SWAMI VIVEKANAND SUBHARTI UNIVERSITY
UGC Approved Meerut

Ordinance No. :- V-126-B-36

(Approved in Academic council meeting held on 11.03.2026
Proposed to be ratified in forthcoming executive council)

Evaluation Scheme and Syllabus
of
B.Sc. Biochemistry
FOUR – YEAR UNDER GRADUATE PROGRAM
(AS PER NEP-2020)

Keral Verma Subharti College of Science

Swami Vivekanand
SUBHARTI UNIVERSITY
Meerut

(Effective from session 2025-26)

K. V. Subharti College of Science
S. V. Subharti University
NH-58 Bypass Road, Meerut

PROGRAM OBJECTIVES

PO1: Build Strong Foundations in Life Sciences and Computational Biology

PO2: Develop Competence in Bioinformatics Tools, Databases, and Algorithms

PO3: Foster Scientific Inquiry, Problem-Solving, and Research Skills

PO4: Promote Digital, Computational, and AI-Based Competencies

PO5: Cultivate Innovation, Entrepreneurship, and Industry Readiness

PO6: Strengthen Ethical Reasoning, Biosafety Awareness & Responsible Research Practice

PO7: Develop Effective Communication, Documentation & Presentation Skills

PO8: Encourage Lifelong Learning and Adaptability to Emerging Technologies

PO9: Integrate Interdisciplinary Knowledge for Real-World Problem Solving

PO10: Foster Holistic, Socially Responsible, and Value-Driven Education

PROGRAM OUTCOME

PSO1: Biological Literacy and Conceptual Understanding

PSO2: Computational and Programming Proficiency

PSO3: Bioinformatics Databases, Tools, and Analytical Skills

PSO4: Scientific Reasoning, Research Aptitude, and Problem-Solving

PSO5: Data Science, Machine Learning, and AI Applications in Life Sciences

PSO6: Laboratory Skills and Experimental Competence

PSO7: Ethical, Legal, and Social Responsibility in Biosciences

PSO8: Effective Communication and Documentation Skills

PSO9: Entrepreneurship, Innovation, and Industry Readiness

PSO10: Multidisciplinary Integration and Holistic Thinking

PSO11: Digital Fluency and Financial/Digital Citizenship

PSO12: Lifelong Learning, Adaptability, and Professional Growth

CREDIT DISTRIBUTION TABLE

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Life Science

B.Sc Biochemistry
(Session 2025-26 onwards)

		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
1	Major	6	6	9	15	10	14	16	4	80
2	Minor	3	3	3	3	6	6	4	4	32
3	Multi Disciplinary	3	3	3						9
4	Ability Enhancement Course	2	2	2	2					8
5	Skill Enhancement Course	3	3	3						9
6	Value Added Course	3	3							6
7	Internship					4				4
8	Research								12	12
	Total	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**160**

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EVALUATION SCHEME
I YEAR

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT												
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Life Science												
Course Name – B.Sc. Biochemistry												
Batch:2024 -25							**SEM:I**					
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**
				L	**T**	**P**						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/ Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 1	BSBC-101	**Cell biology and genetics**	4	0	0	4	5	10	15	70	100
2	Practical Major 1	BSBC-101P	**Cell Biology and Genetics Lab**	0	0	4	2	5	10	15	70	100
3	Minor 1	BSBC-102	A. Micro organisms for human welfare B.Biotechnology and Human Welfare C. Biochemistry in health and disease	3	0	0	3	5	10	15	70	100
4	Multi Disciplinary	M-DIS-SM	Soil Microbiology	3	0	0	3	5	10	15	70	100
5	Ability Enhancement Course	AEC-01	English Communication	2	0	0	2	5	10	15	70	100
6	Skill Enhancement Course	SEC-AE	Advance Excel	1	0	3	3	5	10	15	70	100
7	Value Added Course	VAC-AILS	AI for Life Sciences	1	0	3	3	5	10	15	70	100
8	IKS / Rastra bodh	IKSRB-01		2	0	0	2	5	5	10	30	50
TOTAL CREDITS / ASSESSMENT							**22**	**40**	**75**	**115**	**520**	**750**

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT												
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Life Science												
Batch:2024 -25								**SEM:II**				
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**
				L	**T**	**P**						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 2	BSBC-201	Fundamentals of Biochemistry	4	0	0	4	5	10	15	70	100
2	Practical Major 2	BSBC-201P	Fundamentals of Biochemistry Lab	0	0	4	2	5	10	15	70	100
3	Minor 2	BSBC-203	**Bioresource technology and bioproducts**	3	0	0	3	5	10	15	70	100
4	Multi Disciplinary 2	M-DIS-		3	0	0	3	5	10	15	70	100
5	Ability Enhancement Course 2	AEC-02	Environment Science	2	0	0	2	5	10	15	70	100
6	Skill Enhancement Course 2	SEC-		1	0	3	3	5	10	15	70	100
7	Value Added Course 2	VAC-DFL	Digital and Financial Literacy	3	0	0	3	5	10	15	70	100
8	IKS / Rastra bodh	IKSRB-02		2	0	0	2	5	5	10	30	50
TOTAL CREDITS / ASSESSMENT							**22**	**40**	**75**	**115**	**520**	**750**

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SYLLABUS MAJOR COURSES

Programme/Class: B.Sc.	**Year:** I	**Semester:** I
Department: BIOCHEMISTRY		
Course Code: BSBC-101	**Course Title: CELL BIOLOGY AND GENETICS**	
Course Outcomes (Cos)		
This course introduces the principles of cell biology and genetics. After completion of this course, students will be able to: • Understand the cell as a basic unit of life, its structure, function, and the organelles involved. • Comprehend structural and functional details of plasma membrane and cellular communication. • Learn about chromosomes, their structure, organization, and processes of cell division. • Grasp fundamental principles of Mendelian and non-Mendelian genetics. • Explore the genetic basis of mutations, sex determination, and population genetics.		
Credits: 4	**Core Compulsory**	

Unit	**Topics**	**No. of Lectures**
	Cell as a Basic Unit and Cellular Organelles • Concept of the cell, historical perspectives, discovery, and Cell Theory. • Ultra structure of Prokaryotic and Eukaryotic cells (plant and animal). • Structure and functions of cellular organelles: Endoplasmic Reticulum, Golgi Complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus, Vacuole, Cytosol. • Cytoskeleton structures: Microtubules, Microfilaments, Intermediate filaments.	**12**
II	**Surface Architecture** • Plasma membrane and cell wall structure and function in eukaryotes. • Ultra structure of plasma membrane – Fluid Mosaic Model, membrane fluidity. • Membrane transport: Symport, Antiport, Uniport, Active and Passive Transport. • Differentiation of cell surface: Basement membrane, Tight junctions, Gap junctions, Desmosomes, Hemidesmosomes.	**10**
III	**Chromosomes and Cell Division** • Introduction to chromosomes: Discovery, morphology, Centromere, Secondary constriction, Telomere, Chromonema. • Euchromatin and Heterochromatin, chemical composition, Karyotype, Genome organization. • Cell cycle and division: Phases, Mitosis, Meiosis, regulation, checkpoints, involved enzymes. • Significance of cell cycle, Interphase nucleus, Achromatic apparatus, Synaptonemal complex. • Cell senescence and programmed cell death.	**14**

IV	**Genetics** • Introduction and historical background. • Mendelian inheritance: Laws of Dominance, Segregation, Incomplete Dominance, Codominance, Independent Assortment. • Test cross, Backcross. • Non-Mendelian inheritance: Gene interaction (complementary, supplementary, 13:3 ratio), Epistasis, Maternal inheritance. • Sex-linked inheritance, Chromosome theory of inheritance, Linkage and crossing over. • Multiple allelism (e.g., Human blood groups), Polygenic inheritance (e.g., skin colour).	**12**
V	**Mutation and Population Genetics** • Mutations: Types, Spontaneous vs. Induced, Physical and Chemical mutagens. • Sex determination in plants and animals; Allosomes and Autosomes. • Non-Mendelian inheritance patterns: Mitochondrial inheritance, Complex inheritance, Environmental variation, Heritability, Behavioural traits. • Population genetics: Phenotype, Genotype, Gene frequency, Hardy-Weinberg Law. • Factors affecting Hardy-Weinberg equilibrium: Mutation, Selection, Migration, Genetic drift, Gene flow. • Inherited disorders: Allosomal (Klinefelter and Turner's syndromes), Autosomal (Down's syndrome)	**12**

Suggestive Reading Books:

- Alberts B et al. (2002) Molecular biology of the cell, Garland Publications
- Burke, J D, (1970) Cell Biology, William and Wilkins
- Gardner E.J., Simmons M.J. and Snustad D.P. (2003) Principles of Genetics, 8th Ed., John Wiley & Son Publications
- Clark, CA. (1970) Human Genetics and Medicine, Edward Arnold, London
- Dale JW. (1990) Molecular genetics of bacteria. John Wiley and Sons.
- Darnell J. Lodish H, Baltimore D, (1990) Molecular Cell Biology, Scientific American Books
- De Robertis EDP & Robertis EMF (1980) Cell Biology & Molecular Biology, Saunders College.

Course: Cell Biology and Genetics Lab (Practical Major I)

List of Practical

1. *Study and maintenance of simple and compound microscope*
2. *Use of Micrometre and calibration, measurement of onion epidermal cells and yeast*
3. *Study of divisional stages in mitosis from onion root tips*
4. *Study of divisional stages in meiosis in grasshopper testes/onion or Rheo flower buds.*
5. *Mounting of polytene chromosomes*
6. *Buccal smear – Barr bodies*

7. *Karyotype analysis – Human and Onion Human – Normal and Abnormal – Down and Turner's syndromes*
8. *Isolation and staining of Mitochondria*
9. *Isolation and staining of Chloroplast*
10. *RBC cell counts by Haemocytometer*
11. *Simple genetic problems based on theory*

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Programme/Class: B.Sc	**Year:** I	**Semester:** II
Subject: BIOCHEMISTRY		
Couse Code: BSBC-201	**Course Title:**Fundamentals of Biochemistry	
Course Outcomes (Cos)		
This course introduces the basic principles of biochemistry. After completion of this course, students will be able to • Understand the chemical basis of life and types of chemical bonds. • Explain the structure, properties, and biological roles of biomolecules like carbohydrates, proteins, lipids, and nucleic acids. • Understand enzyme kinetics, mechanism, and inhibition. • Describe the role of buffers and pH in biological systems. • Gain insight into bioenergetics and metabolic pathways like glycolysis, TCA cycle, and oxidative phosphorylation.		
Credits: 4	**Core Compulsory**	

