Post Graduate Curriculum Framework

With effect from the Academic Session 2026–27, the M.Sc. in Biochemistry programme in the Universities of Bihar shall be offered in accordance with the UGC Curriculum and Credit Framework for Postgraduate Programmes (PGCF) and the provisions of the National Education Policy (NEP), 2020.

The programme provides flexibility to students to pursue either a Two-Year Master's Degree Programme or a One-Year Master's Degree Programme for candidates who have completed a four-year undergraduate degree with the requisite credits and qualifications as prescribed by UGC.

The curriculum is designed under the Choice Based Credit System (CBCS) and comprises a combination of Core Courses (CCs), Discipline Specific Electives (DSEs), Generic Electives (GEs), Skill Enhancement Courses (SECs), Ability Enhancement Courses (AECs), and Value Added Courses (VACs). The programme seeks to impart advanced theoretical knowledge, computational proficiency, research aptitude, and practical skills in Statistics and its applications.

Each academic year shall consist of two semesters. Students shall be required to successfully complete the prescribed combination of Core, Elective (Discipline/Generic/Open), Skill Enhancement, Ability Enhancement, and Value Added Courses in each semester to fulfil the credit requirements of the programme.

The curriculum incorporates contemporary developments in Biochemistry, including proteomics, molecular biology, and enzymology, etc. The syllabus and reading materials shall be reviewed periodically to ensure alignment with emerging developments in academia, research, industry, and public policy.

Teaching-learning methodologies may include lectures, tutorials, seminars, laboratory sessions, statistical computing exercises, case studies, project work, field-based applications, and research assignments. Practical training shall provide hands-on experience with statistical software packages, data analysis techniques, computational tools, and real-world problem-solving.

Assessment shall be conducted through a combination of continuous evaluation and end-semester examinations, including assignments, presentations, practical examinations, projects, viva-voce examinations, and written tests, as prescribed by the authorities concerned from time to time.

Students shall have the opportunity to choose elective and generic courses in accordance with their academic interests, subject to the availability of courses and institutional regulations, thereby promoting interdisciplinary learning and specialization within the broad domain of Biochemistry.

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COURSE OF STUDIES

[NAME OF SUBJECT / PROGRAMME]

Programme Level	Master of Science (MSc)
Subject / Discipline	Biochemistry
Faculty	Faculty of Science
University	Universities of Bihar Established under the BSU AC 1976/PU Act 1976.
Duration	Two Years / Four Semesters
NHEQF Level	Level 6.5
Effective from	2026-27 onwards

A PART A — PROGRAMME OVERVIEW & OBJECTIVES

A.1 Graduate Attributes (GAs)

The programme nurtures the following Graduate Attributes in alignment with the National Higher Education Qualifications Framework (NHEQF) Level 6.5:

Graduate Attributes	Description
Core Knowledge in Biochemistry	Apply advanced knowledge of biomolecules, metabolism, cell biology, and molecular mechanisms to understand life processes at the biochemical level.
Analytical and Problem-Solving Skills	Analyze biochemical data and interpret experimental results to solve complex biological and clinical problems
Laboratory and Technical Competence	Demonstrate proficiency in modern biochemical techniques, including molecular biology methods, enzymology, and clinical diagnostic procedures using advanced instrumentation.
Communication and Scientific Reporting	Effectively communicate scientific concepts, prepare research reports, and present findings in oral and written forms.
Biochemical Analysis and Diagnostic Applications	Perform and interpret biochemical and clinical diagnostic tests relevant to healthcare, pathology laboratories, and medical research.
Research Orientation and Employability Skills	Develop strong research aptitude and technical competence to enhance employability in research institutions, laboratories, and higher education
Application in Applied Sciences	Apply biochemical principles in healthcare, agriculture, pharmaceuticals, biotechnology, and industrial processes.

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A.2 Programme Outcomes (POs)

PO code	Description
PO1	The M.Sc. Biochemistry programme trains skilled biochemists with strong theoretical and practical knowledge to apply biochemical principles in healthcare, industry, agriculture, and environmental management.
PO2	The programme develops practical and analytical skills through laboratory training in biochemical analysis, molecular biology, and diagnostic techniques, enhancing employability in pharmaceutical, biotechnology, clinical, and research sectors.
PO3	The programme prepares students to support sustainable development by applying biochemistry in environmental restoration, pollution control, waste treatment, biodegradation, and resource conservation.
PO4	Overall, the M.Sc. Biochemistry programme equips graduates with modern knowledge and skills to contribute effectively in biotechnology, pharmaceuticals, healthcare, environmental sciences, and research for human health and sustainable development.

A.3 Programme Specific Outcomes (PSOs)

Upon successful completion of this programme, a student shall demonstrate the following learning outcomes:

PSO code	Description
PSO1	Biochemistry underpins Botany, Zoology, Microbiology, and Biotechnology and supports Medical, Dental, Veterinary, and Agricultural sciences, giving M.Sc. Biochemistry graduates have broad interdisciplinary knowledge and diverse academic and industrial career opportunities.
PSO2	Students completing this programme will be well-prepared for teaching positions at various levels, such as Assistant Professor, Tutor, and Demonstrator in colleges and universities. They will also be eligible for higher academic roles after qualifying for competitive examinations.
PSO3	In today's science, biochemistry is central to life and medical research, making the M.Sc. Biochemistry graduates are highly valued for R&D roles across medical, pharmaceutical, agricultural, environmental, and biotechnology sectors.
PSO4	Students will develop the ability to design experiments, conduct laboratory investigations, and analyze and interpret biochemical data for solving problems in biological and allied sciences. This strengthens their research aptitude and analytical thinking.
PSO5	Graduates will also have opportunities to pursue higher studies (PhD) and competitive examinations such as CSIR-NET, GATE, ICMR, and other national-level tests that lead to careers in research and academia.
PSO6	M.Sc. Biochemistry graduates can work in the pharmaceutical, biotechnology, food processing, agriculture, aquaculture, environmental, and biofertilizer industries as Research Associates, Technical Assistants, Production Officers, and Quality Control Analysts, with additional opportunities in banking, KPO, and technical documentation.
PSO7	Entrepreneurial opportunities are also open for graduates, including establishing pathology laboratories, consultancy services, training centres, and biotechnology-based startups.
PSO8	Several multinational companies, such as Dr Reddy's Laboratories, Dabur, Hindustan Unilever, and Ranbaxy, as well as companies in the pharmaceutical, chemical, beverage, and textile industries, recruit biochemists not only for

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	research roles but also for marketing and product development.
PSO9	Students will also understand the importance of biochemical innovations in addressing challenges related to health, environment, agriculture, and sustainability, and contribute toward developing eco-friendly and sustainable solutions.
PSO10	In addition, global career opportunities are available in countries such as the USA, Canada, Germany, Australia, and others, where biochemistry is a rapidly growing field with strong demand for skilled professionals.

B PART B — COURSE STRUCTURE (CBCS/NHEQF FRAMEWORK)

B.1 Semester-wise Course Structure

The following table presents the full four-semester course structure. Column headings: L = **Lectures per week**; T = Tutorials per week; P = Practicals per week; CC = Core Course; DSE = Discipline Specific Elective; GE/OE = Generic/Open Elective; SEC = Skill Enhancement Course; PROJ = Project/Dissertation.

