hands-on-training to pack purification columns. Various optimization techniques will be taught for achieving better expression and solubility of proteins. Enzyme assays will be carried out under different conditions.	Discussions on the concepts of purification and the enzymatic assays will be carried out, students will be asked oral questions and quizzes will be conducted for the assessment of their concepts of enzyme inhibition.
Unit III	Students will learn to perform tissue culturing, transfection of mammalian cell lines, expression of proteins in cell lines and immunoblotting.	Chalk and Board teaching, discussion of lab practices, basic concepts of cell culturing, plasmid isolation, transfection. Live demonstration of DNA precipitate preparation will be given, various methods of introducing DNA into cells will be discussed using powerpoint presentation and consultation of scientific articles.	Students will be asked oral questions related to cell culture techniques and general GLPs. Group discussion, debates, solving analytical questions, quiz etc. Students will be encouraged to read research articles related to the practicals and discuss the findings. Solving of practical based analytical questions, discussion of situations in research, quiz, students will be asked to prepare short presentations on the practicals performed and discuss their findings.
Unit IV	Students will get hands on experience of using various bioinformatics tools that will be useful in drug discovery, big data analysis etc.	Computational hands-on training will be provided to the students so that they will be able to employ the bioinformatics tools for research applications and scripting will be taught through power-point presentation.	For the assessment of their bioinformatics knowledge, the students will be given tests and assignments tasks to analyse data and perform simple computational tasks.

DISCIPLINE SPECIFIC CORE COURSE – DSC-06: CLASSICAL TO FUTURE TO INNOVATIONS IN BIOCHEMISTRY

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		
DSC-06 CLASSICAL TO FUTURE INNOVATIONS IN BIOCHEMISTRY	04	03		01	-	-

Number of weeks: 15
Number of hours: 45 (T) + 30 (P)

Learning Objectives:

The course intends to engage in an independent, active and self-driven learning method and to inculcate the skills in students to explore important classical and future innovations and present collated information that reflects understanding of the topic.

Learning Outcomes:

1. Students will learn about the history of scientific landmarks and classical discoveries.
2. Students will learn about various techniques that have impacted progress of science.
3. Students will learn to carry out survey on a particular area and topic.
4. Students will imbibe the skills of preparation of scientific presentations and documents.

Contents:

Unit I: Historical perspective on the landmark developments in science, their impact on the present-day science, major breakthrough discoveries of biological processes, survey of seminal research articles in the literature.

10 hours

Unit II: Innovations that led to development of tools and techniques in cell biology, immunology, molecular biology and recombinant DNA technology, and allied areas, the impact of these techniques on progress of scientific understanding, evolution of these techniques with time.

12 hours

Unit III: Integration of scientific knowledge, tools and techniques to address a particular area and problem related to human health, study of available literature on the specific problem, experimental strategies to address the problem, major results and key findings, gap areas,

limitations and future scope to address fundamental questions in the area to devise interventions.

12 hours

Unit IV: Compilation of the information into a detailed presentation, documentation of the information in a scientific manner using appropriate tools, relevance of statistical tools in research and data presentation.

11 hours

Practical: **30 hours**

1. Group discussions for classical Nobel prize discoveries/innovations and understanding the research studies and findings
2. Group discussions and assignments to identify research gap areas in the relevant and emerging areas.
3. Group discussion on plagiarism – definition, types, use of plagiarism detection tools with an emphasis on ethical integrity in science.

Suggested Readings:

1. Review articles in scientific journals.
2. Research articles in scientific journals.
3. Standard textbooks of Biochemistry as appropriate.
4. Nobel prize website
5. Books by Nobel laureates

Teaching Learning process and Assessment methods

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will get aware of some of the classical innovations and seminal discoveries from the literature.	Students will be taught how to access the articles by using the online tools and journal websites.	Students will be assigned topics on important innovations and discoveries and they will be asked to retrieve literature and select relevant articles which will be assessed for their suitability for the presentation by the teachers. They will be motivated to make short presentations as journal club seminars for practice of oration.

II	Students will learn the skill of reading review and research articles, how to understand the background of a particular study, identify the gap areas and how to plan a particular study to address the problem and also how to interpret research findings.	Teachers will assist the students in understanding various selected articles and the experiments employed to address the research gap and in the analysis of the results	Students will be assessed for their understanding of research findings in the presentation.
III	The students will learn how to make presentations in public and will also learn to answer questions related to their presentation.	Previous presentations by students will be shown. Interactions on how to deliver seminars and answer the questions will be conducted	Students will be evaluated for their presenting skills and handling of questions at the end of the semester. Questions will be asked based on the topics presented and the students will be assessed based on their performance.
IV	Students will learn how to prepare a scientific academic document to summarize their understanding of a research topic.	Teachers will describe how to prepare a scientific document and what are the points to keep in mind while doing so. Students will be informed about the issues related plagiarism. Various bibliography tools will also be introduced to the students.	Students will need to write term paper on the topic assigned. The assessment will be based on the quality and completeness of the scientific document submitted by the students.

DISCIPLINE SPECIFIC ELECTIVE COURSE : DSE-01
DEVELOPMENTAL 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		
DSE-01 DEVELOPMENTAL BIOLOGY	04	03		01	B.Sc. in any area of Life Sciences	-

Number of weeks: 15
Number of hours: 45 (T) + 30 (P)

Learning Objectives:

This course aims to provide a comprehensive understanding of Developmental Biology, covering fundamental principles, molecular mechanisms, model systems and their applications in research, medical implications of developmental biology in understanding disorders and treatment of various human diseases.