Unit	**Topics**	**N0. Of Lectures**
I	• **Basics of Biochemistry:** Definition and scope of biochemistry, Types of chemical bonds: ionic, covalent, hydrogen, hydrophobic interactions, Properties of water and its biological significance, pH, pKa, buffers and their role in biological systems, Carbohydrates: classification, structure, and biological functions.	12
II	• **Proteins and Amino Acids**: Classification, structure and properties of amino acids, Peptide bond and structure of proteins, Protein classification and biological functions, Methods of protein purification and characterization (basic concepts), Protein denaturation and renaturation.	10

III	• **Lipids and Nucleic Acids**: Classification and structure of lipids (fatty acids, triglycerides, phospholipids, steroids), Biological roles of lipids, Structure of nucleotides and nucleic acids (DNA & RNA), DNA double helix model (Watson & Crick), types of RNA, Functions of nucleic acids in cellular processes.	9
IV	• **Enzymes**: Introduction to enzymes: classification and nomenclature (IUBMB), Structure of enzymes, active site, specificity, Mechanism of enzyme action and factors affecting enzyme activity, Enzyme kinetics: Michaelis-Menten equation (basic concept), Enzyme inhibition: competitive and non-competitive	9
V	• **Bioenergetics and Metabolism Overview**: Concept of free energy, endergonic and exergonic reactions, ATP: structure and role as energy currency, Overview of metabolism: anabolic and catabolic pathways, Introduction to glycolysis, TCA cycle, oxidative phosphorylation (basic steps and significance), Brief mention of metabolic regulation.	14

Suggestive Reading Books:

1. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox
2. Biochemistry by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer
3. Harper's Illustrated Biochemistry by Victor W. Rodwell
4. Fundamentals of Biochemistry by Donald Voet, Judith G. Voet, and Charlotte W. Pratt
5. Textbook of Biochemistry by A.V.S.S. Rama Rao
6. Text book of Biochemistry by U. Satyanarayana & U. Chakrapani
7. Text book of Biochemistry by Donald Voet & Judith G. Voet

Course: Introduction to Biochemistry Lab (Practical Major 2)

List of Practical

1. Preparation and Standardization of Buffers
2. Qualitative Tests for Carbohydrates
3. Qualitative Tests for Proteins and Amino Acids
4. Estimation of Proteins by Biuret or Lowry Method
5. Qualitative Tests for Lipids
6. Extraction and Quantification of DNA from Plant Material (e.g., Banana or Onion)
7. Study of Enzyme Activity: Effect of Temperature or pH on Amylase Activity

MINOR COURSES SYLLABUS

Programme/Class: B.Sc	**Year:** I	**Semester:** I
Subject: BIOCHEMISTRY		
Couse Code: BSBC-102	**Course Title: BIOCHEMISTRY IN HEALTH AND DISEASE**	
Course Outcomes (COs)		
This course introduces the biochemical basis of health and disease. After completion of this course, students will be able to – • Understand the fundamental metabolic processes and their role in maintaining human health. • Recognize the biochemical basis and clinical implications of major metabolic disorders such as diabetes, obesity, and cardiovascular diseases. • Learn the functional aspects of liver and kidney biochemistry and associated diagnostic tests. • Explore hormonal regulation and related endocrine disorders. • Understand the biochemical pathways involved in cancer and infectious diseases, and their diagnostic tools.		
Credits: 3	**Core Compulsory**	

Unit	Topics	N0. of Lectures
I	• **Fundamentals of Human Biochemistry and Health**: Overview of metabolism in normal physiology, Concept of homeostasis and metabolic regulation, Nutrients and their role in maintaining health (carbohydrates, proteins, fats, vitamins, minerals), Malnutrition: protein-energy malnutrition, vitamin and mineral deficiencies, Antioxidants and free radicals in health.	9
II	• **Biochemical Basis of Metabolic Diseases**: Diabetes mellitus: types, biochemical basis, insulin mechanism, Obesity: biochemical aspects and metabolic syndrome, Hyperlipidemia and cardiovascular diseases: lipoproteins, cholesterol, and triglyceride metabolism, Gout and uric acid metabolism.	9
III	• **Liver and Kidney Function in Health and Disease**: Liver function tests (LFTs): bilirubin, ALT, AST, ALP, Jaundice: types and biochemical markers, Renal function tests (RFTs): urea, creatinine, uric acid, electrolytes, Acidosis and alkalosis: biochemical disturbances, Nephrotic syndrome and proteinuria.	9
IV	• **Hormonal and Endocrine Disorders**: Hormone classification and mechanism of action, Thyroid dysfunction: hypothyroidism, hyperthyroidism, goiter, Adrenal disorders: Addison's disease, Cushing's syndrome, Reproductive hormones and disorders (PCOD, infertility), Hormone assays and diagnostic markers.	9

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V	• **Cancer, Infectious Diseases and Diagnostic Biochemistry**: Biochemistry of cancer: oncogenes, tumor suppressor genes, metabolic reprogramming, Tumor markers and clinical enzymes (e.g., PSA, CEA, AFP, LDH), Oxidative stress and inflammation, Role of biochemistry in infectious diseases (HIV, hepatitis, tuberculosis), Basic principles of diagnostic biochemistry (ELISA, RIA, point-of-care tests).	9

Suggestive Reading Books:

1. Textbook of Biochemistry for Medical Students by DM Vasudevan, Sreekumari S, Kannan Vaidyanathan
2. Biochemistry by U. Satyanarayana and U. Chakrapani
3. Harper's Illustrated Biochemistry by Victor W. Rodwell et al
4. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics by Carl A. Burtis, David E. Bruns
5. Clinical Biochemistry by William J. Marshall, Márta Lapsley
6. Essentials of Medical Biochemistry: With Clinical Cases by Chandar Mohan

Programme/Class: Certificate	**Year:** First (I)	**Semester:**Second(II)
Subject: BIOCHEMISTRY		
Couse Code: BSBC-203	**Course Title: BIO RESOURCE TECHNOLOGY AND BIOPRODUCTS**	

Course Outcomes (COs)

- Fundamental understanding of the bioresources and its applications for attainment of social objectives (energy, environment, product, sustainability).
- Acquire knowledge with respect to the properties of the bioresources and the conversion technologies.
- Exhibiting knowledge of the systems used for bioresources and bioresource technology.
- Understanding about analysis of data and their applications in design of the systems and development of the bioprocess.

Credits: 3	**Core Compulsory**

Unit	Topics	No. of Lectures
I	**Bioresources** • Natural and anthropogenic; importance of bio-resources and their utilization. • Natural bio-resources: agricultural, forestry and aquatic biomass. • Biomass availability, production and food security, non-edible biomass characteristics.	**3**

	• Anthropogenic bio-resources: Organic wastes-domestic and industrial; characteristics of municipal sewage / sludge and industrial sludges.	
II	**Conversion processes** • Biochemical, thermo-chemical and physico-chemical conversion processes • Biochemical processes: Microbial anaerobic and aerobic processes • Enzymatic processes; fermentation for alcohols and acids; penicillin and other therapeutic products. Production of single cell protein (SCP) • Bio-pulping, Bio gasification.	**3**
III	**Thermo-chemical processes** • Pyrolysis (coke and pyro-oils), oxidation-combustion • Gasification: downdraft, updraft and fixed bed gasification, fluidized bed and entrained bed gasification • Various methods of manufacture of activated carbons	**3**
IV	**Biofuels** • Biofuels and biomaterials, specialty chemicals (gylcol, acetic acid and downstream chemicals) • Anhydrous alcohols-ethanol and butanol • Biodiesel, bio-aviation turbine fuel (BATF) • Physico-chemical processes: Pretreatment, steam/acid/alkali hydrolysis, effect of temperature on hydrolysis	**6**

Suggestive Reading Books:

- Tripathi, G., "Bioresource Technology", CBS Publications (2002).
- Pandey, A., "Concise Encyclopaedia of Bioresource Technology", CRC Press (2004).
- Shuler, M., Kargi, F., “Bioprocess Engineering, Basic Concept”, Prentice Hall of India Pvt. Ltd. (2004)

SYLLABUS MULTIDISCIPLINARY COURSES

Programme/Class: B.Sc	**Year:** I	**Semester:** I
Subject: BIOCHEMISTRY		
Couse Code: M-DIS-BTB	**Course Title:** BIORESOURCE TECHNOLOGIES AND BIOPRODUCT	
Course Outcomes (COs)		

Course Outcomes (COs):

CO1: Understand the concept of bioresources, their types, availability, and importance in sustainable development.

CO2: Explain the principles and methods used to explore and utilize biological resources for the production of bioproducts.

CO3: Describe the technological processes involved in microbial, plant, and environmental bioproduct development.

CO4: Analyze various bioproducts such as biofuels, bioplastics, biofertilizers, and enzymes and their industrial relevance.

CO5: Evaluate the environmental, economic, and ethical considerations in bioresource management and bioproduct commercialization.

Credits: 3	**Core Compulsory**

Unit	**Topics**	**N0. of Lectures**
I	Unit I — Introduction to Bioresources (12 Lectures) • Definition, scope, and significance of bioresources. • Types of bioresources: Microbial, plant, animal, and environmental resources. • Renewable vs. non-renewable biological resources. • Traditional vs. modern bioresource utilization.	12
II	Unit II — Microbial Bioresources (12 Lectures) • Importance of microbes in bioresource technology. • Industrial microbial strains: Yeast, bacteria, fungi, algae. • Microbial screening, isolation, and strain improvement (basic concepts). • Fermentation technology: Principles, types (batch, fed-batch, continuous).	12
III	Unit III — Plant-based and Environmental Bioresources (12 Lectures) • Medicinal and aromatic plants: Importance and applications. • Plant tissue culture as a tool for bioresource generation. • Biomass: Types, collection, and conversion strategies. • Environmental bioresources: Compost, vermicompost, algal biomass. • Biofertilizers: Rhizobium, Azotobacter, Cyanobacteria—production and applications.	12
IV	Unit IV — Bioproduct Technologies (12 Lectures) • Biofuels: Bioethanol, biodiesel, biogas—production and applications. • Biopolymers and bioplastics: PLA, PHA—properties and uses. • Biosurfactants, bio-pesticides, and bio-remediation agents. • Value-added products: nutraceuticals, probiotics, functional foods.	12

	• Concept of biorefineries.	
V	Unit V — Sustainability, Regulations, and Commercialization (12 Lectures) • Environmental impact of bioresource utilization. • Sustainable development and circular bioeconomy. • Intellectual Property Rights (IPR), patents, and bioresource protection. • Ethical issues in bioresource exploitation. • Market potential and entrepreneurship opportunities in bioproducts.	

