- **Proposed Course Structure of M.Sc. Biochemistry with two semesters of research**

	Sem- 1	**Sem- 2**	**Sem-3 & Sem 4**
Core	(4 courses of 3 credits each) 1. Biomolecules and Bioenergetics 2. Molecular Biology 3. Cell Biology 4. Plant and Microbial Biochemistry	(3 courses of 3 credits each) 1. Enzymology 2. Metabolism 3. Immunology	Dissertation
Discipline elective	(1 course of 3 credits) 1. Developmental biology Or Genetic Engineering	Nil	
IDC/Multidisciplinary	Nil	(1 course of 2 credits) Basic of Biochemistry or Human Health and Lifestyle Diseases	
Practicals/internships/apprenticeship/skill course/field visit etc	Biochemistry Practical-I (4 credits)	Biochemistry Practical-I (4 credits) Biostatistics (2 credits)	
Ability enhancement courses (AEC)	Bioanalytical Techniques (2 credits)	Clinical Biochemistry (2 credits)	
Value Based	Nil	(1 course of 2 credits) Analytical Biochemistry and Molecular Diagnostics Or Environmental Biochemistry or Bioinformatics for Next Generation Sequencing Data or Research Methodology	
Total credits	**21**	**21**	

Central University of Punjab

M.Sc. Program in Biochemistry

Batch - 2026-27

Department of Biochemistry

Graduate Attributes

Students graduating from the program will benefit the society by adding to the highly skilled scientific workforce, in biomedical and agricultural sectors, in academia, industry and research institutions. They will develop critical thinking skills and capabilities aligned to the science driven changing needs to resolve emerging regional, national and international problems in health, agriculture and environment.

M.Sc. Biochemistry

Semester – I

Course Code	Course Title	Course Type	Contact Hours			Credit Hours
			L	T	P	Total
MBCH.400	Cell Biology	Core	3	0	0	3
MBCH.401	Biomolecules and Bioenergetics	Core	3	0	0	3
MBCH.402	Molecular Biology	Core	3	0	0	3
MBCH.403	Plant and Microbial Biochemistry	Core	3	0	0	3
MBCH.404	Bioanalytical techniques	AEC	2	0	0	2
MBCH.405	Biochemistry Practical-I	Skill Based	0	0	6	4
	Integrated Education Program/ Tutorials	Non-credit	0	2	0	0
Discipline Elective courses (select one)						
MBCH.522	Genetic Engineering	DE	3	0	0	3
MBCH.523	Developmental Biology	DE	3	0	0	3
					Total Credits	**21**

M.Sc. Biochemistry

Semester – II

Course Code	Course Title	Course Type	Contact Hours			Credit Hours
			L	T	P	Total
MBCH.524	Enzymology	Core	3	0	0	3
MBCH.525	Immunology	Core	3	0	0	3
MBCH.526	Metabolism	Core	3	0	0	3
MBCH.527	Clinical Biochemistry	AEC	2	0	0	2
MBCH.528	Biostatistics	Skill Based	2	0	0	2
MBCH.529	Biochemistry Practical-II	Skill Based	0	0	8	4
Value added course (select one)						
MBCH.511	Analytical Biochemistry and Molecular Diagnostics	VAC	2	0	0	2
MBCH.512	Environmental Biochemistry	VAC	2	0	0	2
MBIM.512	Bioinformatics for Next Generation Sequencing Data	VAC	2	0	0	2
MBCH 513	Research Methodology	VAC	2	0	0	2
IDC/Multidisciplinary course (select one)						
MBCH.506	Basics of Biochemistry	IDC	2	0	0	2
MBCH.530	Human Health and Lifestyle Diseases	IDC	2	0	0	2
					Total Credits	**21**

M.Sc. Biochemistry

Semester – III

Course Code	Course Title	Course Type	Contact Hours			Credit Hours
			L	T	P	Total
MBCH.599-1	Dissertation part I	Skill Based	0	0	40	20
					Total Credits	20

M.Sc. Biochemistry

Semester – IV

Course Code	Course Title	Course Type	Contact Hours			Credit Hours
			L	T	P	Total
MBCH.599-2	Dissertation part II	Skill Based	0	0	40	20
					Total Credits	20

L: Lectures; T: Tutorial; P: Practical

Program outcomes: At the completion of this course, the students will be able to

1. Understand the key concepts, principles, theories, structure, and function of various biological molecules.
2. Understand the biochemical pathways, genomic organization, gene expression and their regulation in living organisms.
3. Apply knowledge of biochemistry to carry out interdisciplinary research.
4. Evaluate gaps in research related to biochemistry and propose solutions to meet academic, industrial, health and agricultural demands.
5. Design, conduct and analyze experiments independently to advance scientific understanding in biochemistry and related areas and address research challenges.

Employability: Students will either get PG diploma (1 year) or Master's degree (2 years) on completion of the course. They can then find employment in the biochemical, agricultural, medical, and educational fields. They may work in drug discovery, developing new therapies, or improving existing ones. Students can choose to pursue careers in academia, working as researchers or lecturers in universities or research institutions. Students can work in clinical laboratories, conducting diagnostic tests, analyzing samples, and interpreting results to aid in the diagnosis and treatment of diseases.

Mapping of course outcomes with Program Outcomes (3=high correlation, 2=medium correlation, 1= low correlation)

Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5
Semester – 1st						
MBCH.400	Cell Biology	3	2	2	1	1
MBCH.401	Biomolecules and Bioenergetics	3	2	2	1	1
MBCH.402	Molecular Biology	3	3	2	2	2
MBCH.403	Plant and Microbial Biochemistry	3	2		2	
MBCH.404	Bioanalytical techniques	3	1	2	3	2
MBCH.405	Biochemistry Practical-I	2				3
MBCH.522	Genetic Engineering	2	3	3	3	3
MBCH.523	Developmental Biology		3		1	
Semester – 2nd						
MBCH.524	Enzymology	3	1	3	2	2
MBCH.525	Immunology	3	2	3	3	2
MBCH.526	Metabolism	2	3	2	1	1
MBCH.527	Clinical Biochemistry		2	3	3	3
MBCH.528	Biostatistics			2		3
MBCH.529	Biochemistry Practical-II	3	3			
MBCH.511	Analytical Biochemistry and Molecular Diagnostics			3		2
MBCH.512	Environmental Biochemistry	2	1	3		
MBCH 513	Research Methodology			1		2
MBIM.512	Bioinformatics for Next Generation Sequencing Data			3		2
MBCH.506	Basics of Biochemistry	3	1			
MBCH.530	Human Health and Lifestyle diseases	3	1	3		
Semester – 3rd						
MBCH.599-1	Dissertation Part I				2	2
Semester – 4th						
MBCH.599-2	Dissertation Part II				2	3

Post-Graduate Diploma will be awarded after the end of the first year of M.Sc. Biochemistry programme.

It is mandatory for students in every PG program to complete at least one course on SWAYAM platform accompanied by credit transfer. The students shall be responsible for payment of fees for courses on SWAYAM.

Students are encouraged to take skill-based courses on SWAYAMPLUS platform.

MOOCs: MOOCs may be taken upto 40% of the total credits (excluding dissertation credits). MOOC may be taken in lieu of any course but content of that course should match a minimum 70%. Mapping is to be done by the respective department and students may be informed accordingly.

Multiple Entry and Exit-There shall be one exit point for those who join the two-year Master's programme, that is, at the end of the first year of the Master's programme. Students who exit after the first year shall be awarded the Post-Graduate Diploma.

Dissertation at Other Institutions: Students will have an option to carry out dissertation work in industry, national institutes, Central and State Universities. Students may also carry out dissertations in private Universities in the top 100 NIRF ranking (University Category). Each department should start efforts for roping in industries/HEIs for accepting students for dissertation/projects/internship and other academic activities for industry-academia interaction. The department may also collaborate for conducting experiments.

Group Dissertation: Group dissertation may be opted with a group consisting of a maximum of four students. These students may work using a single approach or multidisciplinary approach. Research projects can be taken up in collaboration with industry or in a group from within the discipline or across the discipline.

MOOCs may be taken upto 40% of the total credits (excluding dissertation credits). MOOC may be taken in lieu of any course but content of that course should match a minimum 70%. Mapping will be done by the department and students will be informed accordingly.

Examination pattern and evaluation

Formative Evaluation: Internal assessment shall be 25 marks using any two or more of the given methods: tests, assignments, term paper, presentations etc. The Mid-semester test (MST) shall be of 25 marks including short answer and essay type except for some courses as given in the table below. Each answer shall carry a maximum weightage of five marks in MST. The teachers shall have the flexibility to

decide on the number of questions and distribution of marks following above guidelines.

Summative Evaluation: The End semester examination (ESE) shall be 50 marks with upto 100% descriptive type and upto 30% objective type which shall be conducted at the end of the semester. The objective type shall include a few words (very short) answers, fill-in the blanks, MCQs', and matching. Each answer shall carry weightage of upto two marks depending on the level of difficulty. The descriptive type shall include short answer and essay type questions. Each answer shall carry a maximum weightage of ten marks in ESE. The teachers shall have the flexibility to decide on the number of questions and distribution of marks following above guidelines. Questions for exams and tests shall be designed to assess course learning outcomes along with focus on knowledge, understanding, application, analysis, synthesis, and evaluation.

The evaluation for IDC, VAC and entrepreneurship, innovation and skill development courses ($\leq$2 credits) shall include MST (50 marks) and ESE (50 marks). The pattern of examination for both MST and ESE shall be the same as given in the table.

Evaluation of dissertation proposal and presentation in the third semester shall include 50% weightage by supervisor and 50% by HoD and senior-most faculty of the department. The evaluation of dissertation in the fourth semester shall include 50 marks for continuous evaluation by the supervisor for regularity in work, mid-term evaluation, report of dissertation, presentation, and final viva-voce; 50 marks (50% weightage) by an external expert shall be based on report of dissertation (25 marks), presentation (10 marks), novelty/originality (5 marks) and final viva-voce (10 marks). The-- external expert may attend final viva-voce through offline or online mode.

Examination pattern from 2026-2027 session onwards

Core, Discipline Elective, and Compulsory Foundation Courses			**IDC, VAC, Entrepreneurship, Innovation and Skill Development Courses (≤2 credits) or any other theory course of ≤2 credits**	
	Marks	Evaluation	Marks	Evaluation
Internal Assessment	25	Various methods	-	-
Mid-semester test (MST)	25	Descriptive	50	Descriptive (upto 100%) Objective (upto 30%)
End-semester exam (ESE)	50	Descriptive (upto 100%) Objective (upto 30%)	50	Descriptive (upto 100%) Objective (upto 30%)

Dissertation Proposal (Third Semester)			**Dissertation and Fourth Semester)**		
	Marks	**Evaluation**		**Marks**	**Evaluation**
Supervisor	50	Dissertation proposal and presentation	Supervisor/ co-supervisor (s)	50	Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce
HoD and senior most faculty of department	50	Dissertation proposal and presentation	External expert	50	Report of dissertation (25), presentation (10), novelty/originality (5) and final viva-voce (10).