Learning Outcomes:

1. Students will acquire knowledge about fundamental developmental processes, explain key principles of embryogenesis, cell fate determination, germ layer formation, and morphogenesis, linking developmental mechanisms to evolutionary changes.
2. Students will be able to describe the role of signaling pathways, cell-cell communication, and gene regulation in developmental processes, including Nieuwkoop center, Spemann-Mangold organizer, and EMT etc.
3. Students will be able to evaluate contributions of various model systems in studying pattern formation, organogenesis, and gene function in developmental biology and understanding various development associated defects.
4. Students will learn about the significance of stem cells, regenerative medicine, and therapeutic cloning in treating developmental disorders and designing future medical therapies. Case studies and discussions will foster critical thinking and research aptitude.

Contents

Unit I: Fundamentals of Developmental Biology and Early Developmental Processes: History and basic concepts of developmental processes, mechanisms of specifying cell fate, role of development in evolutionary change, early events of fertilization, implantation, generation of multicellular embryo, formation of germ layers, patterning of vertebrate body plan, morphogenesis including cell adhesion, cleavage, blastula formation, gastrulation, neural tube formation, and cell migration.

10 hours

Unit II: Molecular Events in Development and Signaling Pathways: Molecular events of embryogenesis: Nieuwkoop center, Spemann-Mangold organizer theory, mesodermal induction, role of cell-cell communication in development, concepts of induction and competence, epithelial-mesenchymal interactions, developmental signals from the extracellular matrix, and roles of various signaling pathways during development.

10 hours

Unit III: Model Systems in Development: Model organisms and their contributions to developmental biology: *C. elegans* (cell lineage, cell fate determination, regulation of blastomere identity, body axis formation, organogenesis), Drosophila (maternal and zygotic genes, polarity determination, pattern formation, segmentation, homeotic genes), Zebrafish (developmental stages, somite formation, pigment patterning), Mouse (vertebrate development, gene function studies with knockout/knock-in models, generation of disease models), Arabidopsis (life cycle, phytohormones, embryogenesis, flowering, ABC model, homeotic genes, MADS-box, shoot-root development, genetic control of floral modifications and organ patterning). Transgenics and their applications.

15 hours

Unit IV: Role of Stem Cells in Development and Medical Implications of Developmental Biology: Classification and properties of stem cells, adult and embryonic stem cells, cancer stem cells, stem cell markers, applications of stem cells, advancements in research, and associated ethical issues. Developmental disorders, in-vitro fertilization, gene therapy, therapeutic cloning, iPS technology and regeneration therapy, and design of future medicines leveraging developmental biology concepts.

10 hours

Practical: **30 hours**

1. Observation of embryogenesis stages in model organisms such as Drosophila, Zebrafish, and *C. elegans*,
2. Analysis of cell adhesion, cleavage, gastrulation, somite formation through microscopy. Learning techniques of stem cell culture and differentiation techniques, 3D culture, tissue engineering and 3D printing.
3. Case studies on developmental disorders, and review of research articles based on various model systems and developmental pathways.

Suggested readings:

1. S. F. Gilbert. 2018. Developmental Biology (11th Edition), Sinauer Associates, Inc., MA, USA.
2. D.L. Riddle, T. Blumenthal, B.J. Meyer, J.R. Priess. 1997. C. elegans II. Cold Spring Harbor Laboratory Press, New York, USA.
3. Worm Book: The Online Review of C. elegans Biology. 2005. The C. elegans Research Community, Pasadena, USA. (www.wormbook.org)
4. L. Wolpert, R. Beddington, T. Jessell. 2010. Principles of Development (4th Edition), Oxford University Press, New York, USA.
5. P. Matsudaira. 2003. Molecular Cell Biology, W.H. Freeman, New York, USA. Nagy, M. Gertsenstein, K Vintersten, R. Behringer. 2003. Manipulating the mouse embryo: a laboratory manual, Cold spring Harbor Press, New York, USA.

Facilitating the achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I.	Students will learn about basic concepts of developmental processes, how cell fate is determined and link between development evolution. Role of various signaling pathways will be learnt, early events of fertilization, implantation, germ layer formation and patterning of vertebrate body plan.	Chalk and board and power point presentations, regular question-answer activities, consultation of relevant research articles and watching videos.	Assessment through interactive discussion in the class, periodic question-answer sessions during teaching. Oral questions will be asked, students will be given to solve analytical problems relating to class teachings. Students will be asked to read original research articles and discuss the experimental approach and findings.
II.	Students will learn the molecular events of embryogenesis: Nieuwkoop center, Spemann organizer theory, mesodermal induction and cell movements during gastrulation.	Chalk and board and Power point presentations, regular question-answer activities, consultation of relevant research articles, reviews and watching videos.	Writing assignments given to students, schematics of various molecular events will be shown with missing links, students will fill in the names of the missing molecules. Other activities like quiz, puzzles etc. will be held in class. Students will be asked to read relevant research papers and discuss the results in class.
III	Students will learn about utility of various model organisms to follow development processes and development of various disease models. Students will learn how to elucidate the development related signaling mechanisms.	Chalk and board and Power point presentations, regular question-answer activities, consultation of relevant research articles and reviews.	Pictures of various mutants will be shown for students to identify the developmental defects, oral questions, quiz and puzzles will be used for day to day evaluation during class. Reading of research papers related to various model organisms and discussion.
IV	Properties and significance of stem cells and their role in development will be learnt. They will understand their research applications and current research status in India. Students will learn about developmental disorders, *in-vitro* fertilization, therapeutic cloning, iPS and regenerative medicine.	Chalk and board and Power point presentations, regular interaction activities, discussion of case studies.	Students will be asked to segregate different type of stem of cells based on the markers, they will be asked design experiments to test stemness properties of cells in animal models. Students will be evaluated through class discussion, assignments and tests.