S.No.	Paper Code	Title of the Course/Paper	L	T	P	Credits	Max. Marks	Type
SEMESTER I								
1	**MSBCH-CC-101**	Core Course I :[Basic Chemical Biology]	3	1	0	4	100	CC
2	**MSBCH-CC-102**	Core Course II: [Cell Biology]	3	1	0	4	100	CC
3	**MSBCH-CC-103**	Core Course III: [Biophysical Techniques]	3	1	0	4	100	CC
4	**MSBCH-PC-104**	Core Course IV: [Practical-General Biochemistry]	0	0	4	4	100	CC
5	**GE-1**	Generic Elective I: [One course to be chosen from Basket I]	3	1	0	4	100	OE
6	**VAC/SEC**	VAC/AEC/SEC	2	0	0	2		VAC/AEC/SEC
		Total — Semester I	14	4	4	**22**	**500**	
SEMESTER II								
1	**MSBCH-CC-201**	Core Course I: [Enzymology]	3	1	0	4	100	CC
2	**MSBCH-CC-202**	Core Course II: [Biomolecules and Metabolism]	3	1	0	4	100	CC
3	**MSBCH-CC-203**	Core Course III: [Molecular Biology]	3	1	0	4	100	CC
4	**MSBCH-PC-204**	Core Course IV: [Practical-Enzymology & Biomolecules]	0	0	4	4	100	CC

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S.No.	Paper Code	Title of the Course/Paper	L	T	P	Credits	Max. Marks	Type
5	**GE 2**	Generic Elective II: [One course to be chosen from Basket II]	3	1	0	4	100	GE
6	**VAC/SEC**	VAC/AEC/SEC	2	0	0	2		VAC/AEC/SEC
		Total — Semester II	**14**	**4**	**4**	**22**	**500**	

Particulars	Semester	Course Code	Course Title
GE Basket I	I	**MSBCH-GE-105**	Plant Biochemistry
		MSBCH-GE-106	SWAYAM/MOOCs
GE Basket II	II	**MSBCH-GE-205**	Human Physiology and Biochemistry
		MSBCH-GE-206	Developmental Biology

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-CC-101
Title of the Paper	Core Course I: [Basic Chemical Biology]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester I
Nature of Course	Core Course (CC)
L – T – P	3 – 1 – 0
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	70	—	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	**—**	**30**	**100**
Passing Marks	**32**	**—**	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	The concept of chirality will help to understand organic molecules in the biological system
COB 2	Heterocyclic systems ensure the medicinal value to combat diseases
COB 3	The concept of coordination compounds facilitates the development of nature and the living system
COB 4	Bioenergetics will develop an understanding of energy change in living systems
COB 5	The concept of buffer will help to understand the action of a drug in the living system

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Students will be able to recall and explain the electronic structure of atoms and molecules, including bonding theories, hybridisation, and molecular properties influencing chemical behaviour.
CLO 2	Students will be able to identify and interpret types of organic reactions and isomerism, including structural, geometric, and optical isomerism, as they relate to biological systems.
CLO 3	Students will be able to apply the principles of thermodynamics to biological systems, including energy changes, entropy, and Gibbs free energy in living organisms.
CLO 4	Students will be able to analyse chemical equilibrium, pH, buffers, and reaction kinetics, and relate them to enzymatic and biochemical reaction rates.

C.5 Syllabus — Unit-wise Breakdown

Course Name: BASIC CHEMICAL BIOLOGY (MSBCH-CC-101)		
Unit	**Content**	**Suggested Lectures hours**
I	**BASIC CHEMISTRY I:** Basic principles of Valence Bond theory, Hybridisation, and Molecular orbital theory. Concepts of Ionisation Potential, Electron affinity, Electronegativity, Dipole moments, Hydrogen Bond, Vander waal's force. Resonance and its significance in explaining molecular stability and structure. Electronic displacement effects in organic molecules, including: Inductive effect, Mesomeric effect, Electronic effect, Inductomeric effect, Hyperconjugation, Steric effect.	8–10
II	**BASIC CHEMISTRY II:** Isomerism and Stereochemistry: Structural Isomerism and its various types, Stereoisomerism: Geometrical isomerism and E–Z nomenclature. Optical isomerism: optical activity and specific rotation. Concepts of chirality, chiral centre, enantiomers, diastereomers, and meso compounds. D–L and R–S nomenclature. Dihedral angles and their significance in molecular conformation.Overview of fundamental Organic Reactions: Substitution, addition, condensation and polymerisation. Heterocyclic Compounds: Structure, nomenclature, and biological significance of heterocyclic systems occurring in living organisms, including: Pyrimidine, Purine, Quinone, Pyridine, Piperidine.	8–10
III	**CO-ORDINATION AND RADIOCHEMISTRY:** Fundamentals of coordination compounds. Valence Bond Theory (VBT) and Molecular Orbital Theory (MOT) applied to coordination complexes. Biological importance of coordination compounds, with special reference to metalloenzymes, haemoglobin, and Chlorophyll. Nature and characteristics of radioactivity. Properties of α (alpha), β (beta), and γ (gamma) radiations. Applications of radioactivity in scientific research and related fields.	8–10
IV	**THERMODYNAMICS IN BIOLOGICAL SYSTEMS:** Scope and significance of thermodynamics in biology, System, surroundings, boundaries, and state functions, Intensive and extensive properties, Thermodynamic equilibrium, First Law of	8–10

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	Thermodynamics, Internal energy, work, and heat, Enthalpy and biological heat production, Thermochemistry of biochemical reactions, Entropy and spontaneity, Entropy changes in biological processes, Gibbs free energy and Helmholtz free energy, Criteria for equilibrium, Chemical potential, Third Law of Thermodynamics, Free-energy transduction in living systems, Coupled reactions, Oxidation-reduction reactions, Protein folding and stability, Membrane thermodynamics	
V	**WATER AND KINETICS IN BIOLOGICAL SYSTEMS** Physical properties and structure of water; ionisation of water; pH scale; acids and bases; buffers; Henderson equation; titration curve; buffer solutions and their action. Kinetics of zero and first order reaction, methods for measuring Kinetic and rate constants of enzymic reactions & their magnitude	8–10
	Total Suggested Lectures	**60 (For 4 Credit Course)**
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

C.6 Prescribed Textbooks

1. Atkins, P., & de Paula, J. (2018). Physical Chemistry (11th ed.). Oxford University Press.
2. Clayden, J., Greeves, N., Warren, S., & Wothers, P. (2012). Organic Chemistry (2nd ed.). Oxford University Press.
3. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W.H. Freeman and Company.

C.7 Reference Books & Readings

1. Miessler, G. L., Fischer, P. J., & Tarr, D. A. (2014). Inorganic Chemistry (5th ed.). Pearson Education.
2. Cornish-Bowden, A. (2013). Fundamentals of Enzyme Kinetics (4th ed.). Wiley-Blackwell.
3. Arnikar, H. J. (2014). Essentials of Nuclear Chemistry (4th ed.). New Age International Publishers.

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM: https://swayam.gov.in/
- NPTEL (Chemistry, Biochemistry, Thermodynamics, Organic Chemistry Courses): https://nptel.ac.in/courses
- e-PG Pathshala (Chemistry and Life Sciences): https://epgp.inflibnet.ac.in/e-PG Pathshala.

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-CC-102
Title of the Paper	Core Course II: [CELL BIOLOGY]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester I
Nature of Course	Core Course (CC)
L – T – P	3 – 1 – 0
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	70	—	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	**—**	**30**	**100**
Passing Marks	**32**	**—**	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	Identify the structure and function of major cell organelles
COB 2	Define the importance of cell cycle regulation and checkpoints.
COB 3	Gain a comprehensive understanding of cellular organization and function.
COB 4	Learn the molecular basis of human diseases, particularly cancer.
COB 5	Build a strong foundation for careers and research in biotechnology, genetics, molecular biology, medicine, and biomedical sciences.

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to recall and describe the structure, organisation, and functions of prokaryotic and eukaryotic cells, including major cellular organelles and their roles in cellular activities.
CLO 2	Students will be able to explain the cell cycle, mitosis, and meiosis, and analyse the mechanisms regulating cell growth, division, and inheritance.
CLO 3	Students will be able to interpret the principles of cell communication and signal transduction, including receptor-mediated signalling, cell adhesion, and intercellular communication mechanisms.
CLO 4	Students will be able to analyze the molecular basis of cancer development and apoptosis, including the roles of oncogenes, tumour suppressor genes, carcinogens, and therapeutic approaches.

C.5 Syllabus — Unit-wise Breakdown

Course Name: MICROECONOMICS (MAECO-CC101)		
Unit	**Content**	**Suggested Lectures hours**
I	**Cell: Structure and Functions of Cell Organelles:** Eukaryotic and prokaryotic cells, Cell wall, nucleus, mitochondria, ribosome, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	8–10
II	**CELL CYCLE:** Historical development of cell cycle research, Overview of prokaryotic and eukaryotic cell cycles, Cell cycle phases: G1, S, G2, and M, Cell growth, division, and homeostasis, Quiescence (G0 phase), Cell cycle commitment and restriction point, Methods for studying the cell cycle, Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.	8–10
III	**MEMBRANE BIOLOGY:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes (membrane potential), transport of macromolecules across plasma membrane.	8–10
IV	**CELL COMMUNICATION AND SIGNALING:** Cell communication: general principles of cell communication, cell adhesion and roles of different adhesion molecules, cell junction/gap junctions, extracellular matrix, integrins. Signal transduction: Cell surface receptor, G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, bacterial chemotaxis and quorum sensing.	8–10
V	**CANCER BIOLOGY** Biochemistry of cancer cells, concept of proto-oncogenes and tumour suppressor genes. Microenvironment of a cancer cell, cancer as a multistep process. Role of carcinogens, Treatment of cancer,	8–10

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	Apoptosis	
	Total Suggested Lectures	**60 (For 4 Credit Course)**
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

C.6 Prescribed Textbooks

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). Molecular Biology of the Cell (7th ed.). Garland Science.