All the faculty members and external mentor shall give marks for internship.

SEMESTER – I

L	T	P	Cr
3	0	0	3

Course Code: MBCH. 400
Course Title: Cell Biology
Total Hours: 45

On completion of this course, students will be able to:

1. **CLO1:** Demonstrate the concept of structure and basic components of prokaryotic and eukaryotic cells, especially organelles and their related functions.
2. **CLO2:** Analyze cell cycle regulation, death, and cytoskeletal dynamics in health and disease.
3. **CLO3:** Explain cell signaling pathways and its mechanisms with clinical examples.
4. **CLO4:** Critically evaluate the concept of protein trafficking in the subcellular organelles.

Unit/ Hours	Contents	Mapping with CLO
I 12 Hours	**Structural Organization and Function of Intracellular Organelles**: Cell theory and Evolution, precellular evolution, artificial creation of cells. Cell membrane and Membrane biology, Cell organelle structure and function, Nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and centrioles, Organization of the cytoskeleton. **Learning Activities:** *Assignment on diseases of different organelles.*	CLO1

II 12 Hours	**Cell cycle, Cell Death and their regulatory mechanism:** Overview of the cell cycle and its control, The molecular mechanisms for regulating mitotic and meiotic events, Amitosis, Cell cycle control, Checkpoints in cell cycle regulation. Cell death including Apoptosis, Necrosis, Autophagy and their respective pathways. Tumor suppressor genes, proto-oncogenes and oncogenes. **Learning Activities:** *Peer discussion on techniques of cell cycle determination and representation of cell cycle data.*	CLO2
III 11 Hours	**Cell Communication and Adhesion:** Cell signaling, G-Protein Coupled Receptors (GPCRs), Receptor Tyrosine Kinases (RTKs), and MAPK cascades), Cell adhesions, Cell junctions and the extracellular matrix, Cell-cell adhesion and communication, Cell matrix adhesion, Collagen the fibrous protein of the matrix, Non-collagen component of the extracellular matrix. ***Learning activities:*** *Exercises on the underlying signaling pathways in different cancers.*	CLO3
IV 10 Hours	**Protein Trafficking:** Vesicular transport, Organelle biogenesis and protein secretion, protein folding and the role of chaperones (Hsp70/90) and the Unfolded Protein Response (UPR) in the ER, intracellular and vesicular traffic in the secretory pathway involving COP-I/II and clathrin-coated vesicles. Protein sorting in the Golgi bodies, traffic in the endocytic pathway, exocytosis, molecular basis of vesicle docking and fusion mediated by SNAREs. **Learning activities:** *Exercises on the underlying protein trafficking pathways in diseases.*	CLO4

Suggested Readings:

1. 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.

2. Karp, G., Iwasa, J., Marshall, W. (2019). *Karp's Cell and Molecular Biology*. 9th Edition. John Wiley & Sons.

3. De Robertis, E.D.P. and De Robertis, E.M.F. (2017). *Cell and Molecular Biology*. 8th Edition (South Asian Edition). .

4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Yaffe, M. & Amon A. (2021). *Molecular Cell Biology*, 9th Edition W. H. Freeman; USA

5. Alberts B, Hopkin K, Johnson AD *et al.* (2023) *Essential Cell Biology*, 6th Ed., W W Norton & Company.

Web resources:

- https://www.ncbi.nlm.nih.gov/books/NBK26873/
- https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/video-lectures/lecture-19-cell-cycle-signaling/
- http://docs.abcam.com/pdf/protocols/Introduction_to_flow_cytometry_May_10.pdf

Modes of transaction

- Lecture
- Problem solving approach
- Group discussion
- Learning centric activity
- Self-learning
- Peer learning

Tools used

PPT, Video, Google meet, Animations, WhatsApp, NPTEL

L	T	P	Cr
3	0	0	3

Course Code: MBCH.401
Course Title: Biomolecules and Bioenergetics
Total Hours: 45

Learning outcomes: Students will be able to
CLO1: Demonstrate the concepts of biomolecules as components of cells from structural and functional which are essential for energy generation and their biosynthesis.
CLO2: Understand the role of proteins and DNA as biological molecules with reference to the physiological milieu they work in.
CLO3: Describe and apply basic concepts of thermodynamics and bioenergetics in correlation with biomolecules

Unit/ Hours	Contents	Mapping with CLO
I/ 10 Hours	**Carbohydrate:** Classification, structure, and stereochemistry, functions of polysaccharides starch, glycogen, cellulose and chitin, complex carbohydrates; amino sugars, proteoglycans and glycoproteins. **Lipids:** Classification, structure, properties and functions of fats and fatty acids, essential fatty acids, phospholipids, sphingolipids, cerebrosides, steroids, bile acids, prostaglandins. **Vitamins**: Fat and water soluble vitamins structure and function **Learning Activities:** *Peer discussion on the existence of these biomolecules in different organisms.*	CLO1
II/ 12 Hours	**Buffers and Proteins:** Classification, structure and properties of amino acids. The concept of pH, dissociation and ionization of acids and bases, pKa, buffers and buffering mechanism, Henderson Hasselbalch equation, and ionization of amino acids. Classification and properties of proteins. Primary, Secondary, Tertiary and Quaternary structures of proteins. Peptide cleavage. Thermodynamics of Protein folding, coagulation and denaturation of proteins. **Learning Activities:**	CLO2

	Presentations on buffers and proteins properties and its constituents.	
III/ 10 Hours	**Nucleic acids**: Structure of purines, pyrimidines, nucleosides and nucleotides. Structure, types and biological role of RNA and DNA. Primary, secondary, and tertiary structure of nucleic acids, DNA forms and conformations, UV absorption and Denaturation of DNA, C-value paradox, Cot curve analysis. **Learning activities:***In depth discussion on the role of DNA modification and its effects.*	CLO2
IV/ 10 Hours	**Bioenergetics:** Laws of Thermodynamics, Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials & free energy change. High energy phosphate compounds, phosphate group transfer, and free energy of hydrolysis of ATP. **Learning activities:** *Group discussion on analysis of thermodynamic parameters*	CLO3

Suggested Readings:

1. Outlines of Biochemistry. Eric E. Conn and Paul K. Stumpf (2006). 5th edition John Wiley and Sons, India edition.
2. Davidson, VL and Sittman, DB (1999) *Biochemistry* NMS, 4th ed. Lippincott. Willams and Wilkins.
3. Voet, D and Voet JG (2010) *Biochemistry*, 4th ed. Wiley
4. Rodwell V, Bender D, Botham KM, Kennelly PJ and Weil PA (2018) *Harper's Illustrated Biochemistry.* 31st ed. McGraw Hill.
5. Berg JM, Stryer L, Tymoczko JL, Gatto GJ (2018) *Biochemistry*, WH Freeman, 9th ed.
6. Lodish, H, Birk, A, et al. (2016) *Molecular Cell Biology*. 8th ed. WH Freeman.
7. Nelson DL and Cox MM (2017) *Lehninger's Principles of Biochemistry*, 7th ed. WH Freeman.
8. **Web resources:**

- https://nptel.ac.in/courses/104/103/104103121/
- https://www.youtube.com/watch?v=iuW3nk5EADg

- https://www.youtube.com/watch?v=ZqoX2W1N6l0
- https://www.youtube.com/watch?v=DhwAp6yQHQI
- https://www.youtube.com/watch?v=jLyi2K-29xU
- https://www.youtube.com/watch?v=C0ky85Kk2Zc
- https://www.youtube.com/watch?v=Fp1wKo72b2A
- https://www.youtube.com/watch?v=zOO5qdpl24I

Modes of transaction

-Lecture cum Demonstration
-Problem solving approach
-Self-Learning
-Inquiry training
-Co-operative learning

Tools used

PPT, YouTube Video, Google meet, NPTEL

L	T	P	Cr
3	0	0	3

Course Code: MBCH.402
Course Title: Molecular Biology
Total Hours: 45

Learning outcome: Students will be able to

CLO1: Understand the molecular processes in a cell and how they are related to biochemical processes in microbes and higher organisms.

CLO2: Apply and effectively communicate scientific reasoning and data analysis in both written and oral forums related to molecular biology.

CLO3: Apply molecular biology to societal needs with reference to agriculture, environment, and health.

Unit/ Hours	Contents	Mapping with CLO
I 12 Hours	**Mendelian Principles, their Extensions and Molecular Basis:** Theory and applications **Extra-Chromosomal Inheritance:** Molecular basis of chromosomal, mitochondrial and cytoplasmic inheritance **Physical and Genetic Mapping with Molecular Markers:** RFLP, SSR, SNP as markers; BACs and chromosome walking	CLO1 & CLO3

	Learning Activity: *Apply Punnett squares to solve problems in Genetics and Molecular Genetics.*	
II 12 Hours	**Genome organization:** Gene structure, Genome composition and dynamics, repetitive DNA and their biological significance. **Molecular Techniques:** Classical and emerging techniques and their applications. **DNA Replication and Repair:** Prokaryotic and eukaryotic DNA replication, Replication errors, DNA damage and repair, Relevance to diseases **Learning activities:** *Team presentations demonstrating the applications of molecular techniques to real life issues.*	CLO1 & CLO3
III 12 Hours	**Recombination:** Site-specific, homologous, DNA transposition, retrotransposition and non-homologous end joining. Reverse and forward Genetics and their applications **Transcription and mRNA Processing:** Prokaryotic & eukaryotic transcription; Post-transcriptional changes: Capping, Polyadenylation, Splicing, RNA editing and their relevance to disease biology. **Learning activities:** *Group discussion on applications in agriculture and human health.*	CLO1 & CLO3
IV 12 Hours	**Translation:** Prokaryotic and eukaryotic translation, co- and post-translational modifications, mechanism of translation inhibition by antibiotics. **Gene Regulation:** Prokaryotic gene regulation: lac and trp operons, lambda gene regulation during lysogeny and lytic cycles; Eukaryotic gene regulation: yeast and higher eukaryotes, spatial and temporal regulation, hormonal regulation of genes, epigenetic regulation, RNA interference; Gene regulation during cancer. Novel and emerging concepts in gene regulation. **Learning activities:** *Student-driven analysis of recent trends.*	CLO1, CLO2 & CLO3

Suggested Readings:

1. Watson, J.D. (2024). *Molecular Biology of the Gene*. 8th Edition, Affiliated East West Press.
2. Watson, J.D., Baker,T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2017). *Molecular Biology of the Gene*. 7th Edition, Benjamin Cummings, USA.

3. Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T. (2017). *Lewin's Genes XII.* Jones & Bartlett Learning, USA.
4. Craig, N.L., Green, R.R., Greider, C.C., Storz, G.G., Wolberger, C., Cohen-Fix, O. (2021). *Molecular Biology: Principles of Genome Function.* 3rd Edition, Oxford University Press.

Web Resources:

- https://www.genome.gov/about-genomics/teaching-tools/Genomics-Education-Websites
- e-PG Pathshala on Molecular Biology
- Videos and animations on YouTube and other web sites

Modes of transaction

-Lecture cum Demonstration
-Problem solving approach
-Self-Learning
-Inquiry training
-Co-operative learning

Tools used

YouTube Videos, Google Drive, Google Classroom, Animations, PPT

L	T	P	Cr
3	0	0	3

Course Code: MBCH.403
Course Title: Plant and Microbial Biochemistry
Total Hours: 45

Learning outcomes: Students will be able to
CLO1: Develop an understanding of basic concepts of light driven biochemical processes, nitrogen fixation and plant hormones
CLO2: Describe and correlate plant biochemistry with agriculture and related aspects.
CLO3: Correlate microbial biochemistry with industrially important metabolites production.

Unit/ Hours	Contents	Mapping with CLO
I 11 Hours	**Photosynthesis:** Ultrastructure and organisation of chloroplast, Light reactions and electron transport chain; Photosystems: PS I & PS II, Z-scheme of electron transport, Photolysis of water and oxygen evolution. Benson-Calvin cycle (C3 cycle), its regulation, Biochemistry of RUBP carboxylase/oxygenase, activation of RUBISCO, oxygenation reaction, photorespiration (C2 cycle) and CO2 compensation point C4 photosynthesis - Hatch and slack pathway, CAM plants and regulation of CAM pathway, Factors affecting photosynthesis; Light intensity, CO_2 concentration, temperature. **Learning activities:** *Assignment on the above topics.*	CLO1
II 11 Hours	**Nitrogen Metabolism:** Nitrogen fixation, Biological nitrogen fixation, nitrogenase complex, mechanism of action of nitrogenase. Nitrate Assimilation: Enzymes of nitrate assimilation, nitrate reductase and nitrite reductase. **Phytohormones;** auxins, cytokinins, gibberellins, abcissic acid, ethylene, Jasmonic acid. **Sensory photobiology;** Structure, function and mode of action of phytochromes, cryptochromes and phototropins, concept of photoperiodism and vernalization. **Learning activities:** *Classroom presentation and discussion on the topic*	CLO2
II 13 Hours	**Microbial Growth, Nutrition and Physiology:** Microbial carbon metabolism and energy generation, nutrient uptake and transport, Bacteriological media, biochemical basis of using different media helpful in isolation and identification of different bacteria, microbial growth kinetics, Measurement of growth and growth yields, growth curve and kinetic models, Synchronous growth, batch, fed-batch and continuous culture, factors affecting growth. **Learning activities:** *Developing SOP to grow a particular microorganism of interest.*	CLO3
IV 10 Hours	**Microbial Metabolism:** Metabolic pathways specific to microbes and their application for metabolic	CLO3

	engineering, strain improvements for the production of primary and secondary metabolites, antibiotics, enzymes and other industrially important metabolites, alcohol/lactate fermentation, microbial biotransformation, microbial biomolecules in the infectious process, bacterial toxins, their classification and mode of action, principle of food spoilage and its control. **Learning activities:** *Classroom discussion.*	

Suggested Readings:

1. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015). *Biochemistry and Molecular Biology of Plants.* 2nd Ed. Wiley-Blackwell.
2. Campbell, M.K., Farrell, S.O. and McDougal OM. (2016). *Biochemistry.* 9th Ed. Brooks/Cole, USA.
3. Dey, P.M., Harborne, J.B. (1997). *Plant Biochemistry*.Academic Press, UK.
4. Goodwin, T.W., Mercer, E.I. (2005). *Introduction to Plant Biochemistry*. 2nd Ed. CBS Publishers & Distributors, New Delhi, India.
5. Taiz, L., Zeiger, E. Mollar, I. M. and Murphy, A. (2022). *Plant Physiology and Development* 7th edition. Sinauer Associates Inc., USA.
6. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGraw Hill Higher Education, USA. 2019.
7. Microbial Biochemistry by G.N. Cohen. 2nd edition. Springer, Germany. 2014.
8. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 6th edition. W. H. Freeman, UK. 2012.
9. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond and C. Fuqua. 4th edition. Oxford University Press, UK. 2011.

Web Resources:

- https://www.youtube.com/watch?v=bsqSELXsmLA
- https://www.youtube.com/watch?v=slm6D2VEXYs
- https://www.youtube.com/watch?v=GR2GA7chA_c
- https://www.youtube.com/watch?v=7ynX_F-SwNY
- https://www.youtube.com/watch?v=nz0PmLL78e4
- https://www.youtube.com/watch?v=LdHp4Na3X_0
- https://www.youtube.com/watch?v=orHqYE_1CLI
- https://www.youtube.com/watch?v=fmQNlF_X-6E
- https://www.youtube.com/watch?v=MsPZp7lM16A

Modes of transaction:

-Lecture cum Demonstration
-Problem solving approach
-Self-Learning

-Inquiry training
-Team teaching

Tools used

PPT, YouTube Videos, Google meet, Google classroom

L	T	P	Cr
2	0	0	2

Course Code: MBCH.404
Course Title: Bioanalytical Techniques
Total Hours: 30

Course Learning Outcomes (CLO):

On completion of this course, students will be able to:

CLO1: Demonstrate the utility of spectroscopy and spectrometry techniques.

CLO2: Demonstrate the ability to understand proteins and DNA based techniques

CLO3: Apply microscopy and radioisotopes-based techniques in both written and oral forums related to biochemistry.

CLO4: Demonstrate the utility of immunological techniques

Unit/ Hours	Contents	Mapping with CLO
I 9 Hours	**Spectroscopy, Centrifugation and Biophysical Techniques**: Absorption Spectroscopy, UV & Visible spectroscopy and its applications; Beer-Lambert's law, extinction coefficient and its importance, design of colorimeter, spectrometer and spectrophotometer, InfraRed spectrometry, Optical rotatory dispersion (ORD), Circular Dichroism (CD), X-ray diffraction, NMR spectroscopy, Sedimentation velocity and centrifugal force, differential and density gradient centrifugation, subcellular fractionation, analytical and preparative ultracentrifugation techniques, Mass spectrometry, MALDI-TOF. **Learning Activities:** *Seminars on application of the techniques in bioscience research*	CLO1

II 7 Hours	**Chromatography:** Principles and applications of different types of chromatography. Thin layer, ion-exchange, hydrophobic-interaction, size-exclusion, Adsorption, Partition, Ion-Exchange, Chromatofocusing, Reverse Phase, and affinity chromatography. High performance liquid chromatography, Gas Chromatography, LC-MS, GC-MS **Learning Activities:** *Group discussion on the importance of chromatography in biochemistry lab.*	CLO2
III 7 Hours	**Recombinant and cell culture techniques,** Plant & tissue culture. Gene cloning, cloning and expression vectors, site-directed mutagenesis, CRISPR/Cas9 technology. **Microscopy:** Principles and applications of Light microscopy, Bright field, Dark field, phase-contrast, fluorescence microscopy. Electron microscopy, Scanning and Transmission electron microscopes, and Immune electron microscopy. **Learning activities*:*** *Group discussion on the application of gene editing technology & microscopy.*	CLO3
IV 7 Hours	**Electrophoresis techniques:** Agarose gel electrophoresis for DNA and RNA analysis; Polyacrylamide gel electrophoresis for DNA and protein analysis; Isoelectric focusing, native and SDS-PAGE, 2D-PAGE. Pulsed-Field Gel Electrophoresis **Radioisotopic Tracer Techniques**: Detection and measurement of isotopes, Geiger–Müller, Scintillation Counter, Autoradiography, Applications in biology. **Learning activities:** *Peer group discussion on use of the immune-techniques in research and health care.*	CLO4

Suggested Readings:

1. Berg, J.M., Stryer, L., Tymoczko, J., Gatto, G. (2019). Biochemistry. WH Freeman. 9th ed.
2. Nelson DL, Cox MM and A. Hoskins (2021). Lehninger's Principles of Biochemistry, 8th ed. WH Freeman.
3. Wilson, K., Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology. 8th Edition, Andreas Hofmann and Samuel Clokie, Cambridge University Press.
4. Iain D Campbell (2012). Biophysical Techniques, Oxford University Press.

5. Shourie, A., Chapadgaonkar, S.S. (2015). Bioanalytical Techniques. TERI, New Delhi.
6. Terrance G. Cooper (2011). The Tools of Biochemistry. Wiley India Pvt Ltd

Web resources:

- https://www.youtube.com/watch?v=siXdckB1HzU
- https://www.youtube.com/watch?v=WP6JpnHZJlQ
- https://www.youtube.com/watch?v=pjG4FTdMsEY
- https://www.youtube.com/watch?v=yl3EZX5kKbM
- https://www.youtube.com/watch?v=eH7UkTB7m8U
- https://www.youtube.com/watch?v=vMzs4NyVvuc
- https://www.youtube.com/watch?v=ZN7euA1fS4Y

Transaction Mode: Lecture cum Demonstration, Problem solving approach, Self-learning, Group discussions, Industrial/Research institute visit for exposure to advanced analytical instrumentation and laboratory practices.

Tools used

PPT, YouTube Video, Google meet, NPTEL

L	T	P	Cr
0	0	8	4

Course Code: MBCH.405
Course Title: Biochemistry Practical-I
Total Hours: 120

Course learning outcomes: After the completion of this course, the students will be able to

CLO1: Perform experiments pertaining to biomolecules and molecular biology, cell biology and Plant and microbial biochemistry.

CLO2: Apply the scientific method to the processes of experimentation and hypothesis testing.