DISCIPLINE SPECIFIC ELECTIVE COURSE : DSE-02
INTERMEDIARY METABOLISM

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		
DSE-02 INTERMEDIARY METABOLISM	04	03		01	B.Sc. in any area of Life Sciences	-

Number of weeks: 15
Number of hours: 45 (T) + 30 (P)

Learning Objectives:

The objective is to offer detailed and comprehensive knowledge about the synthesis and catabolism of biomolecules such as carbohydrates, lipids, amino acids and nucleotides. The regulation of the metabolic processes as well as the disease correlation of the metabolic disorders will also be taught.

Learning Outcomes:

1. Students will learn about various kinds of biomolecules and their physiological role.
2. Students will gain insights into the detailed synthesis and breakdown of the various biomolecules
3. Students will gain knowledge about various metabolic disorders that will help them to know the importance of various biomolecules in terms of disease correlation.
4. Students will learn about the integration of various metabolic pathways and their cross-talk.

Contents

Unit I: Carbohydrate metabolism. Overview of metabolism and metabolic reactions, catabolism, anabolism, ATP as energy currency of the cell, reducing power of the cell. Anaerobic production of ATP, Glycolysis, Fermentation, Regulation, Utilization of sugars other than glucose. Gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis, pentose phosphate pathway, glucuronic acid pathway. Aerobic production of ATP, TCA cycle, regulation. Glycogenesis and glycogenolysis, regulation of glycogen metabolism, Signalling pathways, Hormonal regulation of carbohydrate metabolism, molecular aspects of diseases caused by dysregulation of metabolic pathways.

12 hours

Unit II: Lipid Metabolism. Absorption, transport and storage of lipids and TAGs, Lipid metabolism and regulation, Biosynthesis and degradation of TAGs and phospholipids, fatty acid oxidation, ketone bodies metabolism, ketoacidosis, cholesterol metabolism, Molecular mechanism of steroid and lipoprotein metabolism.

11 hours

Unit III: Amino Acids and Nucleotide Metabolism. Role of essential and non-essential amino acids in growth and development. Protein calorie malnutrition - Kwashiorkor and Marasmus, catabolism of amino acids. Glucogenic and ketogenic amino acids. Disorders of amino acids metabolism, biosynthesis of urea, its regulation and urea cycle disorders, overview of amino acid synthesis, Biosynthesis of non-essential amino acids and its regulation, precursor functions of amino acids and its importance, De novo synthesis and breakdown of purine and pyrimidine nucleotides, regulation and salvage pathways, Digestion of nucleic acids, Inhibitors of nucleotide metabolism.

11 hours

Unit IV: Integration of metabolic pathways, tissue specific metabolism (brain, muscle, and liver). Molecular mechanisms and regulation of carbohydrate, lipid, amino acids and nucleotide metabolism.

11 hours

Practicals: **30 hours**

1. Case studies for various metabolic disorders - diseases caused by abnormal metabolic pathways, glycogen storage diseases, inborn errors of metabolism, disorders of nucleotide metabolism
2. Group discussion on importance of metabolites in disease diagnosis and development of various diagnostic methods
3. Case studies for analysis of blood reports and disease diagnosis.

Suggested readings

1. Lehninger: Principles of Biochemistry (2021) 8th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1- 4641-0962-1
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4 / BRV ISBN: 978-0-470-60152-
3. Biochemistry (2023) 10th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.
4. Harper's Biochemistry (2022) 32nd ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-3.

Teaching Learning process and Assessment methods

Unit No.	Course learning outcome	Teaching and learning activity	Assessment task
Unit I	Students will gain insights into the detailed synthesis and breakdown of the carbohydrates and the metabolic disorders associated with these pathways	Board and powerpoint teaching methods will be employed for taking the lectures. Classes will be held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	Internal assessment tests (mid-term and end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a power-point presentation on the assigned topics.
Unit II	Students will gain insights into the detailed synthesis and breakdown of the lipids and the metabolic disorders associated with these pathways	Board and powerpoint teaching methods will be employed for taking the lectures. Classes will be held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	Internal assessment tests (mid-term and end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a power-point presentation on the assigned topics.
Unit III	Students will gain insights into the detailed synthesis and breakdown of the amino acids and nucleotides and the metabolic disorders associated with these pathways	Board and powerpoint teaching methods will be employed for taking the lectures. Classes will be held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	Internal assessment tests (mid-term and end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a power-point presentation on the assigned topics.
Unit IV	Students will learn about the integration of various metabolic pathways and their cross-talk	Board and powerpoint teaching methods will be employed for taking the lectures. Classes will be held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	Internal assessment tests (mid-term and end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a power-point presentation on the assigned topics.

DISCIPLINE SPECIFIC ELECTIVE COURSE : DSE-03
INFECTIOUS DISEASE 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		
DSE-03 INFECTIOUS DISEASE BIOLOGY	04	03		01	B.Sc. in any area of Life Sciences	-

Number of weeks: 15
Number of hours: 45 (T) + 30 (P)

Learning Objectives:

The objective is to offer detailed knowledge about the mechanisms of various human infectious diseases, their cause, transmission, detection, treatment and prevention.