Suggestive Reading Books:

- Crueger, W., &Crueger, A. — *Biotechnology: A Textbook of Industrial Microbiology* (Panima)
- Stanbury, P. F., Whitaker, A., & Hall, S. — *Principles of Fermentation Technology* (Butterworth-Heinemann)
- Singh, R. P. — *Environmental Biotechnology* (New Age International)
- Demirbas, A. — *Biofuels: Securing the Planet's Future Energy Needs* (Springer)

Programme/Class: B.Sc	**Year:** I	**Semester:** II
Subject: BIOCHEMISTRY		
Couse Code: M-DIS-PC	**Course Title:** PHARMACEUTICAL CHEMISTRY	

Course Outcomes (COs)

Course Outcomes (COs):

CO1: Describe the basic concepts, terminology, and scope of pharmaceutical chemistry.
CO2: Explain the sources, properties, and classification of drugs and pharmaceuticals.
CO3: Understand the principles of drug action, dosage forms, and drug metabolism.
CO4: Identify common synthetic pathways of essential drug classes and their pharmaceutical importance.
CO5: Evaluate the safety, quality control, and regulatory aspects in pharmaceutical chemistry.

Credits: 3	**Core Compulsory**

Unit	**Topics**	**N0. of Lectures**
I	Unit I — Introduction to Pharmaceutical Chemistry (12 Lectures) • Definition, scope, and importance of pharmaceutical chemistry. • Difference between drug, medicine, and pharmaceutical chemicals. • History and development of pharmaceuticals. • Classification of drugs: based on chemical structure and therapeutic action. • Sources of drugs: natural, semi-synthetic, synthetic, and	12

	biotechnological sources.	
II	Unit II — Physicochemical Principles in Pharmacy (12 Lectures) • Basic concepts: pH, buffers, solubility, partition coefficient. • Drug stability: hydrolysis, oxidation, photolysis (elementary concepts). • Role of chemical bonds and functional groups in drug action. • Introduction to stereochemistry: isomerism and its relevance in pharmaceuticals. • ADME overview: Absorption, Distribution, Metabolism, and Excretion.	12
III	Unit III — Drug Development and Drug Action (12 Lectures) • Drug discovery process: lead identification, lead optimization (basic). • Mechanisms of drug action: receptor theory, enzyme inhibition. • Dose–response relationship. • Drug metabolism: Phase I and Phase II reactions.	12

IV	Unit IV — Synthetic and Natural Drugs (12 Lectures)
	• Basic synthetic pathways of important drug classes:
	  ○ Analgesics (Aspirin, Paracetamol)
	  ○ Antipyretics
	  ○ Antimicrobials (Sulfonamides, Penicillin – basic chemistry)
	  ○ Antacids
	• Natural drugs and phytopharmaceuticals: alkaloids, glycosides, tannins, terpenoids.
		12

V	Unit V — Pharmaceutical Quality, Safety & Regulations (12 Lectures) • Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP). • Quality control and quality assurance in pharmaceuticals. • Adulteration and contamination: causes and prevention. • Regulatory bodies: WHO, USFDA, CDSCO.	

Suggestive Reading Books:

- **Chatwal, G. R., & Anand, S.** — *Instrumental Methods of Chemical Analysis*, Himalaya Publishing.
- **Ashutosh Kar** — *Medicinal Chemistry*, New Age International.
- **Wilson & Gisvold** — *Textbook of Organic Medicinal and Pharmaceutical Chemistry*, Lippincott.
- **Patrick, G.** — *An Introduction to Medicinal Chemistry*, Oxford University Press.
- **Lemke, T., & Williams, D.** — *Foye's Principles of Medicinal Chemistry*, Lippincott Williams & Wilkins.

SYLLABUS SKILL ENHANCEMENT COURSES

Programme/Class: B.Sc	**Year:** I	**Semester:** I
Subject: BIOCHEMISTRY		
Couse Code: SCE-PAP	**Course Title:** PLANT AROMATICS AND PERFUMERY	

Course Outcomes (COs)

- To introduce students to aromatic and perfumery plants and their industrial importance.
- To understand the chemistry, extraction, and uses of essential oils and natural fragrances.
- To impart knowledge about cultivation, processing, and quality control of aromatic plants.
- To develop skills related to extraction techniques and formulation of perfumery products.
- To create awareness about the commercial and export potential of aromatic and perfumery industries in India.

Credits: 3	**Core Compulsory**

Unit	Topics	N0. of Lectures
I	**Introduction to Aromatic and Perfumery Plants** • Definition, scope, and importance of aromatic and perfumery plants. • Historical development and traditional uses in India. • Classification based on plant part used: leaves, flowers, roots, wood, fruits, seeds. • Botanical sources of major aromatic plants. • Economic, ecological, and cultural significance.	12
II	**Chemistry of Aromatic Compounds and Essential Oils** • Definition, occurrence, and functions of essential oils. • Chemical constituents: terpenes, alcohols, aldehydes, ketones, esters, phenols, and acids. • Biosynthesis and storage of volatile compounds in plants. • Factors affecting yield and quality of essential oils. • Analytical methods: basic principles of GC, TLC, and spectrophotometry.	12
III	**Extraction and Processing Techniques** • Methods of extraction: steam and hydro-distillation, solvent extraction, enfleurage, cold pressing, supercritical CO_2 extraction. • Post-harvest handling and storage of aromatic plant materials. • Standardization, adulteration, and quality control of essential oils. • By-products and waste utilization in essential oil industry.	12

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IV	**Applications and Industrial Aspects of Perfumery** • Uses of essential oils and aromatic compounds in perfumes, cosmetics, soaps, and pharmaceuticals. • Formulation of perfumes and incense products; blending and role of fixatives. • Important aromatic crops of India: rose, jasmine, sandalwood, lemongrass, vetiver, patchouli, lavender. • Cultivation, harvesting, and processing overview of selected crops. • Industrial scenario, export potential, and government organizations (CIMAP, NMPB, FRLHT).	12
Suggestive Reading Books: • Lawrence, B.M. *Essential Oils: History, Production, and Uses.* • Guenther, E. *The Essential Oils – Volumes I–VI.* • Kapoor, L.D. *Handbook of Ayurvedic Medicinal Plants.* • Khandelwal, K.R. *Practical Pharmacognosy.* • CSIR Publications: *Wealth of India – Raw Materials (Vol. 1–11).* • Bose, T.K., Kabir, J., and Das, P. *Aromatic and Medicinal Plants.*		

Programme/Class: B.Sc	**Year:** I	**Semester:** II
Subject: BIOCHEMISTRY		
Couse Code: SCE-MDT	**Course Title:** MOLECULAR DIAGNOSTIC TECHNIQUES	
Course Outcomes (COs)		
CO1: Understand the basic principles and scope of molecular diagnostics in healthcare and biotechnology. **CO2:** Explain the structure, function, and handling of nucleic acids in diagnostic workflows. **CO3:** Describe and compare major molecular diagnostic tools such as PCR, RT-PCR, electrophoresis, blotting, sequencing, and CRISPR-based diagnostics. **CO4:**Analyze the application of molecular techniques in detecting infectious diseases, genetic disorders, and cancer biomarkers. **CO5:** Evaluate quality control, biosafety, ethical issues, and regulatory aspects of molecular diagnosis.		
Credits: 3	**Core Compulsory**	

Unit	**Topics**	**N0. of Lectures**
I	Unit I — Introduction to Molecular Diagnostics (12 Lectures) • Definition, history, and significance of molecular diagnostics. • Advantages over traditional diagnostic methods. • Central dogma and relevance to diagnosis. • Overview of biomarkers: DNA, RNA, proteins. • Workflow of a molecular diagnostic laboratory.	12

II	Unit II — Nucleic Acids in Diagnostics (12 Lectures) • DNA and RNA: structure, properties, extraction basics. • Sample types: blood, tissue, buccal swabs, microbial samples. • Purification techniques: column-based, magnetic bead–based, precipitation. • Quantification and quality assessment: spectrophotometry, fluorometry, gel electrophoresis.	12
III	Unit III — Molecular Diagnostic Techniques (12 Lectures) • **PCR Techniques:** Conventional PCR, RT-PCR, qPCR—principles and applications. • **Electrophoresis:** Agarose gel electrophoresis and interpretation of bands. • **Blotting Techniques:** Southern, Northern, Western—basic concepts and uses. • **Hybridization Techniques:** Probes, FISH basics.	12
IV	Unit IV — Applications in Disease Diagnosis (12 Lectures) • **Infectious disease diagnosis:** COVID-19, TB, HIV, HPV. • **Genetic disorder diagnosis:** Thalassemia, sickle-cell anemia, BRCA mutations. • **Cancer diagnostics:** Tumor markers, liquid biopsy (basics). • **Prenatal and neonatal diagnostics:** Chromosomal abnormalities, metabolic disorders.	12
V	Unit V — Quality Control, Biosafety, and Ethics (12 Lectures) • Good Laboratory Practices (GLP) for molecular labs. • Contamination control strategies: unidirectional workflow, sterile techniques. • Quality assurance: Internal and external quality control. • Regulatory guidelines: ICMR, NABL, WHO basics.	

Suggestive Reading Books:

- **Molecular Diagnostics: Principles and Practice** — *David E. Bruns & Edward Ashwood (Elsevier)*
- **Molecular Biology: Principles and Practice** — *Michael M. Cox et al.*
- **Brown, T. A.** — *Genomes* (Oxford University Press)
- **Sambrook & Russell** — *Molecular Cloning: A Laboratory Manual* (Cold Spring Harbor Press)
- **Kumar, A. & Singh, R.** — *Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications*

SYLLABUS VALUE ADDED COURSE

Programme/Class: B.Sc	**Year:** I	**Semester:** I

Subject: BIOCHEMISTRY	
Couse Code: VAC-BBD	**Course Title:** BIOCHEMICAL BASICS OF DISEASE
Course Outcomes (COs)	
CO1: Understand the basic biochemical principles underlying normal cellular function and metabolism. **CO2:** Explain how biochemical alterations lead to the onset and progression of major human diseases. **CO3:** Describe the molecular mechanisms involved in metabolic, genetic, infectious, and lifestyle-related disorders. **CO4:**Analyze clinical biomarkers, enzymatic dysfunctions, and molecular indicators associated with common diseases. **CO5:** Evaluate preventive, diagnostic, and therapeutic strategies based on biochemical pathways and disease mechanisms.	
Credits: 3	**Core Compulsory**

Unit	Topics	N0. of Lectures
I	Unit I — Introduction to Disease Biochemistry (12 Lectures) • Definition of health and disease: biochemical perspective. • Homeostasis: biochemical basis of physiological balance. • Biomolecules and their role in disease (proteins, lipids, carbohydrates, nucleic acids). • Concept of mutations and biochemical defects. • Overview of diagnostic biochemistry: enzymes, hormones, metabolites.	12
II	Unit II — Metabolic Disorders (12 Lectures) • Carbohydrate metabolism disorders: Diabetes mellitus (Type I & II), hypoglycemia. • Lipid metabolism disorders: Obesity, hyperlipidemia, fatty liver disease. • Protein and amino acid metabolism disorders: Phenylketonuria (PKU), alkaptonuria, urea cycle defects. • Inborn errors of metabolism (introductory).	12
III	Unit III — Genetic and Molecular Basis of Disease (12 Lectures) • DNA damage, repair mechanisms, and disease development. • Genetic mutations and inherited disorders: Sickle-cell anemia, thalassemia, cystic fibrosis. • Chromosomal abnormalities: Down syndrome, Turner syndrome (basic concept). • Molecular basis of cancer: oncogenes, tumor suppressor genes, apoptosis..	12
IV	Unit IV — Biochemistry of Infectious and Immune-related Diseases (12 Lectures) • Biochemical basis of bacterial, viral, and fungal infections. • Mechanisms of pathogen invasion and host–pathogen interactions.	12

	• Immune response basics: innate and adaptive immunity. • Autoimmune disorders: rheumatoid arthritis, type-1 diabetes (biochemical aspects). • Inflammation: molecular mediators (cytokines, CRP, prostaglandins).	