Part	Contents	Mapping with CLO

A	**Biomolecules**
	1. Preparation of solutions, buffers, pH setting etc.
	2. Colour reactions for amino acids
	3. Osazone formation test.
	4. Qualitative tests
	  1. Pentose, and hexoses
	  2. Ribose sugars.
	5. Preparation of calibration curves.
	6. Quantitative estimation of total lipids.
	7. Isolation of protein from biological sample
	8. Quantitative estimation of phenolic compounds.
	9. Determination of protein by Biuret and Lowry's method.
	10. Quantitative estimation of glucose using glucose oxidase method
		CLO1 & CLO2

B	**Cell Biology** 1. Training with a light microscope to observe morphology of bacterial, plant and animal cells 2. To learn the use of micrometers to measure the length and breadth of a given cell sample. 3. To observe different stages of mitosis in onion root-tip cells 4. Cell counting and cell viability assays using Trypan blue and haemocytometer 5. Depicting nature of biological membranes: Osmosis, Hypertonicity, Hypotonicity, Isotonicity 6. Subcellular fractionation to separate nuclear/cytoplasmic fractions 7. Demonstration of cell cycle analysis using flow cytometry	CLO1 & CLO2
C	**Molecular Biology** 1. Isolation of genomic DNA using phenol-chloroform method 2. Isolation of total RNA using Trizol 3. Quantification of nucleic acids 4. Retrieving gene, transcript and protein sequences from NCBI and Ensembl databases 5. Primer design and amplification of a specific gene using Polymerase Chain Reaction (PCR) 6. Agarose gel electrophoresis for genomic DNA, RNA, plasmid and PCR product 7. Isolation of plasmid DNA 8. Restriction digestion of DNA (vector and insert)	CLO1 & CLO2

	9. Ligation of vector and insert DNA 10. Preparation of competent cells, transformation and screening of transformed colonies 11. NCBI BLAST, Multiple Sequence Alignment and Phylogenetic analysis using MEGA 12. Demonstration of Real Time PCR	
D	**Plant and Microbial Biochemistry** 1. Leaf chlorophyll estimation using spectrophotometer 2. Extraction and estimation of DNA from plant source 3. Design and construction of Plant binary vector 4.Estimation of plant antioxidants (phenolics, flavonoids etc.) 5. Antioxidant enzyme (SOD, Cat, GPx etc.) activity in plants 6. Culture and Isolation of microorganisms: Different methods: 7. Pour plate, Streak plate and spread plate 8. Quantification and viability assays: cell counts and viability 9. Bacterial growth curve: Spectrophotometry and CFU 10. Growth curve: Haemocytometer counting	CLO1 & CLO2

Modes of transaction

-Lecture cum demonstration
-Problem solving approach
-Self-Learning
-Inquiry training
-Team teaching

Tools used

PPT, YouTube Video, Google

Evaluation Criteria for Practical Courses:

Students are evaluated for a total of 100 marks for
-Maintaining the lab records/notebooks (10MM)
-Continuous assessment (20MM)
-Attendance (10MM)
-Final practical examination (30MM)
-Viva-voce (30MM)

L	T	P	Cr
3	0	0	3

Course Code: MBCH.522
Course Title: Genetic Engineering
Total Hours: 45

Learning outcomes: Students will be able to
CLO1: Demonstrate basic concepts and various vectors used in genetic engineering.
CLO2: Demonstrate utility of gene cloning and its applications utilizing microbes.
CLO3: Demonstrate current application of Genetic Engineering
CLO4: Demonstrate functional assessment of genes and application of GMO.

Unit/ Hours	**Contents**	**Mapping with CLO**
I 11 Hours	**Tools of Genetic Engineering:** Enzymes in genetic engineering, Cloning vectors, Expression vectors and their features (Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Expression Vectors, Vectors for Cloning Large DNA Molecules, Transformation and Selection, genomic and cDNA library construction, Site-directed mutagenesis. **Learning activities:** *Inquiry training on usage and advantages/disadvantages of different vector systems.*	CLO1
II 11 Hours	**Model Organisms used in Genetic Engineering: Microbial and Eukaryotic Systems**: Cloning in *E. coli*, Gram-positive bacteria, Streptomycetes, *Saccharomyces cerevisiae* and *Pichia pastoris*, Insect Cells, Mammalian Cells expression system. Fusion proteins, Transcriptional & Translational Fusions, Adding Tags and Signals. Expressing the functional protein for downstream application. **Learning activities:** *Discussion on usage and advantages/disadvantages of different host systems.*	CLO2

III 12 Hours	**Applications of Recombinant DNA Technology: Vaccines** (attenuated, subunit vaccine, recombinant protein, recombinant live vaccines, DNA and mRNA based vaccines, multi-epitope vaccines), **Metabolic Engineering** with examples from microbial, plant and animal systems. Protein Engineering and protein augmentation therapy: Antibody Engineering, Immunotoxins, Enzymes, Antibiotics, Abzymes, Therapies for Genetic Diseases, Bioremediation. **Learning activities:** *Self-learning and classroom discussion.*	CLO3
IV 11 Hours	**Genetic Manipulation and functional assessment:** Functional genomics: Forward and reverse Genetics approach used in Model organisms, Genetically modified plants and animals, Creating Transgenics, Knockouts, Knockdowns, RNAi technology, CRISPR-Cas technology. Generation of Transient and stable cell lines. Model system specific selection markers. **Learning activities:** *Self-learning and classroom discussion.*	CLO4

Suggested Readings:

1. Glick BJ, Patten CL. (2017) *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 5th edition, American Society for Microbiology
2. Primrose SB, Twyman R. (2014) *Principles of Gene Manipulation and Genomics*. 7th edition, Wiley-Blackwell.
3. Green MR, Sambrook J. (2013). *Molecular cloning: A laboratory manual*. 4th edition, Cold Spring Harbor Laboratory Press, New York.

Web Resources:

- http://www.mrrottbiology.com/genetic-engineering--biotechnology.html
- https://www.nature.com › subjects › genetic engineering

Modes of transaction

-Lecture cum Demonstration
-Problem solving approach
-Self-Learning
-Inquiry training
-Co-instructor model of teaching

L	T	P	Cr
3	0	0	3

Course Code: MBCH.523
Course Title: Developmental Biology
Total Hours: 45

On completion of this course, students will be able to:

CL01: Understand the concept of cell growth, cell cycle and cell division

CL02: Understand the principles of development processes as observed in human beings

CL03: Effectively communicate scientific reasoning related to the specific developmental phenomena observed in predominantly utilized model organisms.

CL04: Understand the developmental processes specific to plants

Unit/ Hours	Contents	Mapping with CLO
I 13 Hours	**Cell cycle and basic concepts of development:** Introduction to cell cycle, its regulation and methods to assess cell cycle status in cells, Mitosis and Meiosis, Basic concepts of development: Potency, Commitment, types of Specification, Induction, Competence, Determination and Differentiation, cytoplasmic determinants. Morphogenetic gradients, Cell fate and cell lineages; Stem cells, Genomic equivalence and genomic imprinting; importance of mutants and transgenics in analysis of development. **Learning activities:** *Assignment on diseases resulting from developmental disorders.*	CLO1

II 10 Hours	**Gametogenesis, fertilization and embryogenesis:** Production of gametes, Cell surface molecules in sperm-egg recognition in animals; prevention of polyspermy, zygote formation, cleavage, blastula formation, gastrulation- the formation of germ layers and neurulation in animals; embryogenesis. **Learning activities:** *Debate on ethical issues on experimentation of human embryos for research.*	CLO2
III 12 Hours	**Morphogenesis and organogenesis in animals:** Model organisms in developmental biology (*Drosophila, C. elegans,* Zebrafish, *Xenopus*). Cell aggregation and differentiation in *Dictyostelium*, axes and pattern formation in *Drosophila,* Organogenesis: vulva formation in *C. elegans*,eye lens induction regeneration in vertebrates (salamander limb, hydra, mammalian liver, zebrafish tail/heart) and associated signaling mechanisms; Hormonal regulation of metamorphosis **Learning activities:** *Student Seminar.*	CLO3
IV 10 Hours	**Basic Concepts of Plant Development:** Shoot, root and leaf development; floral meristems and development in plants. Embryogenesis and establishment of symmetry in plants, Seed formation, and double fertilization in plants. Apoptosis and its importance in animal/plant development. Medical implications of developmental biology. **Learning activities:** C*ollect plant leaves at different stages of development.*	CLO4

Suggested Readings:

1. Barresi M.J.F and Gilbert, S.F. (2023). *Developmental Biology*. 13th Ed. Sinauer Associates, Inc. USA.
2. Slack, J.M.W. and Dale, L. (2021). *Essential Developmental Biology*, 4th Ed. Wiley-Blackwell, USA.

Web resources:

- http://www.geochembio.com/metamicrobe/dicty/%20%EF%81%B1%20
- https://cup.gr/wpcontent/uploads/Files/files/11e.devbio.com/index.html
- http://www.wormbook.org/chapters/www_vulvaldev/vulvaldev.html
- http://www.wormatlas.org/
- https://nptel.ac.in/courses/102107075

Modes of transaction

-Demonstration
-Lecture cum demonstration
-Inquiry training
-Problem solving approach
-Self- directed learning
-Co-instructor model of teaching

Tools used

PPT, Video, Google meet, Animation, WhatsApp, NPTEL

SEMESTER II

L	T	P	Cr
3	0	0	3

Course Code: MBCH.524

Course Title: Enzymology

Total Hours: 45

Learning outcomes: Students will be able to

CLO1: Demonstrate a basic understanding of enzyme catalysis, their classification, structure, function and interaction with ligands.

CLO2: Develop a deeper understanding of data analysis in both written and oral forums related to enzyme kinetics.

CLO3: Demonstrate an understanding of enzyme inhibition and the basis of drug design

CLO4: Describe and correlate knowledge of enzymes in research, diagnostics and industrial biotransformation processes.

Unit/ Hours	Contents	Mapping with CLO
I 12 Hours	**Systemic classification and nomenclature of enzymes, Enzyme kinetics:** Subcellular Distribution of Enzymes. Isolation and Purification of Enzymes, Criteria for Enzyme homogeneity, Enzyme Activity , Specific Activity and Turnover Number, Marker Enzymes. Factors affecting rates of enzyme catalyzed reactions, single substrate reactions, concept of Michaelis - Menten, Briggs - Haldane relationship, Determination and significance of kinetic constants, catalytic rate constant and specificity constant, Limitations of Michaelis-Menten Kinetics, Line weaver	CLO1 & CLO2

	burk plot, Classification and kinetics of multisubstrate reactions, Isotopic exchange methods used to differentiate multisubstrate reaction mechanisms. Learning activities: *Discussion on yeast as model system for Enzymes activity and its applications in drug design.*	
II 13 Hours	**Enzyme catalysis:** enzyme specificity and the concept of active site, determination of active site. Site-directed and Random mutagenesis techniques Stereospecificity of enzymes. Enzyme Assays, Steady-State, Pre-Steady State and Equilibrium-State Kinetics, Mechanism of catalysis: Theories on mechanism of catalysis, Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis. Reversible and irreversible inhibition, competitive, non-competitive and uncompetitive inhibitors, determination of Inhibitor constants Ki, Suicide Inhibitors Learning activities:*Classroom presentation on enzyme kinetics and enzyme numerical solving skills.*	CLO3 & CLO4
III 10 Hours	**Coenzyme action: Role and mechanism of action of cofactors** such as NAD+ /NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions with specific examples. Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzyme system, Significance and Examples. Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complexes. Acetyl coA carboxylase Learning activities: *Group discussion on vitamins related diseases and identification*	CLO1

IV 10 Hours	**Enzyme regulation**: General mechanisms of enzyme regulation, Cooperativity phenomenon, Hill plots, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes ATCase and Hemoglobin Reversible and irreversible covalent modifications of enzymes, cascade systems. Immobilized enzymes and their industrial applications. Enzyme engineering and Co-Factor Engineering: Ribozymes, abzymes. Learning activities: *Assignment on the application of enzymes in industry in real life.*	CLO4

Suggested Readings:

1. Yon-Kahn, J and Herve, G. (2016) *Molecular and Cellular Enzymology*, Springer.
2. Bailey, J.E. and Ollis, D.F. (2017). Biochemical Engineering Fundamentals. 2nd Edition. McGraw Hill, New York.
3. Segel, I. H. (2017). Enzyme kinetics, behavior and analysis of rapid equilibrium and steady-state enzyme systems. First Edition. Wiley.
4. Rodwell VW, Bender DA, Botham KA, Kennelly PJ and Weil PA. (2018). Harper's Illustrated Biochemistry 31/e, 31st Ed., McGraw Hill Professional
5. Palmer, T. (2007) *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry.* Second edition, Harwood Publishing.
6. Voet, D. and Voet, J.G. (2010) Biochemistry. 4th Edition, Wiley, Hoboken.