2. Karp, G. (2019). Cell and Molecular Biology: Concepts and Experiments (9th ed.). Wiley.

3. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). Molecular Cell Biology (9th ed.). W.H. Freeman and Company.

C.7 Reference Books & Readings

1. Cooper, G. M., & Hausman, R. E. (2018). The Cell: A Molecular Approach (8th ed.). Sinauer Associates.

2. Hanahan, D., & Weinberg, R. A. (2011). Hallmarks of Cancer: The Next Generation. Cell, 144(5), 646–674.

3. Weinberg, R. A. (2023). The Biology of Cancer (3rd ed.). W.W. Norton & Company.

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM: https://swayam.gov.in/
- NPTEL – Cell Biology: https://nptel.ac.in/courses
- NPTEL – Molecular Biology and Cell Signaling: https://nptel.ac.in/
- e-PG Pathshala (Cell Biology & Molecular Biology): https://epgp.inflibnet.ac.in/

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-CC-103
Title of the Paper	Core Course III: [BIOPHYSICAL TECHNIQUES]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester I
Nature of Course	Core Course (CC)
L – T – P	3 – 1 – 0
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	70	—	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	**—**	**30**	**100**
Passing Marks	**32**	**—**	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	Develop practical knowledge of essential biochemical and biophysical techniques
COB 2	Knowledge of Chromatography and electrophoresis will help separate biomolecules.
COB 3	Learn how to use staining techniques to visualise and study cells and organelles at the micro- and nanoscale.
COB 4	Histochemical and immunotechniques help in studying gene expression, protein localization, and cell behaviour
COB 5	Build a strong foundation for careers in biotechnology and molecular biology

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to apply the principles of centrifugation, chromatographic techniques and electrophoresis for the separation, purification, and characterization of biomolecules and cellular components.
CLO 2	Students will be able to interpret the principles and applications of spectroscopic methods for qualitative and quantitative analysis, as well as for the structural characterisation of biomolecules.
CLO 3	Students will be able to demonstrate knowledge of microscopy and fluorimetry techniques for visualization, imaging, and analysis of cells, organelles, and biological processes
CLO 4	Students will be able to employ immunological and histochemical techniques for the detection, localization, identification, and quantification of biomolecules in biological samples

C.5 Syllabus — Unit-wise Breakdown

Course Name: BIOPHYSICAL TECHNIQUES (MSBCH-CC-103)		
Unit	**Content**	**Suggested Lectures hours**
I	**CENTRIFUGATION AND ELECTROPHORESIS:** Centrifugation: Principles of sedimentation and centrifugal force, Relative Centrifugal Force (RCF) and sedimentation coefficient, Sedimentation behaviour of macromolecules, Types of centrifuges and rotor systems, Differential centrifugation, Density-gradient centrifugation (rate-zonal and isopycnic), Analytical ultracentrifugation and sedimentation equilibrium, Determination of molecular weight, shape, and hydrodynamic properties of biomolecules, Subcellular fractionation and organelle isolation, Applications in proteomics, genomics, and nanobiotechnology. Electrophoretic techniques: Principles of electrophoretic mobility, Factors affecting electrophoretic separation, Continuous and zonal electrophoresis, Capillary electrophoresis, Paper and cellulose acetate electrophoresis, Polyacrylamide gel electrophoresis (Native PAGE and SDS-PAGE), Agarose gel electrophoresis, Pulsed-field gel electrophoresis (PFGE), Two-dimensional gel electrophoresis (2D-PAGE), Isoelectric focusing (IEF), Applications in protein, nucleic acid, and biomarker analysis.	8–10
II	**CHROMATOGRAPHY:** Fundamentals of Chromatography: Principles of chromatographic separation, Partition coefficient and retention mechanisms, Resolution, selectivity, and efficiency Chromatographic Methods: Paper chromatography, Thin-layer chromatography (TLC), Adsorption chromatography, Ion-exchange chromatography, Gel filtration (size exclusion) chromatography, Affinity chromatography, Hydrophobic interaction chromatography, Reverse-phase chromatography, Gas-liquid chromatography (GLC), High-performance liquid chromatography (HPLC), Fast protein liquid chromatography (FPLC), Ultra-performance liquid chromatography	8–10

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	(UPLC) Applications: Protein purification strategies, Peptide and metabolite separation, Coupling chromatography with mass spectrometry (LC-MS/MS), Applications in proteomics, metabolomics, and pharmaceutical analysis	
III	**SPECTROSCOPY:** Spectroscopic Principles: Electromagnetic spectrum and interaction of radiation with matter, Laws of photometry, Beer-Lambert law and quantitative analysis Spectroscopic Techniques: Colorimetry and spectrophotometry, UV-Visible spectroscopy, Infrared (IR) spectroscopy, Fluorescence spectroscopy, Raman spectroscopy, Circular Dichroism (CD), Optical Rotatory Dispersion (ORD). Advanced Structural Techniques: Nuclear Magnetic Resonance (NMR) spectroscopy, One-dimensional and multidimensional NMR, X-ray diffraction and crystallography, Mass spectrometry, Ionization techniques (ESI, MALDI), Mass analyzers, Tandem mass spectrometry (MS/MS).	8–10
IV	**MICROSCOPY AND FLOURIMETRY:** Microscopy: Principles of image formation and resolution, Light microscopy, Phase-contrast microscopy, Differential Interference Contrast (DIC) microscopy, Fluorescence microscopy, Confocal laser scanning microscopy, Electron microscopy: Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM). Super-resolution microscopy (STED, PALM, STORM), Specific staining methods for cells and organelles Fluorimetry: Principles of fluorescence and phosphorescence, Intrinsic and extrinsic fluorescence probes, Fluorescence quenching and energy transfer, Fluorescence Resonance Energy Transfer (FRET), Cellular localization studies	8–10
V	**HISTOCHEMICAL AND IMMUNOTECHNIQUES** Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH, FRAP and GISH.	8–10
	Total Suggested Lectures	**60 (For 4 Credit Course)**
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

C.6 Prescribed Textbooks

1. Wilson, K., & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press.

2. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W.H. Freeman and Company.

3. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of Instrumental Analysis (7th ed.). Cengage Learning.

C.7 Reference Books & Readings

1. Freifelder, D. (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology (2nd ed.). W.H. Freeman and Company.

2. Towbin, H., Staehelin, T., & Gordon, J. (1979). Electrophoretic Transfer of Proteins from Polyacrylamide Gels to Nitrocellulose Sheets: Procedure and Some Applications. Proceedings of the National Academy of Sciences, 76(9), 4350–4354.

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3. Lakowicz, J. R. (2006). Principles of Fluorescence Spectroscopy (3rd ed.). Springer Science + Business Media.

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM: https://swayam.gov.in/
- NPTEL – Biochemical Engineering and Biotechnology Courses: https://nptel.ac.in/courses
- NPTEL – Biophysical Techniques and Instrumentation: https://nptel.ac.in/courses
- e-PG Pathshala (Biochemistry, Biotechnology and Life Sciences): https://epgp.inflibnet.ac.in/NPTEL – Cell Biology: https://nptel.ac.in/courses

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-PC-104
Title of the Paper	Core Course IV: [[Practical-General Biochemistry]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester I
Nature of Course	Practical Course (PC)
L – T – P	0 – 0 – 4
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	—	70	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	—	**30**	**100**
Passing Marks	**32**	—	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	The Basic Principles of various instruments necessary for experiments and research.
COB 2	The concept of buffer will help to understand the action of a drug in the living system
COB 3	Develop analytical and separation skills used in biotechnology and research
COB 4	Build a practical foundation for careers in biotechnology, biochemistry, food technology, clinical laboratories, and research
COB 5	Apply science to health and nutrition awareness

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to gain hands-on experience with common laboratory instruments and techniques
CLO 2	Students will be able to prepare standard and buffer solutions, measure pH, and perform various acid-base titrations to analyze chemical properties of biological samples
CLO 3	Students will be able to detect common food adulterants using qualitative biochemical tests and assess food quality and safety.
CLO 4	Students will be able to apply paper chromatography techniques to separate and identify sugars and amino acids.