Learning Outcomes:

1. Students will gain overall knowledge about the mechanisms of disease cause, transmission, detection, treatment and prevention.
2. The learning gained about development of various intervention strategies such as diagnostics, therapeutics and vaccines will enable them to apply this knowledge later to infection disease research.
3. Students will develop the ability to relate to any existing or emerging infection as well as will learn about drug resistance and its mechanisms. The students will have the know-how to research and develop new tools for their management.

Contents:

Unit I: Overview of infectious diseases, infectious agents - Bacteria, Viruses, protozoa and fungi; pathogenicity and virulence; Facultative/obligate intracellular pathogens. Concepts of epidemiology, disease transmission, management of disease spread and control. Drug discovery and drug resistance, vaccine development, clinical trials. ONE HEALTH approach - associated diseases, pathogens along with introduction to zoonotic diseases.

12 hours

Unit II: Bacterial diseases, epidemiology, transmission, signs and symptoms, causative agent, history, infection and pathogenesis, disease management, intervention strategies: diagnostics, Therapeutics and vaccines for Tuberculosis, Typhoid, Cholera. Drug resistance, mechanisms,

Multidrug efflux pumps, extended spectrum β-lactamases (ESBL) and implications on public health. WHO Bacterial Priority Pathogens List in context to the impact on AMR.

11 hours

Unit III: Viral diseases, epidemiology, transmission, signs and symptoms, causative agent, history, infection and pathogenesis, disease management, Detection, Drugs and inhibitors, Vaccines, molecular mechanisms for AIDS, hepatitis, influenza, dengue, polio, herpes, MRSA, SARS virus, Bird flu, prions, AIDS, Dengue Hemorrhagic Fever. Emerging and re-emerging infectious diseases and evolution of viral diseases.

11 hours

Unit IV: The cell structure of *Leishmania*, Life cycle, Types of leishmaniasis, epidemiology, disease management, Diagnosis, and treatment for visceral and cutaneous leishmaniasis, Mechanism of drug resistance, and drug susceptibility for promastigotes and amastigotes. The cellular structure of *Plasmodium*, the life cycle of *Plasmodium*, factors affecting Transmission of the parasite asymptomatic malaria, Drug-resistant parasites and Vaccine development, identification of new drug targets. The cellular structure of *Entamoeba histolytica*, Life cycle, Mode of transmission, The cellular structure of *Trypanosoma brucei* and *Trypanosoma cruzi*, Life cycle, Trypanosomiasis.

11 hours

Practicals: **30 hours**

1. Case studies for disease diagnostics
2. Pandemic preparedness and emergency responses
3. Group discussion on biosafety levels, recognizing the biosafety levels, case studies on risk assessment and biosecurity events

Suggested readings

1. Principles and practices of Infectious diseases, 7th edition, Mandell, Douglas and Bennett. S, Volume, 2. Churchill Livingstone Elsevier. ISBN: 978-0-443-06839-3
2. Sherris Medical Microbiology: An Introduction to Infectious Diseases, 8th edition. (2021). Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill. ISBN-13: 978-0071604024 ISBN-10: 0071604022
3. Medical Microbiology. 9th edition (2020). Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences. ISBN: 978-0-323-08692-9.
4. System Vaccinology: The History, the Translational Challenges and the Future; by Vijay Kumar Prajapati, Elsevier, ISBN: 9780323859417
5. Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds. American Society for Microbiology Press, Washington, DC USA. 2002

Teaching Learning process and Assessment methods

Unit No.	Course learning outcome	Teaching and learning activity	Assessment task
Unit I	Students will gain overall knowledge about the mechanisms of disease cause, transmission,	Board and PowerPoint teaching methods will be employed for taking the lectures. Classes will be	Internal assessment tests (mid-term and end-term) will be

	detection, treatment and prevention, various intervention strategies, disease management. Students will also gain insights into the concept of ONE HEALTH and zoonotic diseases	held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	conducted. Students will be assigned various topics and will be asked to deliver a power-point presentation on the assigned topics.
Unit II	Students will learn about various bacterial diseases, their molecular mechanisms and intervention strategies.	Board and powerpoint teaching methods will be employed for taking the lectures. Classes will be held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	Internal assessment tests (mid- term and end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a power-point presentation on the assigned topics.
Unit III	Students will learn about various viral diseases, their molecular mechanisms and intervention strategies.	Board and powerpoint teaching methods will be employed for taking the lectures. Classes will be held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	Internal assessment tests (mid- term and end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a power-point presentation on the assigned topics.
Unit IV	Students will learn about various parasitic diseases, their molecular mechanisms and intervention strategies.	Board and powerpoint teaching methods will be employed for taking the lectures. Classes will be held in an interactive mode. Students will be encouraged to ask questions and have discussions on the topics taught.	Internal assessment tests (mid-term and end-term) will be conducted. Students will be assigned various topics and will be asked to deliver a power-point presentation on the assigned topics.

DISCIPLINE SPECIFIC ELECTIVE COURSE: DSE-04
LIFESTYLE DISORDERS

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		
DSE-04 LIFESTYLE DISORDERS	04	03		01	B.Sc. in any area of Life Sciences	-

Number of weeks: 15
Number of hours: 45 (T) + 30 (P)

Learning Objectives

The aim of the course is to provide a broad understanding of lifestyle-associated disorders, including obesity, diabetes, cardiovascular diseases (CVDs), COPD, and cancer, as well as their diagnosis and interventions. This course will also prepare students for careers in healthcare and biomedical research.