Web resources:

- https://www.youtube.com/watch?v=f7jRpniCsaw
- https://www.youtube.com/watch?v=26ho8zCSobI
- https://www.youtube.com/watch?v=Qk4SjxQ2rjA
- https://www.youtube.com/watch?v=KCG5fDKr9HQ
- https://www.youtube.com/watch?v=jUUeR4o_2-0
- https://www.youtube.com/watch?v=qJgEmewoPbw
- https://www.youtube.com/watch?v=pnoOtxIAk9g
- https://www.youtube.com/watch?v=f7jRpniCsaw
- https://www.youtube.com/watch?v=4cN60VBXNlw
- https://www.youtube.com/watch?v=oaWQWB1S5Q4
- https://www.youtube.com/watch?v=cbIeu1kt7nI
- https://www.youtube.com/watch?v=4cN60VBXNlw

Modes of transaction

-Lecture cum demonstration
-Self-learning
-Panel discussion
-Problem solving approach
-Team learning
-Co-instructor model of teaching

Tools used- PPT, YouTube Video, Google meet, NPTEL

L	T	P	Cr
3	0	0	3

Course Code: MBCH.525
Course Title: Immunology
Total Hours: 45

Learning outcomes: Students will be able to
CLO1: Demonstrate the basic concepts related to the immune system.
CLO1: Apply and effectively communicate scientific reasoning and data analysis in both written and oral forums related to immunological concepts in health and disease.
CLO1: Understand and correlate immunology with its clinical implications

Unit/ Hours	Contents	Mapping with CLO
I/ 13 Hours	**Immune system and cells involved in immune response:** Innate and acquired immunity. Structure and functions of primary and secondary lymphoid organs. Immune Cells- mononuclear cells (Phagocytic cells and their killing mechanisms), granulocytic cells (neutrophils, eosinophils and basophils), mast cells and dendritic cells, B-lymphocytes, T-lymphocytes and Null cells, and their diversity. **Learning Activities:** *A diagrammatic representation with origin, percentages and absolute number of different immune cells.*	CLO1
II/ 12 Hours	**Antigen and Antibody:** Immunogenicity vs antigenicity, factors influencing immunogenicity, epitopes, haptens,	CLO2

	adjuvants and mitogens. Classification, fine structure and functions of immunoglobulins, antigenic determinants on immunoglobulins, isotypic, allotypic and idiotypic variants. Clonal selection theory– concept of antigen specific receptor. Organization of immunoglobulin genes: generation of antibody diversity, monoclonal and polyclonal antibodies; hybridoma technology, antibody engineering, abzymes, immunotoxins. **Learning Activities:** *Group discussion on salient structural and functional features of antibodies exploited in varied antibody-based applications*	
III/ 10 Hours	**Immune effector responses and Cell Mediated Immunity:** Kinetics of primary and secondary immune responses, complement activation, agglutination, precipitation and opsonization. Cytokines and co-stimulatory molecules and their role in immune response, hypersensitivity (Types I, II, III, IV). Cell mediated immunity. T-cell receptor diversity, Antigen processing and presentation, Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA). Polymorphism of MHC genes, MHC antigens in transplantation. ***Learning activities:*** *Video demonstration of an effector T cell in real time*	CLO2
IV/ 10 Hours	**The Immune system in health and disease:** Immune-response and Microbial diseases, Vaccines: Sub-unit vaccines; Recombinant DNA and protein-based vaccines, conjugate vaccines; Passive Immunization, Transfusion of immuno-competent cells, Ex vivo manipulation of immune cells, CAR T cells, NK CAR, Macrophage CAR cells in immune-therapy. Immune tolerance and its breakdown, Autoimmunity and related disease, Cancer immunology, Congenital Immunodeficiencies and related disease, Acquired immunodeficiencies and related disease. Immunological Techniques and Applications: Principle and applications of immune diffusion techniques (Ouchterlony double diffusion, radial immunodiffusion and immunoelectrophoresis), ELISA, immunoblotting (Western blotting), immunofluorescence, flow cytometry-based immune profiling, immunoprecipitation, monoclonal antibody production and hybridoma technology, and basic	CLO3

	immunodiagnostic applications in research and clinical settings. **Learning activities:** *Term paper-based discussion, demonstration videos of immunological techniques, interpretation of immune profiling datasets and team learning*	

Suggested Readings:

1. Punt, J., Stranford, S., Jones, P., and Owen, J.A. (2018). *Kuby Immunology* 8th Edition. W.H. Freeman, USA.
2. Abbas, A., Lichtman, A.H. and Pillai S. (2017). *Cellular and Molecular Immunology*. 9th Edition. CBS Publishers & Distributors, India.
3. Murphy, K. and Weaver, C. (2017). Janeway's*Immunobiology: The immune system in health and disease.* 9th Edition. Garland Science.
4. Delves, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M. (2017). *Roitt's Essential Immunology.* Wiley-Blackwell Publishers, USA.
5. Tizard (2013). *Immunology: An Introduction.* 5th edition. Brooks/Cole.

Web resources:

- https://www.immunopaedia.org.za/
- https://www.fun-mooc.fr/en/courses

Modes of transaction

-Lecture cum Demonstration
-Panel discussion
-Problem solving approach
-Self learning
-Team learning
-Co-instructor model of teaching
-Visits to diagnostic laboratories/research institutes for exposure to clinical and translational laboratory practices.

Tools used

PPT, YouTube Video, Google meet, NPTEL

L	T	P	Cr
3	0	0	3

Course Code: MBCH.526
Course Title: Metabolism

On completion of this course, students will be able to:

CLO1: Demonstrate an understanding of metabolism of carbohydrates.
CLO2: Demonstrate an understanding of metabolism of lipids.
CLO3: Demonstrate an understanding of metabolism of amino acids.
CLO4: Demonstrate an understanding of metabolism of nucleic acids.
CLO5: Apply and effectively communicate scientific reasoning and data analysis in both written and oral forums related to the course content.

Unit/ Hours	Contents	Mapping with CLO
I 13 Hours	**Carbohydrates:** Glycolysis, citric acid cycle, its function in energy generation and biosynthesis of energy rich bond, pentose phosphate pathway. Gluconeogenesis, glyoxylate and gamma aminobutyrate shunt pathways, Cori cycle, anaplerotic reactions, Entner-Doudoroff pathway, glucuronate pathway. **Learning activities:** *Classroom discussion on carbohydrate metabolism.*	CLO1 & CLO5
II 12 Hours	**Lipids:** Fatty acid oxidation (α-, β-, ω-oxidation). Oxidation of odd numbered fatty acids – fate of propionate, role of carnitine, degradation of complex lipids. Fatty acid biosynthesis of triacylglycerols, phosphoglycerides, sphingomyelin and prostaglandins. **Learning activities:** *Assignment and term papers-based discussion.*	CLO2 & CLO5
III 10 Hours	**Amino Acids**: General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines. Urea cycle and its regulation. **Learning activities:** *Classroom discussion on amino acid metabolism.*	CLO3 & CLO5
IV 10 Hours	**Nucleic Acids:** Biosynthesis and degradation of purine and pyrimidine nucleotides and its regulation. Purine salvage pathway. Role of ribonucleotide reductase.	CLO4 & CLO5

	Biosynthesis of deoxyribonucleotides and polynucleotides including inhibitors of nucleic acid biosynthesis. **Learning activities:** *Assignment and term papers-based discussion.*	

Suggested Readings:

1. Satyanarayana, U. (2013) Biochemistry, Publisher: Elsevier; Fourth edition ISBN-9788131236017.
2. Berg JM, Stryer L, Tymoczko JL, Gatto GJ (2018) Biochemistry, WH Freeman, 9th ed.
3. Nelson, D. and Cox, M.M. (2017). Lehninger Principles of Biochemistry. 7th edition. WH Freeman.
4. Karp, G., Iwasa, J., Marshall, W. (2020). Karp's Cell and Molecular Biology. 8th Edition. John Wiley & Sons.
5. Satyanarayana, U. (2014) Biochemistry, Publisher: Elsevier; Fourth edition ISBN-9788131236017.

Web Resources:

- https://www.cell.com/cell-metabolism/libraries/resources
- https://academic.oup.com/database/article/doi/10.1093/database/bav068/2433201
- https://metacyc.org/
- https://www.journals.elsevier.com/metabolism

Modes of transaction

- Lecture
- Problem solving approach
- Group discussion
- Learning centric activity
- Self-learning
- Peer learning
-Co-instructor model of teaching

Tools used

PPT, Video, Google meet, Animations, WhatsApp, NPTEL

L	T	P	Cr
2	0	0	2

Course Code: MBCH.527
Course Name: Clinical Biochemistry
Total Hours: 30

On successful completion of this course, students will be able to:

1. Understand the principles, biochemical composition and workflow of clinical biochemistry laboratories, including ethical and regulatory considerations and diagnostic relevance of body fluids.