C.5 Syllabus — Unit-wise Breakdown

Course Name: PRACTICAL-GENERAL BIOCHEMISTRY (MSBCH-CC-104)		
Unit	**Content**	**Suggested Lectures hours**
I	**INTRODUCTION TO INSTRUMENTATION:** Introduction to laboratory safety precautions: personal hygiene, Glassware, Instruments, etc. (Centrifuge, pH meter, Colorimeter, Spectrophotometer, UV & VIS Spectrophotometer, Flame Photometer, Ultra Centrifuge, Electronic Balance, Chemical Analyzer, and ELISA Reader). Verification of Beer-Lambert's Law.	30
II	**GENERAL CHEMISTRY:** a) Preparation of Standard Solution and Buffer Solution b) Determination of pH of the given sample. c) Titration of a mixture of a strong and weak acid d) Titration of a strong acid with a strong base e) Titration of a weak acid with a strong base f) Titration of a polybasic acid with a strong base g) Titration of an amino acid (Neutral) with a strong base and acid	30
III	**IDENTIFICATION OF FOOD ADULTERANTS:** a) Test for dilution of milk with water b) Test for starch in milk or milk products c) Test for Argemone oil in Mustard oil d) Test for common sugar in honey e) Test for khesari Dal in Besan of other Dal f) Test for coloured saw in turmeric powder	30
IV	**BIOTECHNIQUES:** Separation of sugars and amino acids using Paper chromatography	20
V	**CHEMICAL ANALYSIS** a) Detection of vitamin C in fruit juices. b) Chemical Analysis of Milk	10
	Total Suggested Lectures	**60 (For 4 Credit Course)**
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

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C.6 Prescribed Textbooks

1. Plummer, D. T. (2001). An Introduction to Practical Biochemistry (5th ed.). Tata McGraw-Hill Publishing Company Ltd.

2. Wilson, K., & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press.

3. Jayaraman, J. (2011). Laboratory Manual in Biochemistry. New Age International Publishers.

C.7 Reference Books & Readings

1. Sadasivam, S., & Manickam, A. (2008). Biochemical Methods (3rd ed.). New Age International Publishers.

2. Lowry, O. H., Rosebrough, N. J., Farr, A. L., & Randall, R. J. (1951). Protein Measurement with the Folin Phenol Reagent. Journal of Biological Chemistry, 193(1), 265–275.

3. Sawhney, S. K., & Singh, R. (2005). Introductory Practical Biochemistry. Narosa Publishing House.

C.8 Suggested E-Resources / Digital Repositories

- SWAYAM (Biochemistry and Laboratory Techniques Courses): https://swayam.gov.in/
- NPTEL – Biochemistry and Experimental Biology Courses: https://nptel.ac.in/courses
- Virtual Labs (Biochemistry and Biotechnology Experiments): https://www.vlab.co.in/
- e-PG Pathshala (Biochemistry Practical Modules): https://epgp.inflibnet.ac.in/NPTEL – Biochemical Engineering and Biotechnology Courses: https://nptel.ac.in/courses

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-GE-105
Title of the Paper	Generic Elective: [PLANT BIOCHEMISTRY]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester I
Nature of Course	Generic Elective (GE)
L – T – P	3 – 1 – 0
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	70	—	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	—	**30**	**100**
Passing Marks	**32**	—	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	How plants acquire and use the energy and material resources needed to complete their life cycles
COB 2	The general process of photosynthesis in all the plants on the earth is known as efficient plant, as higher photosynthesis leads to higher productivity
COB 3	Develop skills in plant tissue culture and genetic improvement of crops.
COB 4	The concept of environmental biology (especially different types of pollution) makes them aware of the environmental issues.
COB 5	Build a strong foundation for careers in plant biotechnology, agriculture, environmental science, and research

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to explain the mechanisms of water, mineral, and solute transport in plants, including translocation through the xylem and phloem, as well as transpiration.
CLO 2	Students will be able to describe the biochemical pathways of photosynthesis, respiration, nitrogen assimilation, and amino acid biosynthesis, and their significance in plant growth and productivity.
CLO 3	Students will be able to know the role of plant hormones and bioactive compounds in agriculture and industry.
CLO 4	Students will be able to apply the principles and techniques of plant tissue culture, including micropropagation, protoplast culture, genetic transformation, and production of transgenic plants.

C.5 Syllabus — Unit-wise Breakdown

Course Name: PLANT BIOCHEMISTRY (MSBCH-CC-105)		
Unit	**Content**	**Suggested Lectures hours**
I	**SOLUTE TRANSPORT AND PHOTOASSIMILATION TRANSLOCATION:** Uptake, transport and translocation of water, solutes and macromolecules in plants from the soil through the xylem. Process and significance of transpiration in water movement and plant physiology. Mechanisms involved in the loading and unloading of photo-assimilates in the phloem.	8–10
II	**PHOTOSYNTHESIS AND NITROGEN FIXATION:** Structure and function of light-harvesting complexes. Mechanisms of carbon dioxide (CO_2) fixation through the C_3, C_4, and CAM pathways. Photorespiration and its significance in plant metabolism. plant mitochondrial electron transport and ATP synthesis. Nitrate and ammonium assimilation: significance.	8–10
III	**PLANT HORMONES & SECONDARY METABOLISM AND METABOLITES:** Biosynthesis of terpenes, phenols, nitrogenous compounds and their roles. Isolation, Characterization, Classification and Commercialization. Hormones: Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.	8–10
IV	**PLANT TISSUE CULTURE:** Micropropagation, somatic cell culture, somaclonal variations, somatic cell hybridization, protoplast isolation and fusion, protoplast culture, genetic transformation, production of transgenic plants, production of secondary metabolites, primary & transferred cell-culture, differentiated cells in culture, applications.	8–10
V	**ENVIRONMENTAL BIOCHEMISTRY:** Air pollution: Particulate matter, compounds of carbon, sulphur, nitrogen and their interactions, methods of their estimation, their effect on the atmosphere. Water pollution: Types of water bodies and their general	8–10

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	characteristics, major pollutants in domestic, agricultural and industrial wastes, methods of their estimation, effects of pollutants on plants and animals, a brief account on treatment and management of domestic waste, industrial wastes and solid wastes.	
	Total Suggested Lectures	**60 (For 4 Credit Course)**
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

C.6 Prescribed Textbooks

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2022). Plant Physiology and Development (7th ed.). Oxford University Press.

2. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry and Molecular Biology of Plants (2nd ed.). Wiley Blackwell.

3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: The Genetic Manipulation of Plants (2nd ed.). Oxford University Press.

C.7 Reference Books & Readings

1. Hopkins, W. G., & Hüner, N. P. A. (2008). Introduction to Plant Physiology (4th ed.). John Wiley & Sons.

2. Murashige, T., & Skoog, F. (1962). A Revised Medium for Rapid Growth and Bio Assays with Tobacco Tissue Cultures. Physiologia Plantarum, 15(3), 473–497.

3. Heldt, H. W., & Piechulla, B. (2021). Plant Biochemistry (5th ed.). Academic Press.

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM (Plant Physiology, Plant Biotechnology and Environmental Science Courses): https://swayam.gov.in/
- NPTEL – Plant Physiology: https://nptel.ac.in/courses
- NPTEL – Plant Biotechnology: https://nptel.ac.in/courses
- NPTEL – Environmental Biotechnology and Environmental Engineering: https://nptel.ac.in/courses
- e-PG Pathshala (Botany, Plant Sciences and Environmental Sciences): https://epgp.inflibnet.ac.in/NPTEL (Chemistry, Biochemistry, Thermodynamics, Organic Chemistry Courses): https://nptel.ac.in/courses

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-CC-201
Title of the Paper	Core Course I: [Enzymology]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester II
Nature of Course	Core Course (CC)
L – T – P	3 – 1 – 0
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	70	—	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	**—**	**30**	**100**
Passing Marks	**32**	**—**	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	The importance of enzymes and enzyme-catalyzed reactions
COB 2	The mechanism and regulation of various biochemical reactions taking place in living systems.
COB 3	Learn the role of coenzymes, multienzyme complexes, and enzyme inhibitors in cellular processes
COB 4	Understand the industrial, medical, pharmaceutical, and biotechnological applications of enzymes.
COB 5	Build a strong foundation for advanced studies in biochemistry and molecular biology.

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to explain the classification, structure, properties, and biological significance of enzymes, including the relationship between enzyme structure and function.
CLO 2	Students will be able to analyze the organization, function, and regulation of multi-enzyme systems, and evaluate their applications in biotechnology and industrial processes.
CLO 3	Students will be able to apply the principles of enzyme kinetics to determine kinetic parameters, interpret reaction mechanisms, and assess factors influencing enzyme activity.
CLO 4	Students will be able to evaluate various enzyme regulatory mechanisms, including allosteric regulation, feedback control, covalent modification, enzyme inhibition, and protein–ligand interactions.