Suggestive Reading Books:

- Devlin, T. M. — *Textbook of Biochemistry with Clinical Correlations*
- Nelson, D. L., & Cox, M. M. — *Lehninger Principles of Biochemistry*
- Murray, R. K. — *Harper's Illustrated Biochemistry*
- Kumar, V., Abbas, A., & Aster, J. — *Robbins Basic Pathology*
- Dutta, A. — *Clinical Biochemistry*

Programme/Class: B.Sc	**Year:** I	**Semester:** II
Subject: BIOCHEMISTRY		
Couse Code: VAC-NFF	**Course Title:** NUTRACEUTICALS AND FUNCTIONAL FOODS	

Course Outcomes (COs)

CO1: Understand the basic concepts, importance, and scope of nutraceuticals and functional foods.
CO2: Identify major bioactive components and their biochemical roles in human health.
CO3: Explain the sources, processing, and health applications of nutraceuticals and functional foods.
CO4: Analyze scientifically validated health claims, mechanisms, and clinical relevance of nutraceuticals.
CO5: Evaluate regulatory aspects, safety concerns, and commercialization potential of nutraceutical and functional food products.

Credits: 3	**Core Compulsory**

Unit	**Topics**	**N0. of Lectures**
I	Unit I — Introduction to Nutraceuticals and Functional Foods (12 Lectures) • Definition, scope, and importance of nutraceuticals and functional foods. • Difference between dietary supplements, functional foods, and nutraceuticals. • Historical developments and global market trends. • Role of nutrition in prevention and management of diseases.	12

II	Unit II — Bioactive Components in Foods (12 Lectures) • Primary and secondary metabolites in foods. • Phytochemicals: Polyphenols, flavonoids, carotenoids, glucosinolates. • Antioxidants: Vitamin C, Vitamin E, selenium, CoQ10. • Dietary fibers and their physiological significance.	12
III	Unit III — Sources and Processing of Nutraceuticals (12 Lectures) • Plant-based nutraceuticals: Spices, herbs, fruits, vegetables. • Animal-derived nutraceuticals: Fish oils, dairy-based nutraceuticals, collagen peptides. • Microbial nutraceuticals: Probiotics, fermented foods. • Nutraceutical extraction and processing (basic concepts): Drying, solvent extraction, fermentation, encapsulation.	12
IV	Unit IV — Functional Foods and Health Applications (12 Lectures) • Functional foods: Definition and categories. • Functional dairy foods: Probiotic yogurt, fortified milk. • Functional cereals and grains: Oats, millets, whole grains. • Disease-specific nutraceuticals: o Cardiovascular health (omega-3 fatty acids, plant sterols) o Diabetes and metabolic disorders (fibers, cinnamon extracts) o Gut health (probiotics, prebiotics) o Immunity boosters (vitamins, herbal components)	12

Suggestive Reading Books:

- Gibson, G. & Williams, C. — *Functional Foods: Concept to Product* (Woodhead).
- Wildman, R. — *Handbook of Nutraceuticals and Functional Foods* (CRC Press).
- Shi, J., Mazza, G., &Maguer, M. — *Functional Foods: Biochemical & Processing Aspects*.
- Ghosh, D. — *Nutraceuticals, Functional Foods and Dietary Supplements* (Wiley).
- Academic and regulatory sources: FSSAI manuals, FDA guidelines.

II Year

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT												
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Life Science												
Batch:2024 -25							**SEM:III**					
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**
				L	**T**	**P**						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 3	BSBC-301	**Biomolecules and Metabolism**	4	0	0	3	5	10	15	70	100
2	Major 4	BSBC-302	**Molecular biology**	4	0	0	3	5	10	15	70	100
3	Practical 3 (based on Major 3+4)	BSBC-303P		0	0	4	3	5	10	15	70	100
4	Minor 3	BSBC-304	A. Bioprocess Engineering B. Gene Therapy C. Drug Designing	3	0	0	3	5	10	15	70	100
5	Multi Disciplinary 3	M-DIS-		3	0	0	3	5	10	15	70	100
6	Ability Enhancement Course 3 (Disaster Risk Management)	AEC-	Disaster Risk Management	2	0	0	2	5	10	15	70	100
7	Skill Enhancement Course 3	SEC-		1	0	3	3	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							**20**	**35**	**70**	**105**	**490**	**700**

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Life Science

Batch:2024 -25 | **SEM:IV**

S. No.	Course Type	Course Code	Course Name	Teaching Load			Credits		Internal Assessment		External Assessment	Total
				L	T	P						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 5	BSBC-401	**Bioanalytical technique**	4	0	0	4	5	10	15	70	100
2	Major 6	BSBC-402	Enzymology	4	0	0	4	5	10	15	70	100
3	Major 7	BSBC-403	Biochemical calculations of solutions	4	0	0	4	5	10	15	70	100
4	Practical 4 (based on Major (5+6+7)	BSBC-404P		0	0	4	3	5	10	15	70	100
5	Minor 4	BSBC-405	**Genomics and proteomics**	3	0	0	3	5	10	15	70	100
6	Ability Enhancement Course 3 (Course on NCC/NSS/ NGO,s/ Scout Guide / Sports)	AEC-	Course on NCC/NSS/ NGO,s/ Scout Guide / Sports	2	0	0	2	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**

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SYLLABUS MAJOR COURSES

Programme/Class: Certificate	**Year:** Second (II)	**Semester:** Third (III)
Department: BIOCHEMISTRY		
Couse Code: BSBC-301	**Course Title: BIOMOLECULES AND METABOLISM**	
Course Outcomes (COs)		
After completion of this course, students will be able to: • Understand the structure, function, and classification of major biomolecules such as carbohydrates, proteins, lipids, and nucleic acids. • Explain the principles of bioenergetics and thermodynamics in biological systems. • Describe metabolic pathways of carbohydrates and lipids and their regulation. • Acquire knowledge of enzymology including enzyme kinetics, classification, and coenzymes. • Understand the biological significance of nucleotides and metabolic integration.		
Credits: 3	**Core Compulsory**	

Unit	Topics	N0. of Lectures
I	**Amino Acids, Proteins and Carbohydrates** • Amino acids: Structure and properties. • Proteins: Classification, forces stabilizing structure, levels of structural organization. • Protein purification, denaturation and renaturation, fibrous and globular proteins. • Carbohydrates: Structure, function and properties of monosaccharides, disaccharides, and polysaccharides. • Homopolysaccharides, heteropolysaccharides, mucopolysaccharides, bacterial cell wall polysaccharides. • Glycoproteins and their biological functions.	**14**
II	**Bioenergetics and Metabolism Introduction** • Laws of thermodynamics, free energy, enthalpy, entropy, equilibrium constant. • Redox potential, electron flow, redox coupling and ATP bioenergetics, high-energy compounds. • Introduction to metabolism: Anabolic, catabolic and amphibolic pathways. • Enzymes in metabolism: Protein and non-protein (ribozymes), cofactors, prosthetic groups, apoenzymes, holoenzymes, inhibitors, modulators. • Enzyme classification (IUBMB), Fischer's and Koshland's hypotheses.	**10**

III	**Lipids and Nucleic Acids** • Lipids: Classification, structure and function of fatty acids, essential fatty acids. • Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, prostaglandins, cholesterol. • Nucleic acids: Structure and function, nucleosides and nucleotides, purines and pyrimidines. • Properties of DNA and RNA, biologically important nucleotides. • DNA structures: A, B & Z forms, denaturation and renaturation.	**12**
IV	**Enzymes and Coenzymes** • Enzymes: Nomenclature, classification, holoenzyme, apoenzyme, cofactors, coenzymes, prosthetic groups, metalloenzymes. • Monomeric and oligomeric enzymes, activation energy, transition state. • Enzyme activity, specific activity, active site characteristics, types of specificity and theories. • Extremophilic enzymes: Biocatalysts from thermophilic and hyperthermophilic archaea/bacteria. • Roles of NAD^+, $NADP^+$, FMN/FAD, Coenzyme A, TPP, PLP, lipoic acid, biotin, vitamin B_{12}, tetrahydrofolate, and metal ions.	**12**
V	**Carbohydrate Metabolism** • Glycolysis: Reactions, energetics, regulation; fate of pyruvate (aerobic and anaerobic). • Pentose phosphate pathway: Reactions and significance. • Gluconeogenesis, glycogenolysis, and glycogen synthesis. • TCA cycle, electron transport chain (ETC), oxidative phosphorylation. • β-oxidation of fatty acids.	**12**

Suggestive Reading Books:

- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
- Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
- Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
- Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
- Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

Course: Biomolecules and Metabolism Lab (Practical Major 3)
List of Practical

- Estimation of Serum Urea or Creatinine (Kidney Function – Nitrogen Metabolism Indicator)
- Measurement of Lactic Acid in Muscle Extract (Anaerobic Glycolysis)
- Separation of Metabolites using Paper Chromatography (e.g., Amino Acids)
- Demonstration of Lipase Activity (Lipid Metabolism)
- Urease Activity Assay (Nitrogen Metabolism)
- Qualitative Test for Ketone Bodies in Urine (Rothera's Test)
- Estimation of Blood Glucose (Glucose Oxidase Method)

Programme/Class: Certificate	**Year:** Second (II)	**Semester:** Third (III)
Subject: BIOCHEMISTRY		
Couse Code: BSBC-302	**Course Title: MOLECULAR BIOLOGY**	
Course Outcomes (COs)		
After completion of this course, students will be able to: • Understand the molecular organization and function of cellular components and membranes. • Comprehend the structure and properties of DNA and RNA in prokaryotic and eukaryotic systems. • Explore the mechanisms of DNA replication, transcription, and translation. • Learn gene regulation mechanisms in both prokaryotic and eukaryotic systems. • Analyze genetic code interpretation, post-transcriptional and post-translational modifications.		
Credits: 3	**Core Compulsory**	