2. Apply laboratory techniques for analysis of biochemical markers in clinical samples.

3. Interpret laboratory results for diagnosis and clinical decision-making.

4. Recognize emerging trends and technologies in clinical biochemistry.

5. Communicate laboratory findings effectively within a clinical setting.

Unit/ Hours	Contents	Mapping with CLO
I 7 Hours	**Introduction of Clinical Biochemistry** Scope, and significance in healthcare and translational medicine; composition of blood, urine, CSF, and synovial fluid; sample collection, anticoagulants, preservatives; Principles of laboratory medicine: Accuracy, Precision, Sensitivity and Specificity, quality control and quality assurance including Internal and External Quality Control (IQC/EQA), Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), biosafety and documentation practices, lab safety, accreditation (NABL/ISO standards), phases of testing, ethical practices and data integrity in diagnostics, overview of regulatory guidelines relevant to diagnostic and biopharmaceutical laboratories. **Learning activities:** Brainstorming, Presentation, Quizzes, Case-based discussions, and Group Learning	CLO1
II 8 Hours	**Metabolic disorders** Disorders of carbohydrate and lipid metabolism (diabetes, hyperlipidemia, glycogen storage diseases), molecular	CLO2 & CLO3

	mechanisms of insulin resistance (IRS-1/PI3K/Akt pathway). Inborn errors of amino acid and nucleic acid metabolism (e.g., PKU, alkaptonuria); vitamin and mineral deficiency disorders, metabolic syndrome and obesity-linked inflammation; role of gut microbiome in metabolic regulation. **Learning activities:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
III 7 Hours	**Biochemical Biomarkers** Introduction to disease biomarkers: definition, classification, and clinical applications, types of biomarkers (diagnostic, prognostic, predictive, theranostic), Biomarkers in Disease: Diagnostic enzymes, biomarkers in major diseases (CVD, liver, metabolic), emerging biomarkers (high-sensitivity troponins, CRP, D-dimer, circulating miRNAs) and point-of-care testing (POCT) and digital diagnostics integration; basics of biosensors and nano-enabled diagnostics, theranostic biomarkers, precision medicine approaches and biomarker validation strategies. **Learning activities:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning	CLO2 & CLO3
IV 8 Hours	**Laboratory Techniques and Case Studies** Enzymatic assay, immunoassay, and molecular techniques; and proteomics; Case studies: Biomarkers of inflammation, oxidative stress, thrombotic associated cardiovascular complications and cancer, fundamentals of clinical trials, clinical data interpretation and evidence-based diagnostics, overview of the drug discovery and development pipeline including target identification, preclinical evaluation, regulatory approval processes including Investigational New Drug (IND) submission, and translational applications of diagnostics and therapeutics. **Learning activities:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning	CLO4 and CLO5

Suggested Readings:

1. Murphy MJ, Srivastava R, and Deans K (2018) *Clinical Biochemistry:* An Illustrated Colour Text. 6th Ed. Publisher: Churchill Livingstone.
2. Luxton, R (2008) *Clinical Biochemistry*. 2nd Ed. Scion Publishing Ltd.
3. Hall, JE (2019) *A textbook of Medical Physiology*, 2nd South Asia Ed. Publisher: Saunders.
4. Maheshwari, N (2017) *Clinical Biochemistry*. 2nd Ed. Publisher: JPB.
5. Henry, Bernard J et al. (2002). *Clinical diagnosis & Management by laboratory methods.* W.B. Saunders, New York
6. Gradwohls (2000) *Clinical Laboratory Methods and Diagnosis.* (ed) Sonnenwirth AC, and Jarret L, M.D.B.I. Publications, New Delhi
7. Coleman, W. B. and Tsongalis, G. J. (2009). *Molecular Pathology: The Molecular Basis of Human Disease.* Academic Press.
8. Read A and Donnai D (2007). *New Clinical Genetics.* Scion Publishing Ltd., Oxfordshire, UK.
9. Patch, H. S. C. (2009). *Genetics for the Health Sciences*. Scion Publishing Ltd., UK.
10. Milunsky, A., Milunsky, J. (2015). *Genetic Disorders and the Fetus: Diagnosis, Prevention and Treatment*, 7th Edition. Wiley-BlackwellPublishers.
12. Ahmed N (2017) Clinical Biochemistry, 2nd Ed., Oxford University Press

Web Resources:

- https://global.oup.com/uk/orc/biosciences/biomed/ahmed2e/
- https://www.aacb.asn.au/resources/resources
- https://guides.lib.utexas.edu/biochemistry
- https://themedicalbiochemistrypage.org/
- https://www.internetchemistry.com/chemistry/clinical-chemistry.php

Modes of transaction

- Lecture
- Group discussion
- Co-instructor model of teaching
- Visits to diagnostic laboratories/research institutes for exposure to clinical and translational laboratory practices.

Tools used

PPT, Video, Google meet, Animations, WhatsApp, NPTEL

L	T	P	Cr
2	0	0	2

Course Code: MBCH.528
Course Title: Biostatistics
Total Hours: 30
Learning outcomes: Students will be able to
CLO1: Apply statistics for biological data analysis.
CLO2: Describe and correlate experimental data using statistical tools.

Units/ Hours	Contents	Mapping with CLO
I 7 Hours	**Introduction to Biostatistics-**Definition, scope, and applications of biostatistics**,** Types of data: qualitative and quantitative**,** Scales of measurement: nominal, ordinal, interval, ratio**,** Collection and presentation of data (tables, charts, histograms, frequency polygons) **Descriptive Statistics-**Measures of central tendency: mean, median, mode**,** Measures of dispersion: range, variance, standard deviation, coefficient of variation**,** Skewness and kurtosis**,** Percentiles, Range, quartiles, interquartile range, mean deviation, Variance and Standard Deviation, Moments, Normality Tests and Outliers, Moments, **Learning activities:** *Testing with experimental data.*	CLO1
II 7 Hours	**Correlation and Regression-** Pearson's and Spearman's correlation coefficients**,** Simple linear regression and multiple regression**,** Interpretation of regression coefficients**,** Applications in biological research	CLO1

	Sampling and Sampling Distributions-Population and sample, Sampling methods: random, stratified, systematic, cluster, Sampling error and non-sampling error, Concept of standard error. **Learning activities:** *Peer discussion in teams and presentation.*	
III 9 Hours	**Probability and Distributions-**Basic concepts of probability: rules, conditional probability, Probability distributions: Binomial, Poisson, and Normal distributions, Central Limit Theorem, Applications of probability distributions in biology **Statistical Inference-** Hypothesis testing: null and alternative hypotheses**,** Type I and Type II errors, significance level, power of the test**,** Parametric tests: t-test (one sample, two sample, paired), z-test**,** ANOVA (One-way and Two-way)**,** Non-Parametric Tests-Chi-square test **Learning activities:** *Web-based exercises.*	CLO2
IV 7 Hours	**Design of Experiments (DoE)-** Principles of experimental design (randomization, replication, blocking)**,** Completely Randomized Design (CRD)**,** Randomized Block Design (RBD)**,** Latin Square Design (LSD) **Statistical Software and Data Analysis-**Introduction to software: SPSS / R / Excel / GraphPad / SAS**,** Data entry, descriptive analysis**,** Graphical representations **Learning activities:** *Application of statistical tools.*	CLO2

Suggested Readings:

1. Wayne W. Daniel & Chad L. CrossBiostatistics: A Foundation for Analysis in the Health Sciences, 11th Edition.
2. Norman, G. and Streiner, D. (2014). *Biostatistics: The Bare Essentials*, Decker Inc. USA, 4th edition.
3. Samuels, M.L., Witmer, J., Schaffner, A. (2016). *Statistics for the Life Sciences*, 5th edition, Prentice Hall publishers.

4. Sokal, R.R. and Rohlf, F.J. (1994). *Biometry: The Principles and Practices of Statistics in Biological Research.* W.H. Freeman publishers. 3rd edition.
5. Emden, H.F. (2019). *Statistics for Terrified Biologists*. Blackwell Publishers.
6. Rao Nageswara G. (2018) Biostatistics & Research Methodology, 1st Ed. PharmaMed Press

Modes of transaction

-Lecture cum demonstration
-Inquiry training
-Panel discussion
-Problem solving approach
-Self-learning
-Co-instructor model of teaching

Web References:

- https://libguides.alfaisal.edu/biostat/web/resources
- https://bms.ucsf.edu/resources-learning-biostatistics

Tools used

PPT, YouTube Videos, Google, recorded lectures

L	T	P	Cr
0	0	8	4

Course Code: MBCH.529
Course Title: Biochemistry Practical-II
Total Hours: 120

Course learning outcome: After the completion of this course, the students will be able to

CLO1: Perform experiments pertaining to enzymology, immunology and clinical biochemistry.

CLO2: Apply the scientific method to the processes of experimentation and hypothesis testing.

Part	Contents	Mapping with CLO
A	**Enzymology** 1. Enzyme assay for salivary amylase i. Activity ii. Determination of optimum pH iii. Determination of optimum temperature iv. Determination of specific activity 2. Acid phosphatase activity in plant tissue	CLO1 & CLO2

	Enzyme inhibition assays	
B	**Immunology** 1. To perform total leukocyte count of the given blood sample. 2. To perform differential leukocyte count of the given blood sample. 3. Double immunodiffusion test using specific antibody and antigen. 4. To perform immunoelectrophoresis using specific antibodies and antigen. 5. Dot immunoblot assay (DIBA). 6. ELISA 7. Isolation of mononuclear cells from peripheral blood and viability test by dye exclusion method. 8. Immunohistochemistry: H & E staining, Fluorescent staining, Fluorescent Microscopy, Confocal Microscopy	CLO1 & CLO2
C	**Clinical Biochemistry** 1. Estimation of cholesterol in biological tissue and cells. 2. Estimation and separation of serum/plasma proteins in blood 3. Estimation of blood/serum glucose 4. Estimation of serum total cholesterol 5. Tests for proteins, glucose, ketone bodies, bilirubin &urobilinogen in urine 6. Estimation of urea in blood (serum) 7. Determination of uric acid in serum 8. Estimation of serum bilirubin	CLO1 & CLO2

Modes of transaction:

-Lecture cum demonstration
-Experimentation
-Problem solving approach
-Self-directed learning
-Team teaching
-Industrial/research laboratory visits for exposure to advanced Instrumentation and quality laboratory practices.