C.5 Syllabus — Unit-wise Breakdown

Course Name: ENZYMOLOGY (MSBCH-CC-201)		
Unit	**Content**	**Suggested Lectures hours**
I	**ENZYMES: GENERAL ACCOUNT:** Nomenclature and Classification of Enzymes. Characteristics and properties of enzymes. Three-dimensional structure of enzymes and the relationship between structure and function, with special reference to Ribonuclease (RNase). Biological roles and significance of enzymes with reference to Isoenzymes and Allosteric enzymes.	8–10
II	**MECHANISM OF ENZYME ACTION:** Principles and mechanisms of enzyme catalysis, including: Acid–base catalysis, Covalent catalysis, Proximity and orientation effects, Strain and distortion theory of enzymatic catalysis. Water-soluble vitamins as precursors of coenzymes and their roles in enzymatic reactions. Mechanism of catalysis of serine proteases and Ribonuclease.	8–10
III	**MULTI-ENZYME SYSTEM: STRUCTURE AND DYNAMICS:** Occurrence and general properties of multienzyme systems. Structural organization and functional significance of multienzyme complexes. Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthase complex. Advantages of substrate channelling and metabolic efficiency in multienzyme complexes. Immobilized multi-enzyme system and its industrial, biomedical, and biotechnological applications.	8–10
IV	**ENZYME KINETICS:** Fundamentals of Enzyme Kinetics: Enzyme-substrate complex, Active site and catalytic turnover, Steady-state assumptions, Derivation of Michaelis-Menten equation, Significance of Km, Vmax, kcat and catalytic efficiency Kinetic Analysis: Lineweaver-Burk plot, Eadie-Hofstee plot, Hanes-Woolf plot, Direct linear plot Limitations of linear transformations Factors Affecting Enzyme Activity: Temperature, pH, Ionic strength, Substrate concentration, Enzyme concentration. Multi-substrate Reactions: Sequential reactions: Ordered Bi-Bi mechanism, Random Bi-Bi mechanism, Ping-Pong mechanism,	8–10

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	Derivation of rate equations, Initial velocity studies, Product inhibition studies, Isotope exchange experiments	
V	**ENZYME REGULATION** General mechanism of enzyme regulation, Reversible and irreversible covalent modification of enzymes, Monocyclic and Multicyclic cascade system with specific examples. Feedback inhibition and feed-forward stimulation, Enzyme repression, induction and degradation. Allosteric enzymes, concerted/symmetric and sequential model for their action and significance. Competitive, non-competitive, uncompetitive, linear mixed-type inhibition and their kinetics. Suicide inhibitor. Protein-ligand binding measurement, analysis of the binding isotherm. Co-operativity phenomenon with special reference to aspartate transcarbamoylase & phosphofructo kinase, Hill & Scatchard plot.	8–10
	Total Suggested Lectures	**60 (For 4 Credit Course)**
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

C.6 Prescribed Textbooks

1. Cornish-Bowden, A. (2012). Fundamentals of Enzyme Kinetics (4th ed.). Wiley-Blackwell.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2019). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). Wiley.
3. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W.H. Freeman and Company.

C.7 Reference Books & Readings

1. Copeland, R. A. (2000). Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis (2nd ed.). Wiley-VCH.
2. Koshland, D. E., Némethy, G., & Filmer, D. (1966). Comparison of Experimental Binding Data and Theoretical Models in Proteins Containing Subunits. Biochemistry, 5(1), 365–385.
3. Fersht, A. (1999). Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding. W.H. Freeman and Company.

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM (Biochemistry and Enzymology Courses): https://swayam.gov.in/
- NPTEL – Enzyme Science and Technology: https://nptel.ac.in/courses
- NPTEL – Biochemistry: https://nptel.ac.in/courses
- e-PG Pathshala (Biochemistry and Enzymology Modules): https://epgp.inflibnet.ac.in/

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-CC-202
Title of the Paper	Core Course II: [Biomolecules and Metabolism]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester II
Nature of Course	Core Course (CC)
L – T – P	3 – 1 – 0
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	70	—	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	**—**	**30**	**100**
Passing Marks	**32**	**—**	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	Explain the structure, classification, and chemical properties of carbohydrates, amino acids, proteins, and lipids
COB 2	Describe and analyze major metabolic pathways such as glycolysis, TCA cycle, amino acid and lipid metabolism
COB 3	Develop the ability to relate molecular structure to biological function.
COB 4	Gain a strong foundation in the chemistry and metabolism of biomolecules
COB 5	Interpret energy production processes, including bioenergetics and oxidative phosphorylation.

C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to analyze the major metabolic pathways of carbohydrates, amino acids, and lipids, and their regulation in living systems.
CLO 2	Students will be able to describe the relationship between biomolecular structure and

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	function, including protein folding, stability, conformational changes, and associated disorders.
CLO 3	Students will be able to interpret the mechanisms of energy production, storage, and utilization, including cellular respiration, oxidative phosphorylation, and ATP synthesis
CLO 4	Students will be able to evaluate the role of biomolecules in metabolic homeostasis, physiological regulation, and disease conditions.

C.5 Syllabus — Unit-wise Breakdown

Course Name: BIOMOLECULES AND METABOLISM (MSBCH-CC-202)		
Unit	**Content**	**Suggested Lectures hours**
I	**CARBOHYDRATES:** Structure: Classification, Structure, General Properties and function of Monosaccharides, Polysaccharides and complex carbohydrate (Amino sugar, proteoglycans and glycoprotein), Stereoisomerism and optical isomerism of sugar, reactions of aldehyde and ketone groups, ring structure and anomeric forms, mutarotation, reaction of sugar due to hydroxyl group. Metabolism: Glycolysis, TCA cycle, Alternate pathways of carbohydrate metabolism (Gluconeogenesis, Glyoxalate cycle, pentose phosphate pathway, biosynthesis of starch and cellulose, glycogen metabolism); Regulation of Blood glucose, Homeostasis, hormonal regulation of carbohydrate metabolism.	8–10
II	**AMINO ACIDS:** Structure, Properties and Classification: Occurrence and biological significance of amino acids, Chemical structure and stereochemistry of amino acids. Classification based on: Polarity and charge, Side-chain properties, Nutritional requirements, Metabolic fate (glucogenic and ketogenic amino acids). Chemical Properties: Acid-base properties and zwitterionic nature, Isoelectric point (pI) and buffering action, Reactions of amino and carboxyl groups, Reactions of side-chain functional groups. Optical isomerism and chirality. Non-protein amino acids and biologically active derivatives. Amino Acid Metabolism: Biosynthesis: Biosynthetic pathways of essential amino acids, Amino acid families and metabolic precursors, Regulation of amino acid biosynthesis. Catabolism: General pathways of amino acid degradation, Transamination and oxidative deamination, Fate of carbon skeletons, Glucogenic and ketogenic pathways, Metabolic integration with TCA cycle and energy metabolism, Ammonia generation and detoxification, Nitrogen balance.	8–10
III	**PROTEINS:** Structure and Organization: Primary Structure: Peptide bond formation and properties, Peptide conformation, Determination of N-terminal and C-terminal residues, Methods of peptide cleavage. Sequence determination strategies. Secondary Structure: α-Helix, β-Pleated sheet, β-Turns and loops, Random coil structures, Ramachandran plot and conformational constraints. Tertiary Structure: Forces stabilizing protein structure, Hydrogen bonding, Hydrophobic interactions, Ionic interactions, van der Waals forces, Disulfide bonds, Protein domains and motifs, Globular and fibrous proteins. Quaternary Structure: Oligomeric proteins, Symmetry and	8–10