Learning Outcomes

1. Gain knowledge of major lifestyle disorders, their causes, symptoms, and management.
2. Understand the molecular basis and treatment strategies for cancer, CVDs, obesity, and diabetes.
3. Learn diagnostic tools and therapeutic approaches for lifestyle diseases.
4. Explore alternative therapies, including Ayurveda, yoga, and nutraceuticals.
5. Develop research skills through data analysis, surveys, and case studies.

Contents

Unit I: Introduction: Overview of lifestyle-associated disorders, including obesity, diabetes, chronic obstructive pulmonary disease (COPD), cancer, and cardiovascular diseases (CVDs), with a focus on their national and international epidemiological burden. This includes key risk factors, the rising prevalence of obesity and diabetes, and the major public health challenges posed by cancer and cardiovascular diseases.

10 Hours

Unit II: Cancer: History and impact of cancer, characteristics of normal and transformed cells, and the hallmarks of cancer. Understanding the causes, symptoms, pathophysiology of cancer. Cancer related Anaemia and Cachexia. Molecular basis of neoplastic growth, metastasis, key oncogenic pathways, proto-oncogenes, and tumor suppressor genes, tumor viruses and cancer-causing mutations. Diagnosis and Treatment Strategies - Biochemical analysis, screening

methods, molecular diagnostic techniques, and current treatment options, along with their associated challenges and side effects.

12 Hours

Unit III: Cardiovascular Diseases (CVDs), Obesity, and Diabetes: Cardiovascular Diseases (CVDs): Definition and types including hypertension, coronary artery disease, cerebrovascular disease, cardiomyopathy, atherosclerosis. Obesity and Diabetes: Definition and types including Type 1, Type 2, gestational diabetes, classification of obesity, causes and risk factors such as genetic, metabolic, and lifestyle influences, pathophysiology with insulin resistance, beta-cell dysfunction, metabolic syndrome, molecular mechanisms involving adipokines, inflammation, oxidative stress. Introduction to non-alcoholic fatty liver disease, Diagnosis and Treatment Strategies. CVDs: Diagnostic approaches including biomarkers, treatment strategies focusing on drug discovery, disease management. Obesity and Diabetes: Diagnostic tools including HbA1c, fasting glucose, lipid profile, treatment strategies including lifestyle modifications, pharmacological interventions such as Metformin, GLP-1 agonists, bariatric surgery, emerging therapies.

11 Hours

Unit IV: Recent Advances and Research Scope: Introduction to alternative therapies including Ayurveda, yoga, nutraceuticals, advances in understanding the genetic basis of obesity and diabetes, research on novel drug targets and biomarkers for lifestyle diseases, ethical, social, and regulatory concerns in research and healthcare.

12 Hours

Practicals **30 Hours**

1. Analysis of epidemiological data to assess trends in cancer, obesity, diabetes, and CVDs using public datasets.
2. Paper presentations and group discussions on novel drug targets and discovery of biomarkers.
3. Engage in discussions on lifestyle disorders through case studies and debates. Analyze causes, risk factors, and improvements.
4. Explore modern vs. traditional lifestyles, counseling strategies, and health misconceptions.

Suggested Readings:

- Rippe, J.M. (2024) Lifestyle Medicine (4th Edition), CRC Press, USA
- Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M., Roberts, K., Walter, P. (2022) Molecular Biology of the Cell (7th Edition), W. W. Norton & Company, USA.
- Kumar, P., & Clark, M. (2017). Kumar and Clark's Clinical Medicine. Elsevier.
- Kumar, V., Abbas, A. K., & Aster, J. C. (2020). Robbins & Cotran Pathologic Basis of Disease. Elsevier.
- DeVita, V. T., & Lawrence, T. S. (2019). Cancer: Principles & Practice of Oncology. Wolters Kluwer.
- Melmed, S. (2015). Williams Textbook of Endocrinology. Elsevier.

Teaching Learning process and Assessment methods

Unit No.	Course learning outcome	Teaching and learning activity	Assessment task
Unit I	Students will gain foundational knowledge of lifestyle-associated disorders, including obesity, diabetes, cardiovascular diseases, COPD, and cancer. They will understand the epidemiology, causes, and physiological impact of these disorders.	Students will be asked to orally revise the previous class before each new session, allowing for better retention and clarification of doubts. Teaching will be conducted using a combination of blackboard and PowerPoint presentations, supplemented by discussions on real-world case studies.	Internal assessment tests (mid-term and end-term) will be conducted
Unit II	Students will explore the molecular mechanisms underlying cancer, including genetic mutations, metabolic alterations, and environmental risk factors. They will develop an understanding of tumorigenesis and its role in disease progression.	Students will be encouraged to engage in peer discussions and case-based learning to analyze cancer mechanisms. Teaching will involve interactive lectures, presentations, and readings of research articles.	Internal assessment tests (mid-term and end-term) will be conducted. Students will be assigned topics for presentations and discussions.
Unit III	Students will explore the pathophysiology and molecular mechanisms underlying cardiovascular diseases, obesity, and diabetes. They will analyze genetic, metabolic, and environmental influences contributing to these disorders and their interconnections with other diseases.	Students will participate in problem-based learning sessions to assess and compare different diagnostic techniques and treatment strategies. Teaching will include video demonstrations where possible, along with PowerPoint presentations and discussions.	Internal assessment tests (mid-term and end-term) will be conducted. Students will present case studies and submit short reports on diagnostic tools and treatment interventions.
Unit IV	Students will understand the significance of recent advancements in research, including alternative therapies, novel drug discoveries, and precision medicine in the context of lifestyle disorders.	**S**tudents will engage in critical analysis of recent literature, participate in journal club discussions, and present reviews on emerging research. Teaching will involve an integration of interactive lectures, PowerPoint presentations, and active discussions.	Internal assessment tests (end-term) will be conducted. Students will be assigned topics to present research findings and submit a literature review on a selected emerging therapy.