Software tools

BLAST, MEGA

Web Resources:

- https://media.hhmi.org/biointeractive/vlabs/immunology/index.html
- https://www.thermofisher.com/in/en/home/life-science/antibodies/immunoassays/elisa-kits
- https://www.youtube.com/watch?v=Fnx5CkGRBEM
- https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering

Evaluation Criteria for Practical Courses:

Students are evaluated for a total of 100 marks for
-Maintaining the lab records/notebooks (10MM
-Continuous assessment (20MM)
-Attendance during day to day practical (10MM)
-Final practical examination (30MM)
-Viva-voce (30MM)

L	T	P	Cr
2	0	0	2

Course Code: MBCH.511
Course Title: Analytical Biochemistry and Molecular Diagnostics

Total Hours: 30

On completion of this course, students will be able to:

CLO1: Comprehend diverse methods in molecular diagnostics of human diseases and Forensic studies

CLO2: Understand and use the said approaches and techniques in related career paths

Unit/ Hours	Contents	Mapping with CLO

I 7 Hours	**Introduction to instrumentation used in biochemistry laboratory**- UV-spectrometry, chromatography, microscopy. **pH and buffers:** Concept of molarity, molality and normality, preparation of buffers and solutions in laboratory. **Sterilisation techniques:** concept of sterilization; methods of sterilization- wet heat sterilization, dry heat sterilization, radiation sterilization, filter sterilization, Autoclave, Biosafety cabinets & Laminar Air Flow, Biosafety Levels **Learning activities:** *Brief exercises required for preparation of working solutions and physiological buffers*	CLO1 & CLO2
II 7 Hours	**Introduction to Clinical Diagnostics:** General approach to biological specimens, Sample collection (Blood, urine, spinal fluid, synovial fluid, amniotic fluid) - method of collection, preservation, transport and processing of samples. Blood group determination, genetics of ABO and Rh blood group.	CLO1 & CLO2
III 9 Hours	**Molecular Diagnostics:** Nucleic acid extraction from clinical samples, quantization, digestion, hybridization, Amplification by PCR (Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, *In situ* PCR, Long-PCR, PCR-ELISA, iPCR, applications and limitations) DNA fingerprinting **High-throughput Technologies in Diagnostics:** Real-Time PCR, Biosensors – types, applications, examples (glucose etc), telemedicine. Fluorescence based techniques (FISH analysis, Flow cytometry, Fluorescent Microscopy). **Learning activities:** *Group discussion on disease specific application of different tools in real life scenario.*	CLO1 & CLO2

IV 7 Hours	**Medical diagnostics:** Diagnosis of Infectious Diseases – some specific examples of Diagnosis of bacterial infection, fungal infections, viral infections. Genetic Diseases: Organization of human genome, Human Genome Project, Identifying human disease genes. Genetic Counselling. Genetic disorders: Sickle cell anaemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex –linked inherited disorders. **Learning activities:** *Case studies.*	CLO1 & CLO2

Suggested Readings:

1. Green MR, Sambrook J. (2013) *Molecular cloning: A laboratory manual.* 4th edition, Cold Spring Harbor Laboratory Press, New York.
2. Buckingham, L. (2019) *Molecular diagnostics : fundamentals, methods, and clinical applications.* 3rd edition, Philadelphia : F. A. Davis Company
3. Patrinos GP, Ansorge W, Danielson PB. (2016) *Molecular Diagnostics.* 3rd edition, Academic Press
4. Murray, PR (2025) *Chapter 16 - The Clinician and the Microbiology Laboratory* in book Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases, edited by Martin J. Blaser, Jeffrey I. Cohen, Steven M. Holland, 10th edition, Elsevier
5. Chaitanya KV (2022) Diagnostics and Gene Therapy for Human Genetic Disorders, 1st edition, CRC Press
6. Wilson, K., Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology. 8th Edition, Andreas Hofmann and Samuel Clokie, Cambridge University Press.
7. Iain D Campbell (2012). Biophysical Techniques, Oxford University Press.
8. Terrance G. Cooper (2011). The Tools of Biochemistry. Wiley India Pvt Ltd

Web resources:

- https://www.youtube.com/watch?v=siXdckB1HzU
- https://www.youtube.com/watch?v=WP6JpnHZJlQ
- https://www.youtube.com/watch?v=yl3EZX5kKbM
- https://www.youtube.com/watch?v=eH7UkTB7m8U
- https://www.youtube.com/watch?v=vMzs4NyVvuc

Web Resources:

- https://labtestsonline.org/articles/forensic-testing
- https://pubmed.ncbi.nlm.nih.gov/12138499/

- http://www.forensicsciencesimplified.org/

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
- Case study
-Case analysis

Tools used

PPT, Video, Google classroom

L	T	P	Cr
2	0	0	2

Course Code: MBCH.512

Course Title: Environmental Biochemistry

Total Hours: 30

On completion of this course, students will be able to:

CLO1: Understand the importance and types of environmental pollution,

CLO2: Detection of mutagens.

CLO3: Biotechnological approaches to tackle environmental pollution.

Unit/ Hours	Contents	Mapping with CLO

I 7 Hours	**Environment pollution:** Introduction of environmental pollution, Different types of environmental pollution, Air pollution, criteria pollutants, estimation of NOx, SOx, and particulate matter, Major causes of air pollution**,** Industrial Emissions, Deforestation and Biomass Burning and Natural Sources, Air-borne diseases and pathogens Water pollution, various contaminants in water, BOD, COD, Major causes of water pollution**,** waterborne diseases and pathogens, MPN and MFT test; fecal coliform. **Learning activities:** *Classroom discussion on air and water pollution*	CLO1
II 9 Hours	**Treatment methods:** Air pollution treatments methods principle, Working, Types, scrubbers, separators and electrostatic precipitators. Water pollution treatments, study about primary, secondary, and tertiary treatment and process, activated sludge systems principle, trickling filters, Rotating Biological Contactors, 1. Introduction to genetic toxicology, Bacterial Ames test, DNA strand break measurements in cells (comet assay, alkaline unwinding and hydroxyapatite chromatography, alkaline elution), and cytogenetic assays (micronucleus and chromosomal aberration assays. 2. **Learning activities:** *Discussion on various methods of estimation of air and water pollutants.*	CLO2 & CLO3

III 7 Hours	**Solid waste management:** types and process of composting, Factor affecting composting, Sanitary landfill, E-Waste Management in India: Issues and Strategies, Management of lead acid battery, Biomedical waste management. Types and Methods of Biodegradation of organic pollutants Bioremediation: types, method and effect on the environment. **Learning activities:** *Case studies.*	CLO1 & CLO3
IV 7 Hours	**Plastic waste:** Study about Microplastics formation, Microplastics types, sources, distribution and fate. Effect of microplastics on the environment and human health. Study some alternatives to plastics, Biodegradable plastics production, types and benefits. Study different types of Challenges associated with preventive measures **Learning activities:** *Case studies.*	CLO1 & CLO2

Suggested Readings:

1. Brady, N.C. & Well, R.R. 2007.The Nature and Properties of Soils (13th edition), Pearson Education Inc.
2. Oldeman, L. R. 1994. The global extent of soil degradation. Soil resilience and sustainable land use, 9. (http://library.wur.nl/isric/fulltext/isricu_i26803_001.pdf).
3. Jordening, H.J. & Winter J. 2005. Environmental Biotechnology: Concepts and Applications. John Wiley& Sons
4. Rittman, B.E. & McCarty, P.L. 2001. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.
5. Wainwright, M. 1999. An Introduction to Environmental Biotechnology, Springer.
6. Pepper, I.L., Gerba, C.P. &Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.
7. Purohit, S.S. &Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.
8. Hayes, A. W., & Kruger, C. L. (Eds.). (2014). *Hayes' principles and methods of toxicology*. Crc Press.

9. Crawford, C. B., & Quinn, B. (2016). *Microplastic pollutants*. Elsevier Limited
10. Goosey, M., Stevens, G., & Herman, H. (2009). *Electronic waste management* (Vol. 27). Royal Society of Chemistry.

Web Resources:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8497872
https://www.nature.com/articles/s41578-021-00411-y
https://www.biologydiscussion.com/microbiology-2/treatment-of-solid.
https://www.sciencedirect.com/science/article/pii/S0048969721016582

Modes of transaction

-Lecture
-Problem-Solving
-Self-Learning

L	T	P	Cr
2	0	0	2

Course Title: Bioinformatics for Next Generation Sequencing Data Course Code: MBIM.512
Course type: VAC
Total Hours: 30
Course Learning Outcomes (CLO):

On completion of this course, students will be able to,
CLO1: Compare various NGS chemistries and NextGen Sequencing platforms
CLO2: Outline the complexity of NGS data, steps involved in NGS data analysis, and algorithms
CLO3: Describe data analysis approaches used for DNA and RNA sequencing using NGS platforms
CLO4: Examine the real-time application of NGS in medicine and agriculture using case studies

Unit/ Hours	**Contents**	**Mapping with CLO**

I 8 Hours	Introduction to NGS techniques: Illumina sequencing, Roche 454 sequencing, Ion torrent, SOLiD sequencing, Nanopore sequencing. **Learning Activities:** Visit and demonstration of NGS platforms, Seminars on application of the techniques	CLO1
II 8 Hours	Sequence quality evaluation - Phred Scores, Sequence file formats, Alignment of Next-Gen sequences to reference sequences **Learning Activities:** Hands-on training in sequence analysis, discussion and seminars on application of the techniques, Case studies	CLO2
III 7 Hours	NGS methods: Whole genome sequencing, Target sequencing, Exome sequencing, RNA seq, analysis-Transcriptome mapping, Methylation sequencing, ChIP-Seq. **Learning Activities:** Peer discussion, hands-on training in sequence analysis, research paper discussion	CLO3
IV 7 Hours	RNA-Seq data analysis, Differential Expression Analysis Workflow, Aligning Reads to Reference, Transcriptome Assembly, Applications of NGS **Learning Activities:** Peer discussion, hands-on training in sequence analysis, research paper discussion	CLO4

Transactional Modes: Lecture; Tutorial; Problem solving; Self-learning.

Suggested Readings

1. Brown, S. M. (2013). Next-Generation DNA Sequencing Informatics. Cold Spring Harbor Laboratory Press, 1/e.
2. Head, Steven R., Ordoukhanian, Phillip, Salomon, Daniel R (2018) Next Generation Sequencing Methods and Protocols, Humana Press Inc.