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	subunit interactions, Structure-function relationships, Haemoglobin as a model oligomeric protein. Protein Folding and Dynamics: Thermodynamics and kinetics of protein folding, Levinthal's paradox, Protein folding pathways, Molten globule state, Protein conformational dynamics. Protein misfolding and aggregation: Molecular Chaperones, Chaperone-assisted protein folding, Heat Shock Proteins (HSPs), Chaperonins and protein quality control. Protein Conformational Disorders: Prions and prion diseases, Amyloid formation, Alzheimer's disease, Parkinson's disease, Protein Turnover and Degradation, Protein homeostasis (proteostasis). Protein Analysis and Sequencing: Classical Methods, Edman degradation, Sanger's method, Peptide mapping, Mass spectrometry-based protein sequencing	
IV	**LIPIDS:** Structure: Introduction, Classification, Nomenclature, Structure and Properties of Saturated and Unsaturated fatty acids Triacyl glycerol: Nomenclature and properties Characterization of fat hydrolysis, saponification value, rancidity of fats, Reichert-Meissel number and reaction of glycerol. Properties and Functions of Glycerophospholipids (lecithins, lysolecithins, cephalins, phosphatidyl serine, phosphatidyl inositol, plasmalogens), Sphingomyelins, Glycolipids (cerebrosides and Gangliosides), Phospholipid, Isoprenoids and Sterols. Metabolism: Acetyl CoA carboxylase, Fatty acid synthase, desaturase and elongase. Fatty acid oxidation:a, b, ω oxidation and lipo-oxidation. Lipid Biosynthesis: Biosynthesis of triacyglycerols, phosphoglycerides and sphingolipids, Biosynthetic pathways for terpenes, steroids and prostaglandins. Ketone bodies: Formation and utilization. Metabolism of circulating lipids: chylomicrons, LDL, HDL and VLDL. Free fatty acids. Lipid levels in pathological conditions.	8–10
V	**BIOENERGETICS:** Introduction: Energy transformation, Biological oxidations, Oxygenases, hydroxylases, dehydrogenases, free energy on hydrolysis of ATP, standard free energy change of ATP hydrolysis, electrochemical potential, photons energy inter conversions, ionophores and shuttle systems. Phosphorylation: The mitochondrial respiratory chain- order and organization of carriers. The Q cycle, chemiosmotic theory and oxidative phosphorylation, P/O and H/P ratios, respiratory quotient, uncouplers and inhibitors of electron transport chain. Fractionation and reconstitution of respiratory chain complexes and ATP – synthase complex.	8–10
	Total Suggested Lectures	**60 (For 4 Credit Course)**
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

C.6 Prescribed Textbooks

1. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W.H. Freeman and Company.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2019). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). Wiley.
3. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). Biochemistry (9th ed.). W.H. Freeman and Company.

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C.7 Reference Books & Readings

1. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). Molecular Cell Biology (9th ed.). W.H. Freeman and Company.

2. Anfinsen, C. B. (1973). Principles that Govern the Folding of Protein Chains. Science, 181(4096), 223–230.

3. Garrett, R. H., & Grisham, C. M. (2023). Biochemistry (7th ed.). Cengage Learning.

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM (Biochemistry and Metabolism Courses): https://swayam.gov.in/
- NPTEL – Biochemistry: https://nptel.ac.in/courses
- NPTEL – Metabolic Engineering and Systems Biology: https://nptel.ac.in/courses
- e-PG Pathshala (Biochemistry Modules): https://epgp.inflibnet.ac.in/NPTEL – Enzyme Science and Technology: https://nptel.ac.in/courses

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-CC-203
Title of the Paper	Core Course III: [Molecular Biology]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester II
Nature of Course	Core Course (CC)
L – T – P	3 – 1 – 0
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	70	—	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	**—**	**30**	**100**
Passing Marks	**32**	**—**	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	Describe the structure, types, and properties of DNA and RNA, along with their biological significance.
COB 2	Analyse the process of protein synthesis, including the genetic code, translation, and associated factors.
COB 3	Interpret the mechanisms of gene regulation in prokaryotes and eukaryotes, including operon models and chromatin modification.
COB 4	Acquire essential concepts required for research in life sciences, biomedical sciences, and genetic engineering.
COB 5	Gain knowledge of the molecular basis of genetic disorders, mutations, and modern biotechnological applications.

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to explain the structure, properties, and biological functions of DNA and RNA, including nucleic acid organisation and nucleotide metabolism.
CLO 2	Students will be able to interpret the principles of the genetic code and protein synthesis, including the molecular machinery involved in translation.
CLO 3	Students will be able to evaluate the mechanisms that regulate gene expression at the transcriptional, translational, and post-translational levels in both prokaryotes and eukaryotes.
CLO 4	Students will be able to learn how genetic information is regulated and expressed in living organisms

C.5 Syllabus — Unit-wise Breakdown

Course Name: MOLECULAR BIOLOGY (MSBCH-CC-203)		
Unit	**Content**	**Suggested Lectures hours**
I	**INTRODUCTION TO NUCLEIC ACID:** DNA: Structure, physical and chemical properties, DNA topology (Supercoil forms of DNA, Linking number, etc.), Types of DNA -A, B, Z, forms of DNA, Satellite DNA, Centromeric DNA. RNA: Structure, physical and chemical properties of RNA and types (mRNA, tRNA, rRNA, hnRNA, snRNA). Biosynthesis, Degradation and Regulation of Purines and Pyrimidines.	8–10
II	**REPLICATION:** DNA replication: Semi-conservative nature of replication, Replication fork and the origin of replication. DNA polymerases and other enzymes involved in replication. Mechanism, regulation and inhibitors of replication DNA Repair: Mechanisms of DNA repair.	8–10
III	**TRANSCRIPTION:** Transcription in prokaryotes and eukaryotes. RNA polymerase, promoters, initiation, elongation, and termination of RNA synthesis, inhibitors of transcription, post-transcriptional RNA processing in eukaryotes, RNA editing, RNA interference.	8–10
IV	**PROTEIN SYNTHESIS:** Genetic code: Basic features, biological significance of degeneracy, Wobble hypothesis and overlapping genes. Translation: Ribosome structure, A and P sites, charged tRNA, f-met-tRNA, initiator codon, Shine-Dalgarno sequence, Formation of 70S initiation complex. Role of initiation factors, elongation factors, and termination factors; inhibitors of protein synthesis.	8–10
V	**GENE REGULATION:** Regulation of gene expression in prokaryotes and eukaryotes: Operon concept, Lac operon, Trp operon, transcriptional-level control, translational-level control, and post-translational-level control of gene expression. Role of chromatin modifications in gene regulation.	8–10
	Total Suggested Lectures	**60 (For 4 Credit**

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		Course)
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

C.6 Prescribed Textbooks

1. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). Molecular Biology of the Gene (7th ed.). Pearson Education.

2. Weaver, R. F. (2021). Molecular Biology (6th ed.). McGraw-Hill Education.

3. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). Molecular Cell Biology (9th ed.). W.H. Freeman and Company.

C.7 Reference Books & Readings

1. Lewin, B., Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2023). Lewin's Genes XII. Jones & Bartlett Learning.

2. Crick, F. H. C. (1968). The Origin of the Genetic Code. Journal of Molecular Biology, 38(3), 367–379.

3. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). Molecular Biology of the Cell (7th ed.). Garland Science.

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM (Molecular Biology Courses): https://swayam.gov.in/
- NPTEL – Molecular Biology: https://nptel.ac.in/courses
- NPTEL – Genetics and Genomics:https://nptel.ac.in/courses
- e-PG Pathshala (Molecular Biology and Genetics): https://epgp.inflibnet.ac.in/NPTEL – Biochemistry: https://nptel.ac.in/courses

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-PC-204
Title of the Paper	Core Course IV: [Practical-Enzymology & Biomolecules]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester II
Nature of Course	Practical Course (PC)
L – T – P	0 – 0 – 4
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	—	70	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	**—**	**30**	**100**
Passing Marks	**32**	**—**	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	Quantitative estimation of biomolecules will enable students in various biochemical labs and industries to work with them.
COB 2	A test of an enzyme-based reaction will enhance their understanding of the mechanism of enzyme action and, hence, of metabolic processes.
COB 3	Analyze the biological and pharmacological significance of plant secondary metabolites.
COB 4	Develop basic laboratory skills for phytochemical screening and plant-based biochemical analysis
COB 5	Build a strong laboratory foundation for careers in biotechnology

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to perform qualitative tests for the identification of major biomolecules such as carbohydrates, proteins, and lipids, and interpret the results accurately
CLO 2	Students will be able to apply quantitative biochemical methods to estimate proteins and determine physicochemical properties of oils and fats.
CLO 3	Students will be able to evaluate enzyme activity and kinetic parameters, including determining Km and analysing enzyme assays used in biochemical investigations.
CLO 4	Students will be able to develop practical skills in biomolecule analysis, enzyme assays, molecular biology techniques, and phytochemical screening for research and biotechnological applications.