GENERIC ELECTIVE COURSE : GE-01
FOOD AND NUTRITIONAL BIOCHEMISTRY

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		
GE-01 ENZYME ACTIVITY, REGULATION AND ROLE IN METABOLISM	**04**	**03**		**01**	**B.Sc. in any area of Life Sciences**	**-**

Number of weeks : 15
Number of hours : 45 (T) + 30 (P)

Learning Objectives:

The objective of this course is to offer detailed knowledge about enzymes, which catalyze the entire repertoire of biochemical reactions in life processes and provide basic concepts of their mechanism of action, kinetics, regulation, inhibition, purification, and diverse applications. This course will also highlight the importance of enzymes in the development of metabolic disorders.

Learning Outcomes:

1. Students will acquire insights into enzyme assays, kinetics, structure, regulation, mechanism of action, reaction intermediates and inhibition.
2. Students will learn various theories for enzyme action and regulation and experimental evidence thereof.
3. Students will learn different examples of metabolic disorders and their mechanisms.
4. Students will be able to develop an understanding to use enzymes for diagnosing metabolic disorders

Contents

Unit I: Enzymology: Introduction, General characteristics of enzymes, Activation energy, Active site and its importance, Enzyme activity; Specific activity and Units; Classification and nomenclature of enzymes. Optimization of enzyme assays. Factors influencing catalytic efficiency and the mechanisms employed. Enzyme kinetics: Significance; Rapid Equilibrium and Steady State approach, Henry- Michaelis-Menten's and Haldane equations, Significance

of Km, Catalytic efficiency and turnover number; Kinetic perfection. Order of kinetics. Methods of plotting enzyme kinetics data:

12 Hours

Unit II: Regulation and control of enzyme activity: Isozymes, Zymogens, reversible covalent modification, irreversible covalent modification, Enzyme Inhibition, Reversible and Irreversible inhibition, Models and types of inhibition; Kinetics and diagnostic plots related to enzyme inhibition, Dixon plots, Multisubstrate enzymes; Multisite and Allosteric enzymes; Models and examples.

11 Hours

Unit III: Enzymes involved in glycolysis, pentose phosphate pathway, Krebs cycle, glucose and amino acid metabolism, and its enzymes. Metabolic disorders and its enzymatic association. Applied Enzymology: Application of enzymes in industry, diagnostics and medicine, agriculture, research; Immobilized enzymes. Case studies. Synthetic or artificial enzymes and Enzyme engineering

11 Hours

Unit IV: Allosteric regulation of Phosphofructokinase, Aspartate transcarbamoylase, Streptokinase, Urokinase etc. Enzymes in the diagnosis of metabolic disorders, Phenylketonuria, Hyperglycinemia, Homocystinuria, and Maple syrup urine disease.

11 Hours

Practical- **30 Hours**

1. Video demonstrations and simulations on Enzyme kinetics model and mechanisms
2. Case studies on enzyme designing and inhibition
3. Group activities on Phenylketonuria, Hyperglycinemia, Homocystinuria, and Maple syrup urine disease case studies

Suggested Readings:

1. I.H. Segel. 2010. Biochemical Calculations (2nd Ed), John Wiley and Sons, California, USA. ISBN: 978-0-471-77421-1.
2. P. F. Cook, W.W. Cleland. 2007. Enzyme Kinetics and Mechanism, Garland Science Publishing, London, England and New York, USA. ISBN: 978-0815341406.
3. T. Palmer, P. Bonner. 2007. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (2nd Ed.), Woodhead Publishing House, Chichester, England. ISBN: 978-0- 857099921.
4. R. Burgess, M. P. Deutcher. 2009. Guide to Protein Purification (2nd Ed.), Academic Press, San Diego, USA. ISBN: 978-0-12-374978-9.
5. D. Purich. 2010. Enzyme Kinetics: Catalysis and Control (1st Ed.), Academic Press, San Diego, USA. ISBN: 978-0-123809247.

Teaching Learning process and Assessment methods

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about general properties of enzymes like activation energy, active site, etc.; definition of enzyme activity and its various units; classes of enzymes and international nomenclature; they will learn how to perform and optimize enzyme assays; types of enzyme assays; General mechanisms that enzymes employ to attain kinetic perfection and mechanism of catalysis at molecular level.	Outlining history of development of knowledge about enzymes through power point presentations and reading of landmark publications; Question and answer sessions in the class.	Assignments to calculate units of enzyme activity; Classification of assigned enzymes and their nomenclature. A specific enzyme will be assigned to each student and they will need to develop protocol for enzyme assay. Case studies for model enzymes.
II	Importance of investigating enzyme kinetics; the important kinetic parameters like Km, Vmax, Kcat, etc.; derivation of Michaelis-Menten equation; Order of kinetics; Students will learn how to plot experimental data into various forms to calculate various kinetic parameters and advantages and disadvantages of each method. Students will learn how to measure fast Kinetics.	The basic concepts will be explained using chalk and board; Original paper by Michaelis-Menten will be discussed. Power point presentations for better representations. Student interaction in class.	Students will be asked to derive MM equation without help. Numerical problems to estimate kinetic parameters. Students will be asked to rearrange MM equation to derive various equations which underlie each linear plot. Experimental data will be provided to plot data and derive parameters using graph papers. Students will read papers on fast kinetics and discuss about the principles in class in groups of 3.