Unit	Topics	N0. of Lectures
I	**Introduction to Molecular Biology and Cellular Structure** • Overview of molecular biology, evolution of cells and organelles. • Types of cells: Prokaryotic and eukaryotic variations. • Cell growth, adhesion, junctions, and extracellular matrix. • Cell membrane structure: Fluid mosaic model, membrane fluidity and asymmetry. • Active and passive membrane transport. • Cell cycle phases and checkpoints.	**12**
II	**Molecular Nature of Genetic Material** • Structure of DNA: Primary, secondary, and tertiary structures.	**10**

	• Double helix types; Evolution of DNA and RNA. • RNA: Types and molecular structure. • Genetic code, information transfer from DNA to RNA, and translation overview.	
III	**Gene Regulation and DNA Replication** • Gene regulation in prokaryotes: Lac operon, catabolic repression, Trp operon. • Gene expression in eukaryotes. • Plasmids: Types, maintenance, and functions. • DNA replication: Semi-conservative mechanism in prokaryotes and eukaryotes. • Enzymes in replication: DNA polymerases, proofreading, and post-replication modifications.	**14**
IV	**Transcription and RNA Processing** • Transcription: Synthesis of RNA from DNA template. • RNA polymerase, initiation, elongation, and termination of transcription. • Post-transcriptional and co-transcriptional modifications of RNA.	**12**
V	**Protein Biosynthesis** • Translation of genetic code and mRNA. • Role of rRNA in protein synthesis. • Formation of polypeptides: Elongation and termination steps. • Overview of post-translational modifications	**12**

Suggestive Reading Books:

- Molecular Biology of the Gene – By J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick
- Lodish. H, Berk. A, Lawrence, A, Matsudaira. A, Baltimore. D and Dernell. J. Molecular Cell Biology (Fourth Edition). – W.H. Freeman and Company. 2009
- Molecular Biology by T.A. Brown
- Genomes by T.A. Brown
- Sambrook et al 2000. Molecular cloning Volumes I, II & III, Cold Spring Harbor Laboratory Press New York, U SA

Course: Biomolecules and Metabolism and Molecular Biology Lab (Practical of Major 4)
List of Practical:

1. Qualitative tests for sugars, amino acids, proteins & lipids
2. Quantitative estimation of proteins (Folin-Phenol).
3. Quantitative estimation of sugars (DNS method)
4. Quantification of DNA (diphenylamine method)
5. Quantification of RNA (orcinol method)
6. Preparation of solutions for Molecular Biology experiments
7. Isolation of DNA from animal/Plant/bacterial cells.
8. Isolation of DNA from Plant
9. Isolation of DNA from Bacterial
10. Quantitation of DNA by Spectrophotometry

11. Agarose gel electrophoresis of genomic DNA.

Programme/Class: Certificate	**Year:** Second (II)	**Semester:** Fourth (IV)
Subject: BIOCHEMISTRY		
Couse Code: BSBC-401	**Course Title: BIOANALYTICAL TECHNIQUES**	
Course Outcomes (COs)		

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

- Understand fundamental solution chemistry and buffer systems used in biological studies.
- Learn the principles and applications of spectroscopy, centrifugation, and their role in bioanalysis.
- Gain theoretical and practical knowledge of chromatography for separation of biomolecules.
- Understand electrophoretic techniques and tracer methods for the detection and analysis of biological macromolecules.
- Explore advanced biophysical techniques including X-ray crystallography, fluorescence spectroscopy, and NMR for structure prediction of biomolecules.

Credits: 4	**Core Compulsory**

Unit	Topics	No. of Lectures
I	**Solution Chemistry and Buffers** • Water: Structure and interaction, water as a solvent. • pH, Bronsted-Lowry concept of acids and bases, ionization. • Buffers: Henderson-Hasselbalch equation, biological buffer systems (bicarbonate, phosphate, Tris). • Determination of molecular weight: Molarity, molality, normality, equivalent weight.	**10**
II	**Spectroscopy and Centrifugation** • Colorimetry: Basic principles and applications. • UV-Visible and IR spectroscopy: Beer-Lambert's law, instrumentation, applications. • Centrifugation: Principle and types, sedimentation coefficient, sedimentation velocity, ultracentrifugation. • Applications: Separation of macromolecules and subcellular fractionation.	**12**

III	**Chromatographic Techniques** • Basic principles and types of chromatography. • Paper chromatography, thin layer chromatography (TLC). • Column chromatography: Gel exclusion, adsorption, ion exchange, affinity. • Applications in separation of biomolecules.	**12**
IV	**Electrophoresis and Tracer Techniques** • Electrophoresis: Principle and types. • DNA and RNA gel electrophoresis. • Protein gel electrophoresis: SDS-PAGE, native PAGE, documentation. • 2D-electrophoresis, isoelectric focusing. • Tracer techniques: Radioactivity principles, isotopes, radioactive decay (α, β, γ). • Scintillation counting and applications of radioisotopes in biology.	**14**
V	**Biophysical Techniques** • Crystallography: Basic concepts, symmetry elements, laws, X-ray crystallography, determination of crystal structures. • Fluorescence: Concepts, emission, chemiluminescence, luminometry. • NMR spectroscopy: Basics and use in 2D & 3D structure prediction of biomolecules.	**12**
Suggestive Reading Books: • Principle and Techniques of Biochemistry and Molecular biology, 7th ed By Keith Wilson and Jhon Walker, Cambridge Press • Rodney Boyer, Modern Experimental Biochemistry, Pearson Education; 3 Edition		

Programme/Class: B.Sc	**Year:** II	**Semester:** IV
Subject: BIOCHEMISTRY		
Couse Code: BSBC-402	**Course Title: ENZYMOLOGY**	
Course Outcomes (COs)		

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This course introduces the fundamental concepts and applications of enzymology. After completion of this course, students will be able to—

- Understand the classification, nomenclature, and functions of enzymes.
- Analyse enzyme kinetics and regulatory mechanisms.
- Understand the catalytic mechanisms and enzyme action models.
- Gain insight into enzyme inhibition and industrial applications.
- Learn about immobilization techniques and the differences between free and immobilized enzymes.

Credits: 4	**Core Compulsory**

Unit	**Topics**	**N0. of Lectures**
I	• **Overview and classification of enzymes**: Historical perspective and definition of enzymes. Nomenclature of enzymes, enzyme classification and characteristics. Co-enzymes and cofactors. Isoenzymes, abzymes and ribozymes. Metalloenzymes and metal-activated enzymes. Units of enzyme activity. Proteolytic enzymes. Multienzyme complexes: pyruvate dehydrogenase and fatty acid synthase.	12
II	• **Enzyme Kinetics**: Factors affecting enzyme activity: pH, temperature and substrate concentration. Derivation of Michaelis–Menten equation. Limitations and transformation of the MM equation: Lineweaver–Burk plot and Hanes–Woolf plot. Km, Vmax and Kcat. Turnover number, catalytic efficiency and enzyme specificity.	12
III	• **Mechanism of Enzyme Catalysis**: Enzyme active site and its general characteristics. Mechanism of enzyme action: lock-and-key model, induced-fit hypothesis. Mechanisms of enzyme catalysis: acid–base catalysis, covalent catalysis, substrate strain and entropy effect. Mechanisms of action of chymotrypsin, lysozyme and carboxypeptidase.	10
IV	• **Enzyme Regulation**: Enzyme inhibition: reversible (competitive, uncompetitive and non-competitive) and irreversible. Enzyme regulation: covalent modification, allosteric, end-product, and feedback regulation.	12

V	• **Applications of Enzymes**: Immobilization techniques: adsorption, covalent binding, cross linking, entrapment, encapsulation. Properties of immobilized enzymes vs. free enzymes. Enzyme utilization in industry: Food and drink industries, artificial kidney machines, pharmaceutical and detergent industries.	14

Suggestive Reading Books:

1. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox
2. Biochemistry book by Jeremy M. Berg, John L. Tymoczko, Lubert Stryer
3. Fundamentals of Enzymology by Nicholas C. Price & Lewis Stevens
4. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer
5. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson & John Walker
6. Text book of Enzyme Technology by Martin F. Chaplin & Christopher Bucke

Course: EnzymologyLab (Practical of Major 5)

Practical List

- Preparation of Enzyme Extract (e.g., Amylase from Saliva or Germinating Seeds)
- Assay of Amylase Activity Using Starch as Substrate
- Effect of pH on Enzyme Activity
- Effect of Temperature on Enzyme Activity
- Effect of Substrate Concentration on Enzyme Activity (Michaelis-Menten Kinetics)
- Determination of Vmax and Km using Lineweaver-Burk Plot
- Effect of Enzyme Concentration on Reaction Rate
- Demonstration of Competitive Inhibition (e.g., with Urease or Sucrase)
- Demonstration of Non-Competitive Inhibition
- Estimation of Enzyme Activity in Biological Samples (e.g., Serum or Plant Tissues)

Programme/Class:B. Sc	**Year:** II	**Semester:** IV
Subject: BIOCHEMISTRY		
Couse Code: BSBC-403	**Course Title: BIOCHEMICAL CALCULATIONS OF SOLUTIONS**	

Course Outcomes (COs)

This course provides foundational knowledge of biochemical solution calculations. After completion of this course, students will be able to—

- Understand concentration units and solution preparation methods.
- Apply pH, buffer, and dilution principles in laboratory settings.
- Grasp osmolarity, tonicity, and their biological implications.
- Perform spectrophotometric and enzyme activity calculations.
- Implement good laboratory practices and analyze experimental errors.