C.5 Syllabus — Unit-wise Breakdown

Course Name: PRACTICAL-ENZYMOLOGY & BIOMOLECULES (MSBCH-CC-204)		
Unit	**Content**	**Suggested Lectures hours**
I	**QUALITATIVE TEST OF BIOMOLECULES:** 1. Qualitative test for carbohydrate: Molisch's test, Benedict's test, Barfoed's test / Bradford's method, etc. 2. Qualitative test for Unknown Protein: Biuret test, Ninhydrin test, Heller's Nitric Acid test, etc. 3. Qualitative test for Unknown Lipid: Salkowski's test, Emulsification, Saponification, etc.	30
II	**QUANTITATIVE ESTIMATION OF BIOMOLECULES:** 1. Estimation of protein by the Biuret and Lowry's method 2. Iodine value, acid value and saponification value in oil or fat	30
III	**ENZYMOLOGY:** 1. Calculation of the Km value of the enzyme and its Lineweaver-Burk plot 2. Quantitative Study of Biocatalyst (Assay of Enzymes): SGPT, SGOT, Alkaline phosphatase, Amylase, etc.	30
IV	**BASIC MOLECULAR TECHNIQUES:** 1. DNA Isolation (Bacteria, Plant, Animal) 2. Plasmid Isolation 3. Electrophoresis	20
V	**QUALITATIVE AND QUANTITATIVE TESTS FOR SECONDARY METABOLITES IN PLANTS:** 1. Alkaloids 2. Total Phenol 3. Flavonoids 4. Tannins etc.	10
	Total Suggested Lectures	**60 (For 4 Credit Course)**
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

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C.6 Prescribed Textbooks

1. Plummer, D. T. (2001). An Introduction to Practical Biochemistry (5th ed.). Tata McGraw-Hill Publishing Company Ltd.

2. Wilson, K., & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press.

3. Jayaraman, J. (2011). Laboratory Manual in Biochemistry. New Age International Publishers.

C.7 Reference Books & Readings

1. Sadasivam, S., & Manickam, A. (2008). Biochemical Methods (3rd ed.). New Age International Publishers.

2. Lowry, O. H., Rosebrough, N. J., Farr, A. L., & Randall, R. J. (1951). Protein Measurement with the Folin Phenol Reagent. Journal of Biological Chemistry, 193(1), 265–275.

3. Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual (3rd ed.). Cold Spring Harbor Laboratory Press

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM (Biochemistry and Molecular Biology Laboratory Courses): https://swayam.gov.in/
- NPTEL – Biochemistry and Experimental Biology: https://nptel.ac.in/courses
- NPTEL – Molecular Biology Techniques: https://nptel.ac.in/courses
- e-PG Pathshala (Biochemistry and Molecular Biology Modules): https://epgp.inflibnet.ac.in/NPTEL – Molecular Biology: https://nptel.ac.in/courses

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-GE-205
Title of the Paper	Generic Elective: [Human Physiology and Biochemistry]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester II
Nature of Course	Generic Elective (GE)
L – T – P	3 – 1 – 0
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	70	—	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	**—**	**30**	**100**
Passing Marks	**32**	**—**	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	Gain a comprehensive understanding of human body functions at the organ-system level
COB 2	Analyze the physiological mechanisms involved in digestion, circulation, hormonal control, neural communication, and excretion
COB 3	Build a strong foundation for advanced studies in physiology, biochemistry, biotechnology, medicine, and allied health sciences.
COB 4	Acquire essential concepts for careers in biomedical research, healthcare, diagnostics, and life sciences.
COB 5	Develop knowledge of homeostatic regulation and its importance in health and disease.

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to explain the structure, functions, and regulatory mechanisms of the digestive and muscular systems, including nutrient digestion, absorption, and muscle contraction
CLO 2	Students will be able to describe the organization and physiological functions of the circulatory system, blood components, gas transport, blood coagulation, and maintenance of acid-base balance.
CLO 3	Students will be able to analyze the role of the endocrine system in hormonal regulation, signalling mechanisms, and maintenance of physiological homeostasis.
CLO 4	Students will be able to evaluate the structure, function, and regulation of major human organ systems and their roles in maintaining physiological homeostasis.

C.5 Syllabus — Unit-wise Breakdown

Course Name: HUMAN PHYSIOLOGY AND BIOCHEMISTRY (MSBCH-CC-205)		
Unit	**Content**	**Suggested Lectures hours**
I	**DIGESTIVE AND MUSCULAR SYSTEM:** Digestive system: Composition, functions and regulation of saliva, Gastric, pancreatic, and bile secretions – digestion and absorption of carbohydrates, lipids, proteins, and nucleic acids. Muscle System: Types of muscles: skeletal, cardiac and smooth muscles. Ultrastructure and molecular mechanism of contraction of skeletal muscles and their regulation, Role of energy-rich compounds, skeletal muscle diseases, Muscle hypertrophy and hyperplasia.	8–10
II	**CIRCULATORY SYSTEM:** Circulatory system: Cardiovascular and lymphatic vascular system. Blood vessels, Heart, Route of blood, lymphatic vessels, Blood composition and function of Plasma, formed elements – Erythrocytes, Leukocytes, Platelets, including Hb, Plasma proteins in health and diseases. Blood Homeostasis: Blood coagulation, Hydrogen ion homeostasis – Factors regulating blood pH – buffers, respiratory and renal regulation, Acid-base balance, metabolic and respiratory acidosis and alkalosis. transfer of blood gases – oxygen and carbon dioxide, Role of 2, 3 DPG, Bohr effect and chloride shift.	8–10
III	**ENDOCRINE SYSTEM:** Brief outline of various endocrine glands and their physiological roles; storage and secretion of hormones; Feedback regulation of hormone secretion, hormone-receptors and their activation, mechanism and extracellular and intracellular hormone action	8–10
IV	**NERVOUS SYSTEM:** Organization of the system, nerve cells, glial cells, nerve impulses, neurotransmitters and neurotransmission, synapses, Chemical and electrical synapses, functional properties of nerve fibre, action potential, the reflex action and reflex arc.	8–10
V	**EXCRETORY SYSTEM:** Structure and its organization, Functions of glomerular membrane	8–10

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	and glomerular filtration rate (GFR), selective reabsorption and secretion, active and passive transport of various substances (Sugars, amino acids, urea and creatinine), antiport capabilities of various tubule segments, role of aldosterone and anti-diuretic hormones and mechanisms of urine formation.	
	Total Suggested Lectures	**60 (For 4 Credit Course)**
	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

C.6 Prescribed Textbooks

1. Hall, J. E. (2021). Guyton and Hall Textbook of Medical Physiology (14th ed.). Elsevier.
2. Barrett, K. E., Barman, S. M., Brooks, H. L., & Yuan, J. X.-J. (2019). Ganong's Review of Medical Physiology (26th ed.). McGraw-Hill Education.
3. Silverthorn, D. U. (2022). Human Physiology: An Integrated Approach (9th ed.). Pearson Education.

C.7 Reference Books & Readings

1. Boron, W. F., & Boulpaep, E. L. (2022). Medical Physiology (4th ed.). Elsevier.
2. Huxley, A. F., & Niedergerke, R. (1954). Structural Changes in Muscle During Contraction: Interference Microscopy of Living Muscle Fibres. Nature, 173(4412), 971–973.
3. Vander, A. J., Sherman, J. H., & Luciano, D. S. (2018). Vander's Human Physiology: The Mechanisms of Body Function (15th ed.). McGraw-Hill Education.

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM (Human Physiology and Life Sciences Courses): https://swayam.gov.in/
- NPTEL – Human Physiology: https://nptel.ac.in/courses
- NPTEL – Physiology and Biochemistry: https://nptel.ac.in/courses
- e-PG Pathshala (Physiology and Life Sciences): https://epgp.inflibnet.ac.in/NPTEL – Plant Physiology: https://nptel.ac.in/courses

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C PART C — COURSES OF STUDIES

Instructions to Course Experts: Replicate Part C in full for each paper listed in the Course Structure above. Complete all fields; do not leave sections blank. Use 'Not Applicable' where a field genuinely does not apply.

C.1 Paper Identification

PAPER PROFILE	
Paper Code	MSBCH-GE-206
Title of the Paper	Generic Elective: [Developmental Biology]
Programme / Subject	[MSc] — [Biochemistry]
Semester	Semester II
Nature of Course	Generic Elective (GE)
L – T – P	3 – 1 – 0
Credits	4
Maximum Marks	100 (ESE: 70 + Internal Assessment: 30)
Duration of Examination	3 Hours

C.2 Marks Distribution

Component	Paper I	Practical	IA	Total (ESE+IA/ESE+PRAC)
End Semester Examination	70	—	—	70
Practical / Lab Work	—	—	—	—
Internal Assessment	—	—	30	30
Maximum Marks	**70**	**—**	**30**	**100**
Passing Marks	**32**	**—**	**13**	**45 (45%)**

Note: Internal Assessment shall be conducted on the basis of attendance, class tests, seminars, assignments, and viva voce as provided in the regulation.