III	Students will learn about the various types of metabolic disorders; and their associated enzymes.	Concepts will be taught using chalkboard and PowerPoint presentations; Research papers will be provided for applications; Numerical problems will be solved.	Numerical problems on various types of metabolic disorders. Identification of types of human metabolic disorders and their mechanism
IV	Students will learn how metabolic disorders are genetic in nature. Enzymes in the diagnosis of metabolic disorders	Chalk and Board for teaching the basic concepts; Powerpoint presentations for better representations.	Students will be asked to compare different metabolic disorders and their comparison. How enzyme-based diagnostics can be evolved

GENERIC ELECTIVE COURSE: GE-02
ENZYME ACTIVITY, REGULATION AND ROLE IN METABOLISM

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		
GE-02 FOOD AND NUTRITIONAL BIOCHEMISTRY	04	03		01	B.Sc. in any area of Life Sciences	-

Number of weeks: 15
Number of hours: 45 (T) + 30 (P)

Learning objectives

The objective of this course is to provide a comprehensive understanding of food and nutritional biochemistry, including the biochemical properties of nutrients, their metabolism, and their role in health and disease. It aims to prepare the students for careers in nutrition research, healthcare, and food technology.

Learning Outcomes

1. Gain knowledge of food components, their classification, biochemical properties, and nutritional value.
2. Understand nutrient absorption, assimilation, and their role in maintaining metabolic balance.
3. Learn about the biochemical basis of nutritional disorders and their prevention, and explore emerging trends in food technology, nutrigenomics, and functional foods.
4. Develop research skills through practical experience in food analysis, nutritional assessments, and data interpretation.

Contents

Unit I: Fundamentals of Food Biochemistry: Concept of nutrition and functions of food. Composition and classification of food components (carbohydrates, proteins, lipids, vitamins, minerals), biochemical properties and functions of macronutrients and micronutrients, food enzymes and their role in digestion, water and electrolyte balance, nutritional value of major food groups (grains, dairy, fruits, vegetables, and meat), concept of balanced diet: definition, components, and importance for maintaining health and preventing nutrient deficiencies.

12 Hours

Unit II: Nutrient Utilization and Nutritional Disorders: Energy balance and basal metabolic rate (BMR), nutrient absorption and assimilation, adaptations during fasting, exercise, and stress, impact of dietary fibers and antioxidants on health, causes and biochemical basis of malnutrition (protein-energy malnutrition, vitamin and mineral deficiencies), nutritional anemias and osteoporosis, role of functional foods and nutraceuticals in disease prevention.

11 Hours

Unit III: Food Technology and Safety: Principles of food preservation (pasteurization, fermentation, and irradiation), food additives and their biochemical effects, genetically modified foods: benefits and risks, food quality assessment techniques, food contamination, toxicology and safety standards.

11 Hours

Unit IV: Emerging Trends in Nutritional Research: Nutrigenomics and personalized nutrition, probiotics, prebiotics, and their health benefits, role of gut microbiota in nutrition and health, importance of colon health in various diseases, role of bioactive compounds in nutrition, functional beverages and plant-based diets, current trends in sports nutrition and dietary supplements.

11 Hours

Practicals: **30 Hours**

1. Group discussions on nutritional disorders, along with presentations and discussions on the relationship between food and medicine.
2. Discussion on impact of probiotics, dietary pattern surveys, sports nutrition, and comparative studies on traditional and modern nutritional therapies.
3. Paper presentation on Nutrigenomics, personalized nutrition and role of gut microbiome.

Suggested Readings:

- Nelson, D. L., & Cox, M. M. (2017). Lehninger Principles of Biochemistry. W. H. Freeman.
- Willey, J.M., Sandman, K., Wood, D. (2019) Prescott's Microbiology (11th Edition), McGraw-Hill Education, USA.
- Wardlaw, G. M., Smith, A. M., & Collene, A. L. (2021). Contemporary Nutrition. McGraw Hill
- Bender, D. A. (2014). Nutritional Biochemistry. CRC Press.
- Gibney, M. J., Lanham-New, S. A., Cassidy, A., & Vorster, H. H. (2019). Introduction to Human Nutrition. Wiley-Blackwell.