Credits: 4	**Core Compulsory**	
Unit	**Topics**	**N0. of Lectures**

I	• Concentration Units and Solution Preparation: Definitions and conversions: Molarity, Molality, Normality, % (w/v, v/v), ppm, ppb. Preparation of standard and working solutions, Serial dilutions and dilution factor. Stock and working solutions: calculations and preparation. Concept of equivalents and normality in acid/base and redox reactions.	12
II	• pH and Buffer Calculations: Concept and definition of pH and pKa, Henderson-Hasselbalch equation and its application, Calculation of pH for weak acids and bases, Buffer capacity and buffer range, Preparation and standardization of common biological buffers (phosphate, acetate, Tris).	12
III	• Osmolarity and Tonicity: Concepts of osmolarity and osmolality, Calculating osmotic concentrations of solutions, Significance of tonicity in biological systems, Isotonic, hypertonic, and hypotonic solutions.	12
IV	• Spectrophotometric and Enzyme Activity Calculations: Beer-Lambert Law and its application, Calculations involving absorbance, concentration, and extinction coefficient. Enzyme units, specific activity, and turnover number. Basic enzyme kinetics and related numerical problems.	12
V	• Laboratory Math and Error Analysis: Significant figures and scientific notation, Mean, standard deviation, and relative error. Accuracy vs. precision. Good laboratory practices (GLP) in preparing and handling solutions.	12

Suggestive Reading Books:

1. Biochemical Calculations by Irwin H. Segel
2. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson & John Walker
3. Analytical Biochemistry by David Holme & Hazel Peck
4. Biochemistry Laboratory: Modern Theory and Techniques by Rodney F. Boyer
5. Textbook of Biochemistry for Medical Students by DM Vasudevan et al.
6. Laboratory Manual in Biochemistry by J. Jayaraman
7. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler

Course: Biochemical Calculations of Solutions Lab (Practical of Major 6)
Practical List

- Preparation of Molar Solutions (e.g., NaCl, Glucose)
- Preparation of Normal Solutions (e.g., HCl, NaOH)
- Serial Dilutions and Calculation of Dilution Factors

- Preparation of Buffer Solutions (e.g., Acetate, Phosphate Buffer)
- Titrimetric Standardization of a Base using Standard Acid (e.g., NaOH vs. HCl)
- Concept of Equivalent Weight and its Application in Solution Preparation

Minor Course Syllabus

Programme/Class: B.Sc	**Year:** II	**Semester:** III
Subject: BIOCHEMISTRY		
Couse Code: BSBC-304	**Course Title: DRUG DESIGNING**	
Course Outcomes (COs)		
his course introduces the key concepts of modern drug design and discovery. After completion of this course, students will be able to – • Understand the historical context and current approaches in drug discovery and development. • Learn principles of drug design including pharmacokinetics, pharmacodynamics, SAR, and QSAR. • Explore different molecular targets and mechanisms involved in drug action. • Apply basic computational tools in drug design such as molecular docking and pharmacophore modelling. • Gain insight into computer-aided drug design and virtual screening methods.		
Credits: 4	**Core Compulsory**	

Unit	**Topics**	**N0. of Lectures**
I	• **Introduction to Drug Discovery:** History and scope of drug discovery and development, Sources of drugs: natural, synthetic, semi-synthetic, and biological, Drug development process: discovery, preclinical, clinical trials, and approval, Lead compounds and lead optimization, Target identification and validation.	9
II	• **Principles of Drug Design:** Concepts of pharmacodynamics and pharmacokinetics (ADME), Structure-activity relationship (SAR), Quantitative structure-activity relationship (QSAR): basic principles and descriptors, Physicochemical properties influencing drug action: solubility, lipophilicity, ionization, Drug-receptor interactions: types of bonds, receptor theories.	9
III	• **Molecular Targets and Mechanisms of Drug Action:** Enzymes as drug targets (e.g., ACE inhibitors, protease inhibitors), Receptors as drug targets (GPCRs, nuclear receptors), Nucleic acids and ribosomes as drug targets.	9

IV	• **Computer-Aided Drug Design (CADD):** Introduction to computational drug design, Molecular docking: principles and applications, Virtual screening and ligand-based drug design, Pharmacophore modelling, Basics of molecular dynamics and cheminformatics.	9

Suggestive Reading Books:

1. An Introduction to Medicinal Chemistry by Graham L. Patrick
2. Foye's Principles of Medicinal Chemistry by David A. Williams & Thomas L. Lemke
3. Drug Design: Structure- and Ligand-Based Approaches by Kenneth M. Merz, Dagmar Ringe, Charles H. Reynolds
4. Computational Drug Design: A Guide for Computational and Medicinal Chemists by David C. Young
5. The Organic Chemistry of Drug Design and Drug Action by Richard B. Silverman & Mark W. Holladay

Programme/Class: Certificate	**Year:** Second (II)	**Semester:**Fourth (IV)
Subject: BIOCHEMISTRY		
Couse Code: BSBC-405	**Course Title: GENOMICS AND PROTEOMICS**	

Course Outcomes (COs)

- Understand the principles and applications of various DNA sequencing methods, including traditional (Maxam-Gilbert, Sanger) and advanced (pyrosequencing) techniques.
- Explain genome sequencing strategies such as shotgun and hierarchical methods and apply knowledge of genome assembly using computational tools.
- Use and navigate genome databases and web-based tools such as NCBI, ENSEMBL, VISTA, and UCSC Genome Browser for genome data analysis and retrieval.
- Describe the structure and chemical properties of proteins and understand the physical forces (hydrogen bonding, van der Waals, electrostatic, hydrophobic interactions) that influence protein structure and stability.
- Apply techniques for determining protein size and structure, including sedimentation analysis, gel filtration, SDS-PAGE, and Edman degradation.
- Demonstrate understanding of proteomics and analyze proteomes using techniques like 2D-PAGE and mass spectrometry, including protein sample preparation, separation, and identification.

Credits: 3	**Core Compulsory**

Unit	**Topics**	**No. of Lectures**
I	• Introduction to Genomics • DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing • Genome Sequencing: Shotgun & Hierarchical (clone	**6**

	contig) methods • Computer tools for sequencing projects: Genome sequence assembly software.	
II	• Managing and Distributing Genome Data • Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. • Selected Model Organisms' Genomes and Databases.	**3**
III	• Introduction to protein structure, Chemical properties of proteins. • Physical interactions that determine the property of proteins. • Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. • Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE) • Determination of covalent structures – Edman degradation.	**3**
IV	• Introduction to Proteomics, • Analysis of proteomes. 2D-PAGE. • Sample preparation, solubilization, reduction, resolution. • Reproducibility of 2D-PAGE. • Mass spectrometry-based methods for protein identification. • De novo sequencing using mass spectrometric data	**3**

Suggestive Reading Books:

- Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
- Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
- Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
- Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
- 6. Principles of Gene Manipulation 6th Edition, S.B. Primrose, R.M. Twyman and R.W. Old. Blackwell Science, 2001.

Syllabus for Multidisciplinary Courses

Programme/Class: B.Sc		**Year:** II	**Semester:** III
	Subject: BIOCHEMISTRY		
Couse Code: M-DIS-WMB		**Course Title:** WASTE MANAGEMENT AND BIOREMEDIATION	
	Course Outcomes (COs)		

	Course Outcomes (COs): **CO1:** Understand the fundamental concepts of waste, waste types, and waste management strategies. **CO2:** Explain physical, chemical, and biological waste treatment processes. **CO3:** Describe the mechanisms and applications of microbial and phytoremediation technologies. **CO4:**Analyze bioremediation methods used for soil, water, and industrial pollution cleanup. **CO5:** Evaluate sustainable waste management approaches and environmental regulations guiding waste handling and bioremediation.
Credits: 3	**Core Compulsory**

Unit		**Topics**	**N0. of Lectures**
I		Unit I — Introduction to Waste Management (12 Lectures) • Definition and classification of waste: solid, liquid, gaseous. • Sources of waste: domestic, industrial, agricultural, biomedical, and e-waste. • Principles of waste management: reduce, reuse, recycle (3Rs). • Waste collection, segregation, storage, and transportation.	12
II		Unit II — Waste Treatment Technologies (12 Lectures) • Physical waste treatment: screening, sedimentation, filtration. • Chemical waste treatment: neutralization, precipitation, oxidation, disinfection. • Biological treatment processes: aerobic and anaerobic digestion. • Composting and vermicomposting: principles and methods.	12
III		Unit III — Fundamentals of Bioremediation (12 Lectures) • Concept of bioremediation: definition, scope, importance. • Types of bioremediation: in situ vs. ex situ. • Role of microorganisms in remediation: bacteria, fungi, algae. • Factors affecting bioremediation efficiency (pH, nutrients, temperature, pollutants).	12

IV		Unit IV — Bioremediation Techniques and Applications (12 Lectures) • **Microbial remediation**: biodegradation of hydrocarbons, pesticides, and industrial wastes. • **Phytoremediation**: phytoextraction, phytostabilization, rhizofiltration, phytodegradation. • **Bioreactors** for waste treatment: aerobic, anaerobic, trickling filters, activated sludge. • Bioremediation of wastewater, heavy metals, and oil spills.	12
V		Unit V — Sustainability, Policies, and Future Perspectives (12 Lectures) • Sustainable waste management: circular economy and zero-waste concepts. • Environmental laws and regulations: Solid Waste Management Rules, 2016; Biomedical Waste Rules. • Risk assessment and monitoring in bioremediation projects.	
	Suggestive Reading Books: • **Chatwal, G. R., & Anand, S.** — *Instrumental Methods of Chemical Analysis*, Himalaya Publishing. • **Ashutosh Kar** — *Medicinal Chemistry*, New Age International. • **Wilson & Gisvold** — *Textbook of Organic Medicinal and Pharmaceutical Chemistry*, Lippincott. • **Patrick, G.** — *An Introduction to Medicinal Chemistry*, Oxford University Press. • **Lemke, T., & Williams, D.** — *Foye's Principles of Medicinal Chemistry*, Lippincott Williams & Wilkins.		

Syllabus for Skill enhancement Course

Programme/Class: B.Sc	**Year:** II	**Semester:** III
Subject: BIOCHEMISTRY		
Couse Code: SCE-HTMP	**Course Title:** HERBAL TECHNOLOGY AND MEDICINAL PLANTS	
Course Outcomes (COs)		

CO1: Understand the basic concepts of medicinal plants, herbal resources, and their role in traditional and modern healthcare.
CO2: Explain the classification, identification, and phytochemical properties of medicinal plants.
CO3: Describe methods involved in cultivation, processing, extraction, and quality control of herbal materials.
CO4: Analyze the uses of medicinal plants in Ayurveda, Siddha, Unani, and modern phytopharmaceuticals.
CO5: Evaluate regulatory, safety, commercialization, and sustainability aspects of herbal drugs and products.

Credits: 3	**Core Compulsory**

Unit	**Topics**	**N0. of Lectures**
I	Unit I — Introduction to Herbal Technology and Medicinal Plants (12 Lectures) • Definition, scope, and importance of medicinal plants. • Global and Indian scenario of herbal drug usage. • Difference between herbs, herbal formulations, nutraceuticals, and phytopharmaceuticals. • Overview of traditional systems: Ayurveda, Siddha, Unani, Folk medicine.	12
II	Unit II — Classification, Identification, and Phytochemistry (12 Lectures) • Classification of medicinal plants: habitat-based, phytochemical-based, and therapeutic-based. • Botanical identification: morphology, microscopy, organoleptic evaluation. • Introduction to pharmacognosy. • Phytochemicals: alkaloids, flavonoids, terpenoids, glycosides, tannins, phenolics.	12
III	Unit III — Cultivation, Processing, and Extraction Technologies (12 Lectures) • Good Agricultural and Collection Practices (GACP). • Cultivation methods of important medicinal plants (Neem, Tulsi, Ashwagandha, Aloe vera). • Post-harvest processing: drying, storage, preservation. • Extraction methods: maceration, solvent extraction, steam distillation, Soxhlet.	12
IV	Unit IV — Applications of Medicinal Plants and Herbal Products (12 Lectures) • Herbal formulations: powders, decoctions, syrups, tablets, ointments, oils. • Essential oils and aromatherapy. • Herbal cosmetics: skin, hair, and wellness applications.	12

V	Unit V — Safety, Regulations, and Commercialization (12 Lectures) • Toxicity, safety evaluation, and herbal-drug interactions. • National and international regulatory frameworks: AYUSH, WHO guidelines. • Intellectual Property Rights (IPR) and protection of traditional knowledge. • Good Manufacturing Practices (GMP) for herbal industries.	