C.3 Course Objectives (COBs)

COB No.	Course Objectives
COB 1	Explain fundamental concepts of cell fate determination, differentiation, and developmental control mechanisms.
COB 2	Analyze mechanisms of morphogenesis and organ formation in animals, including pattern formation and regeneration
COB 3	Understand plant developmental processes, including meristem activity, flowering, and organogenesis.
COB 4	Interpret the role of programmed cell death (apoptosis), ageing, and developmental regulation in living organisms.
COB 5	Explain how a single cell develops into a complex organism.

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C.4 Course Outcomes (COs)

CLO No.	Course Learning Outcome
CLO 1	Upon completion, students will be able to explain the fundamental principles of developmental biology, including cell fate determination, differentiation, stem cells, and developmental regulation.
CLO 2	Students will be able to describe the processes of gametogenesis, embryogenesis, and early developmental events in both plants and animals.
CLO 3	Students will be able to interpret the processes of plant development, including meristem organization, organ formation, flowering, and seed development.
CLO 4	Students will be able to evaluate the role of apoptosis and senescence in the growth, development, and maintenance of living organisms

C.5 Syllabus — Unit-wise Breakdown

Course Name: HUMAN PHYSIOLOGY AND BIOCHEMISTRY (MSBCH-CC-205)		
Unit	**Content**	**Suggested Lectures hours**
I	**BASIC CONCEPTS OF DEVELOPMENT:** Potency, commitment, specification, induction, competence, determination, differentiation, morphogenetic gradients, cell fate and cell lineages, stem cells, genomic equivalence and the cytoplasmic determinants, imprinting, mutants and transgenics in the analysis of development.	8–10
II	**GAMETOGENESIS, FERTILIZATION AND EARLY DEVELOPMENT:** Production of gametes, cell surface molecules in sperm-egg recognition in animals, zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals. Male gametophyte development, embryo sac development and double fertilization in plants, embryogenesis, establishment of symmetry in plants, seed formation, embryo and endosperm developmental dynamics and germination.	8–10
III	**MORPHOGENESIS AND ORGANOGENESIS IN ANIMALS:** Cell aggregation and differentiation in Dictyostelium, axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis - vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates, differentiation of neurons, post-embryonic development - larval formation, metamorphosis; environmental regulation of normal development; sex determination.	8–10
IV	**MORPHOGENESIS AND ORGANOGENESIS IN PLANTS:** Organization of shoot and root apical meristem, shoot and root development, leaf development and phyllotaxy, transition to lowering, floral meristems, organogenesis and floral development in reference to *Arabidopsis thaliana*.	8–10
V	**BASIC CONCEPTS OF APOPTOSIS:** Programmed cell death, its mechanisms; aging and senescence in animals and plants.	8–10
	Total Suggested Lectures	**60 (For 4 Credit Course)**

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	Total Suggested Contact Hours For Practical/Field Work Courses	**120 Hours/Semester**

C.6 Prescribed Textbooks

1. Gilbert, S. F., & Barresi, M. J. F. (2020). Developmental Biology (12th ed.). Oxford University Press.
2. Wolpert, L., Tickle, C., & Arias, A. M. (2019). Principles of Development (6th ed.). Oxford University Press.
3. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2022). Plant Physiology and Development (7th ed.). Oxford University Press.

C.7 Reference Books & Readings

1. Slack, J. M. W. (2013). Essential Developmental Biology (3rd ed.). Wiley-Blackwell.
2. Lewis, E. B. (1978). A Gene Complex Controlling Segmentation in Drosophila. Nature, 276(5688), 565–570.
3. Wolpert, L. (2011). Developmental Biology: A Very Short Introduction. Oxford University Press.

C.7 Suggested E-Resources / Digital Repositories

- SWAYAM (Developmental Biology and Life Sciences Courses): https://swayam.gov.in/
- NPTEL – Developmental Biology:https://nptel.ac.in/courses
- NPTEL – Plant Development and Physiology:https://nptel.ac.in/courses
- e-PG Pathshala (Developmental Biology Modules): https://epgp.inflibnet.ac.in/

C.8 Assessment Pattern & Question Paper Design

The End-Semester shall be conducted as per the following question paper design:

- Section A: Short Answer Questions (10 × 2 marks = 20 marks) — Covering all units (mandatory)
- Section B: Medium Answer Questions (4 × 5 marks = 20 marks) — Attempt any 4 out of 6
- Section C: Long Answer / Essay Questions (3 × 10 marks = 30 marks) — Attempt 3 out of 5.

Internal Assessment (20 marks) breakdown:

- Written Test(s): 20 marks
- Seminar / Assignment / Project: 05 marks

Attendance & Class Participation: 05 marks

Note: *Generic/Open Elective–I (Course Code) and II (Course Code) courses in Semester- I and Generic/Open Elective–III (Course Code) and IV (Course Code) courses in Semester- II of 2 Year Postgraduate Programme may be offered by an institution based on student demand, academic interest, and the availability of qualified faculty members. These courses shall be open to students of the concerned discipline as well as students from other disciplines, with the objective of promoting multidisciplinary and interdisciplinary learning in accordance with the principles of the National Education Policy (NEP), 2020.*

For fulfilment of the programme requirements, a student shall be required to successfully complete any one of the Generic Elective courses offered during the semester. The institution may decide to offer either or both of the Generic Elective courses, subject to academic feasibility, availability of faculty expertise, and student enrolment.

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D PART D — GENERAL REGULATIONS & PROVISIONS

D.1 Attendance & Eligibility

- A student must have a minimum of 75% attendance in each paper to be eligible to appear in the Semester / Annual Examination.
- Condonation of attendance deficiency shall be governed by the Regulation.
- A student detained due to shortage of attendance may appear to the examinations of same semester in the next academic session subject to payment of prescribed fees.

D.2 Examination & Promotion Rules

- A student is required to clear **at least** 60% (4 out of 6) papers of a particular Semester before being promoted to the succeeding Semester.
- Back / Ex-Student candidates shall be governed by the rules in force at the time of their original admission unless otherwise specifically notified.
- A candidate who fails in one or more papers shall be required to appear only in the failed paper(s) (Carry Forward System) in subsequent examinations of the same Semester.
- A candidate is required to clear all his papers within a maximum of **Five Years of duration** to qualify for the degree.

D.3 Grading System (CBCS)

Letter Grade	% Range	Grade Point	Performance Description	Remarks
O	≥90-100	10	Outstanding	Pass
A+	≥80<90	9	Excellent	Pass
A	≥70<80	8	Very Good	Pass
B+	≥60<70	7	Good	Pass
B	≥55<60	6	Above Average	Pass
C	≥50<55	5	Average	Pass
P	≥45<50	4	Pass	Pass
F	<45	0	Fail	Fail
Ab/M	0	0	Absent/Malpractice	Fail / Reappear

E PART E — ABBREVIATIONS & AUTHENTICATION

E.1 List of Abbreviations

Abbr.	Expansion	Abbr.	Expansion
CC	Core Course	**DSE**	Discipline Specific Elective
GE	Generic Elective	**OE**	Open Elective
AEC	Ability Enhancement Course	**VAC**	Value Added Course
SEC	Skill Enhancement Course	**IKS**	Indian Knowledge System
L	Lecture (hours per week)	**T**	Tutorial (hours per week)
P	Practical (hours per week)	**IA**	Internal Assessment
CCA	Continuous & Comprehensive Assess.	**CLO**	Course Learning Outcome
PLO	Programme Learning Outcome	**GA**	Graduate Attribute
NHEQF	National HE Qualifications Framework	**PROJ**	Project / Dissertation

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E.2 Authentication

Ashish 15/06/2026 **Subject Expert-1: Dr Ashish Kumar Singh** [Department of Biochemistry] [Patna University, Patna] Date: 15/06/2026	Vyomesh Vibhaw 15.06.2026 **Subject Expert-2: Dr Vyomesh Vibhaw** [Department of Biochemistry] [Patna University, Patna] Date: 15.06.2026
Sunita 20 15/6/26 **Subject Expert-3: Dr Sunita Yadav** [Department of Biochemistry] [Patna University, Patna] Date: 15/06/26	

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