Teaching Learning process and Assessment methods

Unit No.	Course learning outcome	Teaching and learning activity	Assessment task
1	Students will understand the composition and classification of food components, including	Students will be engaged in interactive lectures using blackboard and PowerPoint presentations. They will participate in	Mid-term and end-term tests will be conducted. Students will complete case study reports on

	macronutrients and micronutrients. They will learn about food enzymes, digestion, nutritional value, and the concept of a balanced diet.	discussions on food components, their biochemical roles, and dietary balance. Case studies on nutrient deficiencies will be analyzed.	nutritional balance and present findings.
2	Students will explore energy balance, nutrient absorption, metabolic adaptations, and the biochemical basis of malnutrition. They will understand the role of functional foods and nutraceuticals.	Concept-based lectures, group discussions, and problem-solving exercises will be conducted. Students will review case studies on metabolic disorders and analyze dietary interventions.	Mid-term and end-term tests will be conducted. Students will be assigned research projects on nutrient utilization and present their findings.
3	Students will understand food preservation principles, food additives, genetically modified foods, and food safety standards.	Students will engage in hands-on demonstrations on food preservation techniques and participate in debates on genetically modified foods.	Students will complete food quality analysis reports and deliver presentations on food safety regulations. Mid-term and end-term assessments will be conducted.
4	Students will explore the latest research in nutrigenomics, probiotics, gut microbiota, bioactive compounds, and personalized nutrition.	Interactive discussions, literature reviews, and seminar presentations on emerging research trends. Students will critically analyze recent journal articles and research papers.	Students will submit a literature review on a selected topic and present a seminar on emerging nutritional trends. End-term assessment will be conducted.

SKILL ENHANCEMENT COURSE : SEC-01
ICT TOOLS FOR BIOCHEMISTRY

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		
SEC-01 ICT TOOLS FOR BIOCHEMISTRY	02	0		02	-	-

Number of weeks: 15
Number of hours: 60 (P)

Learning Objectives:

This course aims to provide skill and hands on training about the basic information technology computer-based tools that are routinely required for learning, analysis, writing, presentation and data analysis.

Learning Outcomes:

1. Students will gain the skill of various online ICT tools and will be able to use these tools for drafting scientific writing, assignments, term papers etc.
2. Students will be able to make presentations, interactive drawings and images etc.

Contents

Unit I: Microsoft word, Microsoft powerpoint, Microsoft excel, google classroom, Microsoft teams, online meeting and video conferencing tools. Formatting of documents, use of add on features, analysis of data using MS-Excel, Creation of graphs and charts, Export and Import of data, Preparing slides in powerpoint, use of animation functions, clipart and other features, Use of formula function in Excel.

35 hours

Unit II: Online quiz tools, Google forms for survey, Biorender and other online tools for making publication figures and images. Chemdraw to make structures. Online platforms like Canva for making documents and presentations, NCBI and PubMed for accessing literature and databases. PDB for accessing protein structures.

25 hours

Teaching Learning process and Assessment methods

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about general usage of various ICT tools like MS word, powerpoint, excel etc, which will assist the students in scientific writing, making presentations, data plotting, making data graphs etc.	Students will be taught via videos about the functioning of the ICT tools. Demonstrations and hands-on training will be conducted for the usage of these tools.	Assignments will be conducted to assess the learning of the students. Quiz will be also be conducted for the same.
II	Students will learn about general usage of various ICT tools that are useful for attempting quizzes, improving English writing and for making scientific images and figures.	Students will be taught via videos about the functioning of the ICT tools. Demonstrations and hands-on training will be conducted for the usage of these tools.	Assignments will be conducted to assess the learning of the students. Quiz will be also be conducted for the same.

SKILL ENHANCEMENT COURSE : SEC-02
ARTIFICIAL INTELLIGENCE AND ITS APPLICATIONS IN BIOCHEMISTRY

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		
SEC-02 Artificial Intelligence and its Applications in Biochemistry	**02**	**0**		**02**	-	**-**

Number of weeks: 15
Number of hours: 60 (P)

Learning Objectives:

This course aims to provide skill and hands on training about some advanced information technology computer-based tools that are routinely required by all the students for learning, analysis, writing, referencing, video editing etc.

Learning Outcomes:

1. Students will gain the skill of using various online web-based AI tools and will be able to use these tools for making and editing sound embedded videos, protein and DNA analysis, protein structure prediction, protein interaction, analysis of omics data.
2. Students will be able to make videos, edit videos, make movies and visualize structures, perform protein structure prediction, primer designing, DNA structure analysis and analysis of omics data.

Contents

Unit I: Role of AI and Machine Learning in biomedical sciences**,** AI tools for data mining and analysis, AI detection tools, Video editor, OBS studio, open shot editor, movie making, PyMOL for 3D visualization of biomolecules, AI for Small Molecule Analysis & Drug Discovery, PubChem for small molecule compounds & AI-assisted molecule screening, AI docking tools for protein-ligand interaction, AI-driven QSAR modeling for drug prediction. Web based tools for Molecular biology –primer designing, Uniprot, GEO database, case studies on use of ML for biological datasets

40 hours

Unit II: AI-Based Protein Structure Prediction**,** ExPASy tools for protein sequence analysis, comparative homology modelling of proteins, Structure superimposition, RMSD analysis,

protein-protein interaction prediction tools (STRING etc.), analysis of NGS and other omics data, heatmap generation, pathway analysis, gene enrichment, network analysis tools,

20 hours

Teaching Learning process and Assessment methods

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about general usage of various tools for AI detection, video editing etc. protein and DNA analysis, protein structure prediction, protein interaction, analysis of omics data	Students will be taught via videos about the functioning of the web based tools. Demonstrations and hands-on training will be conducted for the usage of these tools.	Assignments will be conducted to assess the learning of the students. Quiz will be also be conducted for the same.
II	Students will learn about general usage of various tools that are useful for visualisation and analysis of protein structures, protein structure prediction etc, protein interaction and omics data analysis.	Students will be taught via videos about the functioning of the ICT tools. Demonstrations and hands-on training will be conducted for the usage of these tools.	Assignments will be conducted to assess the learning of the students. Quiz will be also be conducted for the same.