Suggestive Reading Books:

- Kokate, C.K., Purohit, A.P., & Gokhale, S.B. **Pharmacognosy.**
- Trease & Evans. **Pharmacognosy.** Elsevier.
- Kalia, A.N. **Textbook of Industrial Pharmacognosy.**
- Purohit, S.S. **Medicinal Plants and Aromatic Plants.**
- WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants.
- Chopra, R.N. **Indigenous Drugs of India.**

III Year

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Life Science													
Batch:2024 -25							**SEM:V**						
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**
				L	**T**	**P**						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/ Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 8	BSBC-501	Plant Physiology	4	0	0	4	5	10	15	70	100
2	Major 9	BSBC-502	Animal Physiology	4	0	0	4	5	10	15	70	100
3	Practical 5 (based on Major (8+9)	BSBC-503P		0	0	4	2	5	10	15	70	100
4	Minor 5	BSBC-504	**Microbial remediation**	3	0	0	3	5	10	15	70	100
5	Minor 6	BSBC-505	**A. Microbial Enzyme production and its application** B. Microbial remediation C. Plant Microbe Interaction	3	0	0	3	5	10	15	70	100
6	Internship	BSBC-506I		2	0	0	4	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT												
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Life Science												
Batch:2024 -25							**SEM:VI**					
S. No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**
				L	**T**	**P**						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/ PPT/ Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 10	BS BC-601	**Fundamentals of Nanobiotechnology**	4	0	0	4	5	10	15	70	100
2	Major 11	BS BC-602	Environmental Biochemistry	4	0	0	4	5	10	15	70	100
3	Major 12	BS BC-603	Industrial Biochemistry	4	0	0	4	5	10	15	70	100
4	Practical 6 (based on Major (10+11+12)	BS BC-604 P		0	0	4	2	5	10	15	70	100
5	Minor 7	BS BC-605	A. Stem Cell Biology B. Vaccine Development	3	0	0	3	5	10	15	70	100
6	Minor 8	BS BC-606	A. Stem Cell Biology B. Vaccine Development	3	0	0	3	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**

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SYLLABUS MAJOR COURSES

Programme/Class: B.Sc	**Year:** III	**Semester:** V
Subject: BIOCHEMISTRY		
Couse Code: BSBC-501	**Course Title: PLANT PHYSIOLOGY**	
Course Outcomes (COs)		
This course provides comprehensive knowledge of physiological processes in plants. After completion of this course, students will be able to • Understand water relations, nutrient uptake, and transpiration mechanisms. • Explain photosynthesis, respiration, and enzyme activity in plants. • Learn about nitrogen and lipid metabolism. • Analyze plant growth and developmental processes including hormonal regulation. • Understand plant responses like tropic and nastic movements.		
Credits: 4	**Core Compulsory**	

Unit	Topics	N0. of Lectures
I	• Plant–Water Relations: Diffusion and osmosis, osmotic potential, absorption of water, ascent of sap. Transpiration: significance and factors affecting it; mechanism of stomatal opening and closing. Mineral Nutrition: essentiality of elements; sand and water culture; macro- and micronutrients, their roles and deficiency symptoms; mechanism of ion uptake (passive and active).	12
II	• Enzymes: Discovery, classification and characteristics of enzymes. Photosynthesis: Photosynthetic pigments; photochemical reactions—reaction centers, O2 evolution, photophosphorylation; CO_2 fixation—C_3 and C_4 carbon cycle, CAM plants, photorespiration and glycolate metabolism; factors affecting photosynthesis.	12
III	• Respiration: Aerobic and anaerobic respiration; respiratory pathways—glycolysis, Krebs cycle, pentose phosphate pathway; electron transport, oxidative phosphorylation, cyanide resistance. Lipid Metabolism: Fatty acid synthesis and its oxidation (α and β). Nitrogen Metabolism: Nitrogen cycle, biological nitrogen fixation, nitrite and nitrate reduction, nitrogen assimilation.	12
IV	• Growth and Development: General aspects and phases of growth; flowering—photoperiodism and vernalization, circadian rhythm; seed germination; bud and seed dormancy; abscission and senescence. Phytohormones: Discovery, physiological roles, mechanism of action and	12

	applications of auxins, kinetin, gibberellins, abscisic acid and ethylene. Plant Movement: Nastic and tropic movements.	

Suggestive Reading Books:

1. Plant Physiology and Development by *Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, Angus Murphy*
2. Plant Physiology by *Frank B. Salisbury and Cleon W. Ross*
3. Biochemistry and Molecular Biology of Plants by *Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jones*
4. Introduction to Plant Physiology by *William G. Hopkins and Norman P.A. Hüner*
5. Plant Biochemistry by *Hans-Walter Heldt and Birgit Piechulla*
6. Plant Hormones: Biosynthesis, Signal Transduction, Action by *Peter J. Davies (Editor)*

Course: Plant Physiology Lab (Practical of Major 7)

Practical List

- Demonstration of Osmosis using Potato Osmoscope.
- Measurement of Water Loss through Transpiration (Cobalt Chloride Method)
- Comparative Rate of Transpiration using Four-Leaf Experiment
- Measurement of Rate of Photosynthesis using Aquatic Plants (e.g., Hydrilla)
- Effect of Light Intensity and CO_2 on Photosynthesis
- Extraction and Separation of Plant Pigments by Paper Chromatography
- Demonstration of Aerobic Respiration in Germinating Seeds (CO_2 Detection)
- Study of Imbibition using Gram Seeds
- Effect of Plant Growth Regulators (e.g., Gibberellin, Auxin) on Plant Growth

Programme/Class:B.Sc	**Year:** III	**Semester:** V
Subject: BIOCHEMISTRY		
Couse Code: BSBC-502	**Course Title:** ANIMAL PHYSIOLOGY	

Course Outcomes (COs)

This course provides an understanding of physiological processes in animals. After completion of this course, students will be able to—

- Understand the physiology of digestion and respiration.
- Explain blood composition, heart function, and circulation mechanisms.
- Grasp muscle physiology, osmoregulation, and excretion processes.
- Describe nervous system function and hormonal regulation.

Credits: 4	**Core Compulsory**

Unit	Topics	N0. of Lectures
I	• Digestion and Respiration: Mechanism of digestion and absorption of carbohydrates, proteins, lipids, and nucleic acids. Composition of bile, saliva, pancreatic, gastric, and intestinal juice. Respiration: Exchange of gases, transport	12

	of O_2 and CO_2, oxygen dissociation curve, chloride shift.	
II	• Circulation: Composition of blood, plasma proteins and their role, blood cells, haemopoiesis, mechanism of coagulation of blood. Heart function: Cardiac output, cardiac cycle, origin and conduction of heartbeat.	12
III	• Muscle Physiology and Osmoregulation: Structure of cardiac, smooth and skeletal muscles. Threshold stimulus, all-or-none rule, single muscle twitch, muscle tone, isotonic and isometric contraction. Physical, chemical and electrical events of muscle contraction. Excretion: Modes of excretion, ornithine cycle, mechanism of urine formation.	12
IV	• Nervous and Endocrine Coordination: Generation and propagation of nerve impulse, structure of synapse, synaptic and saltatory conduction, neurotransmitters. Hormones: Mechanism of action of insulin and steroid hormones. Endocrine glands: Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, with hypo- and hyper-secretions.	12

Suggestive Reading Books:

1. Guyton and Hall Textbook of Medical Physiologyby*John E. Hall*
2. Human Physiologyby*C.C. Chatterjee*
3. Human Physiology: From Cells to Systemsby*Lauralee Sherwood*
4. Textbook of Medical Physiologyby*Indu Khurana*
5. Principles of Anatomy and Physiologyby*Gerard J. Tortora and Bryan Derrickson*
6. Essentials of Animal Physiologyby*S.C. Rastogi*

Course: Animal Physiology Lab (Practical of Major 8)

Practical List

- Study of Blood Components using Microscope (RBCs, WBCs)
- Estimation of Hemoglobin Content (Sahli's Method)
- Measurement of Blood Pressure using Sphygmomanometer
- Measurement of Pulse Rate before and after Exercise
- Effect of Temperature on Rate of Heartbeat in Frog/Tadpole (Demonstration)
- Measurement of Lung Capacity using Spirometer (or Balloon Method)
- Observation of Urine Samples – Color, pH, Specific Gravity
- Study of Salivary Amylase Activity on Starch

Programme/Class: Certificate	**Year:** Third (III)	**Semester:** Sixth (VI)
Department: BIOCHEMISTRY		
Couse Code: BSBC-601	**Course Title: FUNDAMENTALS OF NANOBIOTECHNOLOGY**	
Course Outcomes (COs)		
After completion of this course, students will be able to: • Understand the foundational concepts of nanobiotechnology and its evolution from biotechnology. • Learn the integration of molecular biology and nanotechnology for designing biomolecules. • Explore the principles and mechanisms of nano-scale biomolecular systems. • Analyze the potential of nanotechnology in medicine, including drug delivery and diagnostics. • Examine modern applications of nanobiotechnology in biosensors, artificial life, and hybrid materials.		
Credits: 4	**Core Compulsory**	

Unit	Topics	N0. of Lectures
I	**Introduction to Nanobiotechnology** • Overview: From Biotechnology to Bio nanotechnology. • Bio-nano machines in action. • Modern biomaterials and the legacy of biological evolution.	**10**
II	**Biomolecular Design and Tools** • Design of biomolecules in biotechnology. • Recombinant DNA technology. • Monoclonal antibodies and their applications. • Biomolecular structure determination. • Molecular medicine and therapeutic applications.	**12**
III	**Functional Principles of Nanobiotechnology** • Information-driven nano assembly. • Energetics and chemical transformations at nanoscale. • Regulation, biomolecular motors, sensing, and self-replication. • Machine-phase nanobiotechnology.	**12**
IV	**Nanomedicine** • Applications in drug development: Anti-AIDS drugs. • Immunotoxins as targeted cell killers. • Artificial blood substitutes. • Cyclic peptides derived from nanotubes.	**13**

V	**Applications of Nanobiotechnology** • Harnessing molecular motors. • DNA computing and molecular programming. • Molecular design using biological selection. • Artificial life and hybrid biomaterials. • Biosensors and their applications in diagnostics.	**13**

Suggestive Reading Books:

- *Synthesis, Properties, and Applications of Oxide Nanomaterials, edited by José A. Rodriguez, Marcos Fernández-García*
- *Nanochemistry: A Chemical Approach to Nano materials, By Geoffrey A. Ozin, André C. Arsenault, Ludovico Cademartiri*
- *Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers. Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby*
- *Nanomaterial Interfaces in Biology: Methods and Protocols, Paolo Bergese, Kimberly Hamad- Schifferli*
- *Optical Properties and Spectroscopy of Nano materials, Jin Z. Zhang*

Programme/Class: B. Sc	**Year:** III	**Semester:** VI
Subject: BIOCHEMISTRY		
Couse Code: BSBC-602	**Course Title:** ENVIRONMENTAL BIOCHEMISTRY	

Course Outcomes (COs)

This course provides insight into the biochemical basis of environmental pollution, toxicology, and sustainable practices. After completion of this course, students will be able to—

- Understand sources and effects of environmental pollutants.
- Learn microbial and plant-based strategies for bioremediation.
- Explain biochemical responses to environmental stress and xenobiotics.
- Apply knowledge of detoxification and antioxidant defence mechanisms.
- Evaluate green chemistry practices and biosensor technologies for sustainability.