3. Xinkun Wang. (2016). Next-Generation Sequencing Data Analysis. Talyor and Francis Group.
4. Low, L., & Tammi, M. (2017). Introduction to next generation sequencing technologies. Bioinformatics: A Practical Handbook Of Next Generation Sequencing And Its Applications.
5. Lloyd Low and Martti Tammi (2017) A Practical Handbook of Next Generation Sequencing and Its Applications, World Scientific Publishing Co Pte Ltd
6. Beginner's Handbook of Next Generation Sequencing, Genohub
7. Shawn E. Levy and Richard M. Myers, "Advancements in Next-Generation Sequencing". Annu. Rev. Genom. Hum. Genet. 2016. 17:16.1–16.21

L	T	P	Cr
2	0	0	2

Course Code: MBCH 513
Course Title: Research Methodology
Total Hours: 30

On completion of this course, students will be able to:

CLO1: Demonstrate various aspects of research methods, scientific writings and literature search.
CLO2: Implement biosafety measures in scientific research.
CLO3: Discuss the ethical issues associated with scientific research.
CLO4: Assess how research promotes innovation and the importance of filing patents

Unit/ Hours	Contents	Mapping with CLO
I 7 Hours	**General Principles of Research:** Meaning and importance of research, critical thinking, formulating hypothesis and development of research plan, review of literature, interpretation of results and discussion. Scientific writing, web-based literature search engines. Research presentation and poster preparation, plagiarism. **Learning Activities:** *Evaluation of research proposals.*	CLO1
II 8 Hours	**Biosafety:** Orientation to biorisk management—biosafety and biosecurity, Assessment, Mitigation and Performance (AMP) model, case studies Good Manufacturing Practices (GMP), Good Laboratory	CLO2

	Practices (GLP), Quality Assurance (QA) and Quality Control (QC), Genetic pollution, Risk and safety assessment of genetically engineered organisms, Biological containment and physical containment, Physical, Chemical & Biological hazards. Sterilization techniques, decontamination and disposal of biological waste. **Learning Activities:** *Discussion on some case studies on biosafety.*	
III 8 Hours	**Bioethics:** Ethical theories, Ethical considerations during research, Animal handling/testing, Animal experimental models and animal ethics. Ethical issues of the human genome project, ICMR guidelines for biomedical and health research, Social and ethical implication of biological weapons, Cyber security, research integrity, data reproducibility and scientific documentation practices. ***Learning activities:*** *Discussion on bioethics in a hypothetical situation.*	CLO3
IV 7 Hours	**Intellectual property rights:** Introduction and basic concepts of Intellectual property rights (IPRs), Different types of IP, Basic requirements of patentability, patentable subject matter, Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. WTO agreement and TRIPS, Patent Cooperation treaty, introduction to translational and industry-oriented research practices. **Learning activities:** *Dummy filing of a patent application.*	CLO4

Suggested Readings:

1. Karapapa, S. and McDonagh, L. (2019). Intellectual Property Law. Oxford University Press
2. Bently, L., Sherman, B., Gangjee, D., & Johnson, P. (2022). Intellectual Property Law, 6th edition. Oxford University Press
3. Gurumani, N. (2021). Scientific Thesis Writing and Paper Presentation. Mjp Publisher.
4. Saramäki, J. (2018). How to Write a Scientific Paper: An Academic Self-Help Guide for PhD Students. Independently Published.
5. Salerno, R. M., & Gaudioso, J. M. (2021). Laboratory Biorisk Management: Biosafety and Biosecurity. CRC Press.
6. WHO (2019). *Laboratory Biosafety Manual*. 4th Edition. World Health Organization.

7. Sateesh, M. K. (2020). Bioethics and Biosafety. Dreamtech Press
8. Vaughn, L. (2022). Bioethics: Principles, Issues, and Cases. Oxford University Press, USA.

Web Resources:

- https://nptel.ac.in/courses/110106081
- https://nptel.ac.in/courses/110105139

Modes of transaction

-Lecture cum demonstration
-Problem solving approach
- Co-instructor model of teaching
- Research institute/industry visits for exposure to biosafety, regulatory and translational research practices.

Tools used

PPT, YouTube Video, WhatsApp, Animations, Google meet, NPTEL

L	T	P	Cr
2	0	0	2

Course Code: MBCH.506
Course Title: Basics of Biochemistry
Total Hours: 30

Learning outcomes: Students will be able to
CLO1: Demonstrate a basic understanding of biomolecules, their structure, composition and function.
CLO2: Describe and explain basic concept of biological metabolism
CLO3: Describe biological catalyst and their role in metabolism

Unit/ Hours	Contents	Mapping with CLO
I 7 hours	Biomolecules: Water, pH, Buffer. Structure and Function of Biomolecules: Carbohydrates, Lipids, Proteins Primary, Secondary, Tertiary and Quaternary structures, Nucleic acids and Vitamins. **Learning Activities:** *Correlate daily consumed/ used items with biomolecules.*	CLO1

II 8 hours	Catabolic and anabolic reactions, Energy rich phosphate compound, Glycolysis, Kreb's Cycle, electron transport chain, Glycogenesis, Glycogenolysis. **Learning Activities:** *Correlate daily consumed items with metabolism.*	CLO2
III 8 hours	Photosynthesis and pigment system, Calvin-C3 cycle, ammonia assimilation, urea cycle, Nitrogen fixation and nitrate uptake. **Learning Activities:** *Discussion on how light is essential for plant and animal life.*	CLO2
IV 7 hours	Classification of enzymes, Basics of enzyme catalysis, Effect of pH and temperature on enzyme activity, Application of enzymes in diagnosis and industry. **Learning Activities:** *Discussion on the important applications of enzymes in industry.*	CLO3

Suggested Readings:

1. Berg JM, Stryer L, Tymoczko JL, Gatto GJ (2018) *Biochemistry*, WH Freeman, 9th ed.
2. Nelson, D. and Cox, M.M. (2017). *Lehninger Principles of Biochemistry*. 7th edition. WH Freeman.
3. Karp, G., Iwasa, J., Marshall, W. (2020). *Karp's Cell and Molecular Biology*. 8th Edition. John Wiley & Sons.
4. Satyanarayana, U. (2014) *Biochemistry*, Publisher: Elsevier; Fourth edition ISBN-9788131236017.

Web resources:

- https://nptel.ac.in/courses/104/102/104102016/
- https://nptel.ac.in/courses/104/103/104103121/
- https://www.youtube.com/watch?v=iuW3nk5EADg
- https://www.youtube.com/watch?v=ZqoX2W1N6l0
- https://www.youtube.com/watch?v=DhwAp6yQHQI
- https://www.youtube.com/watch?v=jLyi2K-29xU
- https://www.youtube.com/watch?v=C0ky85Kk2Zc

Modes of transaction

-Lecture cum demonstration
-Self-learning
-Panel discussion
-Problem solving approach
-Team learning

Tools used

PPT, YouTube Video, Google meet, NPTEL

L	T	P	Cr
2	0	0	2

Course Code: MBCH. 530
Course Title: Human Health and Lifestyle Diseases (IDC)
Total Hours: 30

Learning outcomes: Students will be able to
CLO1: Explain basic concepts of health, disease, and body functioning
CLO2: Identify causes and risk factors of lifestyle diseases
CLO3: Describe common diseases and their impact on health
CLO4: Apply preventive strategies for maintaining health

Unit/ Hours	Contents	Mapping with CLO
I 6 Hours	**Basics of Health & Disease:** Definition of health (physical, mental, social well-being), Factors affecting health: lifestyle, environment, genetics, Types of diseases: infectious vs non-infectious, Importance of hygiene, nutrition, and immunity **Learning Activities:** *Discussion on "What is health?" Examples of communicable vs lifestyle diseases Awareness on hygiene practices*	CLO1
II 9 Hours	**Common Diseases & Lifestyle Disorders** Overview of infectious diseases (basic awareness only), Lifestyle diseases: diabetes, obesity, heart disease, hypertension, Basic idea of body imbalance (high sugar, fat, BP), Introduction to immunity and body defense (simple concept), Basic awareness of cancer **Learning Activities:** *Case studies (diabetes/obesity) Understanding simple health reports (blood sugar, BP)*	CLO2, CLO3
III 8 Hours	**Risk Factors & Modern Lifestyle Impact:** Unhealthy diet (junk food, processed food), Physical inactivity and sedentary lifestyle, Stress, sleep disorders, and mental health, Substance abuse (drugs, alcohol, smoking) and health impact **Learning Activities:** *Self-assessment of lifestyle habits, Group discussion: technology and health, Comparison of healthy vs unhealthy lifestyle*	CLO2, CLO3

IV 7 Hours	**Prevention & Healthy Living:** - Balanced diet and nutrition basics, Exercise and physical activity, Stress management (yoga, meditation), Preventive healthcare (screening, vaccination awareness), Daily habits for healthy life **Learning Activities:** *Prepare weekly diet plan, Interaction with health expert, Lifestyle improvement plan*	CLO3, CLO4

Suggested Readings:

1. World Health Organization. (2023). *Noncommunicable Diseases Progress Monitor 2023*. WHO.
2. GBD 2019 Diseases and Injuries Collaborators. (2020). Global burden of 369 diseases and injuries. *The Lancet*, 396(10258), 1204–1222
3. Attia, P., & Gifford, B. (2023). *Outlive: The Science and Art of Longevity*. Harmony Books.

Web resources:

https://doi.org/10.2174/97898152744311240101
https://hesperian.org/books-and-resources/
Book - Lifestyle Diseases in Adolescents: Diseases, Disorders, and Preventive Measures | Bentham Science
Public Health and Diseases: A Geographical Study of Women's Health, Urban Mortality and Health Policies | Springer Nature Link

Modes of transaction

-Lecture
-Brain storming
-Problem solving approach

Tools used

PPT, YouTube Video, Google meet, NPTEL

SEMESTER III

Course Code: MBCH.599-1
Course Title: Dissertation Part I
Total Hours: 600

Learning outcomes:

CLO1: Critically analyze, interpret, synthesize existing scientific knowledge based on literature review

CLO2: Demonstrate an understanding of the selected scientific problem and identify the knowledge gap

CLO3: Formulate a hypothesis and design an experimental/theoretical work

Students will prepare a research proposal based on literature review and extensive student-mentor interactions involving discussions, meetings and presentations. Each student will submit a research/dissertation proposal of the research work planned for the M.Sc. dissertation with origin of the research problem, literature review, hypothesis, objectives and methodology to carry out the planned research work, expected outcomes and bibliography.

Students will have an option to carry out dissertation work in industry, national institutes or Universities in the top 100 NIRF ranking. Group dissertation may be opted, with a group consisting of a maximum of four students. These students may work using a single approach or multidisciplinary approach. Research projects can be taken up in collaboration with industry or in a group from within the discipline or across the discipline.

Evaluation Criteria:

The evaluation of the dissertation proposal will carry 50% weightage by supervisor and 50% by HoD and senior-most faculty of the department.

Dissertation Proposal (Third Semester)		
	Marks	Evaluation
Supervisor	50	Dissertation proposal and presentation
HoD and senior-most faculty of the department	50	Dissertation proposal and presentation

Modes of transaction

Group discussions and presentations; Self-Learning; Experimentation

SEMESTER IV

L	T	P	Cr
0	0	40	20

Course Code: MBCH.599-2
Course Title: Dissertation Part II
Total Hours: 600

Learning outcomes:

CLO1: Demonstrate an in-depth knowledge of scientific research pertaining to the area of study

CLO2: Demonstrate experimental/theoretical research capabilities based on rigorous hands-on training

CLO3: Critically analyze, interpret and present the data in light of existing scientific knowledge to arrive at specific conclusions

CLO4: Develop higher order thinking skills required for pursuing higher studies (Ph.D.)/research-oriented career options

Students will carry out their research work under the supervision of a faculty member. Students will interact with the supervisors through meetings and presentations on a regular basis. After completion of the research work, students will complete the dissertation under the guidance of the supervisor. The dissertation will include literature review, hypothesis, objectives, methodology, results, discussion, and bibliography.