Credits: 4	**Core Compulsory**

Unit	**Topics**	**N0. of Lectures**
I	• Air, Water, and Soil Pollution: Types of pollutants—chemical, physical, and biological. Sources and effects of air pollutants: CO_2, SO_2, NO_x, particulates, CFCs. Water pollution: biochemical aspects of BOD, COD, DO. Soil contamination: heavy metals, pesticides, herbicides, and their biochemical impact. Eutrophication and acid rain: biochemical perspectives.	12

II	• Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Microbial degradation of lignin and cellulose. Phytoremediation. Microbial degradation of pesticides and other toxic chemicals including aromatic and chlorinated hydrocarbons and petroleum products.	12
III	• Toxicology and Xenobiotics: Introduction to toxicology and environmental toxicants. Biochemical effects of xenobiotics: pesticides, drugs, industrial chemicals. Xenobiotic metabolism: Phase I and Phase II reactions. Detoxification mechanisms in liver and microbes. Biomarkers of environmental exposure and toxicity.	12
IV	• Environmental Stress and Adaptation: Biochemical responses to stress conditions (heat, drought, salinity, heavy metals). Oxidative stress and reactive oxygen species (ROS). Antioxidant defense in plants and animals. Stress proteins and their role in adaptation.	12
V	• Bioremediation and Sustainable Environment: Principles and types of bioremediations (in situ and ex situ). Microbial degradation of pollutants: hydrocarbons, plastics, pesticides. Biosensors for environmental monitoring. Phytoremediation and bioaugmentation. Green chemistry and sustainable pollution control practices.	12

Suggestive Reading Books:

1. Environmental Biochemistryby P.K. Gupta
2. Principles of Environmental Science: Inquiry and Applicationsby William P. Cunningham and Mary Ann Cunningham.
3. Introduction to Biodeteriorationby D. Allsopp, K.J. Seal, and C.C. Gaylarde
4. Environmental Toxicology by T.W. Clarkson
5. Microbial Ecology: Fundamentals and Applicationsby Ronald M. Atlas and RichardBartha
6. Biodegradation and Bioremediationby Martin Alexander
7. Environmental Microbiologyby Ian L. Pepper, Charles P. Gerba, and Terry J. Gentry

Course: Environment and Industrial Biochemistry Lab (Practical of Major 9 and 10)

Practical List

- Estimation of Dissolved Oxygen (DO) in Water Samples (Winkler's Method)
- Estimation of Biological Oxygen Demand (BOD)
- Estimation of Chemical Oxygen Demand (COD)
- Determination of pH, Temperature, and Turbidity of Water Samples
- Estimation of Nitrate and Phosphate Content in Water or Soil
- Detection of Heavy Metals (e.g., Lead, Cadmium) in Water using Colorimetric Methods
- Estimation of Chlorophyll Content in Algae/Water Plants (using Acetone Extraction)

- Study of Biodegradation using Microbes (Observation of Organic Matter Breakdown)

Programme/Class: B.Sc	**Year:** III	**Semester:** VI
Subject: BIOCHEMISTRY		
Couse Code: BSBC-603	**Course Title:** INDUSTRIAL BIOCHEMISTRY	
Course Outcomes (Cos)		
This course offers foundational and applied understanding of biochemistry in industrial processes. After completion of this course, students will be able to— • Understand the scope and evolution of industrial biotechnology. • Gain knowledge of fermentation types and fermenter design. • Study production of industrially relevant metabolites and enzymes. • Learn downstream processing and scale-up of microbial production. • Understand enzyme applications, SCP/SCO, and biofuel technology.		
Credits: 4	**Core Compulsory**	

Unit	Topics	N0. Of Lectures
I	• Introduction to Industrial Biotechnology: Definition, scope, and importance. History and development of industrial biotechnology. Differences between industrial microbiology and biotechnology. Microbial diversity in industrial processes. Isolation, screening, and improvement of industrial microorganisms. Industrially important microbes: *Aspergillus*, *Penicillium*, *Saccharomyces*, *Streptomyces*, *E. coli*.	15
II	• Fermentation Technology: Basic principles of fermentation. Types: Batch, fed-batch, continuous. Fermenter design and components. Sterilization, aeration, agitation, pH and temperature control. Downstream processing: separation, purification, and product recovery. Solid state and submerged fermentation.	15

III	• Production of Primary and Secondary Metabolites: Alcohol (ethanol), organic acids (citric acid, lactic acid), antibiotics (penicillin, streptomycin), vitamins (B12, riboflavin), amino acids (glutamic acid, lysine), enzymes (amylase, protease, cellulase, lipase), industrial solvents and biopolymers. Scale-up of microbial processes.	15
IV	• Enzyme and Bioproduct Technology: Industrial enzyme technology—sources, production, immobilization. Applications in food, textile, detergent, pharmaceutical, and paper industries. Biotransformation and biocatalysis. Single Cell Protein (SCP) and Single Cell Oil (SCO). Biofuels: bioethanol, biogas, biodiesel. Bioplastics and biodegradable materials.	15

Suggestive Reading Books:

1. Industrial Microbiologyby L.E. Casida Jr.
2. Principles of Fermentation Technologyby Peter F. Stanbury, Allan Whitaker, and Stephen J. Hall
3. Industrial Biotechnology: Sustainable Growth and Economic Successby Christoph Wittmann and James C. Liao
4. Textbook of Industrial Microbiologyby Wulf Crueger and Anneliese Crueger
5. Biotechnology: A Textbook of Industrial Microbiologyby T.D. Brock and D. D. Deshpande
6. Biochemical Engineering and Biotechnologyby Ghasem Najafpour

Syllabus for Minor Courses

Programme/Class: Certificate	**Year:** Third (III)	**Semester:**Fifth (V)
Subject: BIOCHEMISTRY		
Couse Code: BSBC-505	**Course Title: MICROBIAL REMEDIATION**	
Course Outcomes (COs)		
• Understand the principles and scope of microbial remediation and its importance in environmental biotechnology. • Identify different types of pollutants and comprehend microbial strategies for their degradation or transformation. • Evaluate the role of aerobic and anaerobic microbial pathways in bioremediation of industrial, agricultural, and heavy metal pollutants. • Gain insight into practical approaches including biosensors and genetically engineered microbes for effective remediation strategies.		
Credits: 3	**Core Compulsory**	

Unit	Topics	No. of Lectures
I	• Introduction to Microbial Remediation: Scope and Significance • Types of Environmental Pollutants: Organic, Inorganic, Agrochemical, and Heavy Metals • Microbial metabolism and transformation of xenobiotics • Factors affecting microbial remediation efficiency	**3**
II	• Microbial degradation of hydrocarbons and oil spills • Bioremediation of pesticides and agrochemical wastes • Aerobic vs Anaerobic remediation pathways • Case studies on field applications of microbial remediation	**3**
III	• Microbial mechanisms for heavy metal remediation: Biosorption, bioaccumulation, bioprecipitation • Use of fungi and algae in heavy metal cleanup • Bioleaching and microbial mining • Genetic engineering approaches in microbial remediation	**6**
IV	• In situ and Ex situ remediation techniques • Biosensors for pollutant detection and monitoring • Role of consortia and synthetic biology in remediation • Future trends: Bio stimulation, bioaugmentation, and sustainable technologies	**3**

Suggestive Reading Books:

- Environmental Microbiology by R. M. Maier, I. L. Pepper, C. P. Gerba, Academic Press.
- Bioremediation: Principles and Applications by R. L. Crawford and D. L. Crawford, Cambridge University Press.
- Environmental Biotechnology by Bruce E. Rittmann and Perry L. McCarty, McGraw Hill.
- Microbial Ecology: Fundamentals and Applications by Ronald M. Atlas and Richard Bartha.
- Manual of Environmental Microbiology (3rd Edition), Edited by C. J. Hurst et al., ASM Press.

Programme/Class: Certificate	**Year:** Third (III)	**Semester:**Fifth (V)
Subject: BIOCHEMISTRY		
Couse Code: BSBC-505	**Course Title: MICROBIAL ENZYME PRODUCTION AND ITS APPLICATION**	
Course Outcomes (COs)		

- Understand the sources, types, and mechanisms of microbial enzyme production.
- Describe upstream and downstream processes for enzyme production, purification, and characterization.
- Identify the industrial applications of microbial enzymes in pharmaceuticals, food, textiles, and bioremediation.
- Analyze strategies for strain improvement, enzyme engineering, and regulatory aspects of enzyme commercialization.

Credits: 3	**Core Compulsory**

Unit	**Topics**	**No. of Lectures**
I	• Introduction to microbial enzymes: types, classification (EC system) and significance • Sources of microbial enzymes: Bacteria, fungi, actinomycetes • Primary and secondary metabolism in enzyme production • Regulation of enzyme biosynthesis	**6**
II	• Fermentation technology for enzyme production (submerged and solid-state) • Optimization of fermentation parameters • Downstream processing: extraction, purification, and concentration of enzymes • Enzyme formulation and stabilization	**3**
III	• Characterization of microbial enzymes: activity, kinetics, pH/temperature stability • Immobilization of enzymes and their advantages • Genetic engineering and strain improvement for enhanced enzyme yield • Expression systems: Recombinant enzyme production in *E. coli*, yeast	**3**
IV	• Applications of microbial enzymes in food (amylase, protease), textiles (cellulase), pharmaceuticals (penicillinase), and detergents (lipase) • Role in bioremediation and environmental applications Enzymes in molecular biology (Taq polymerase, restriction enzymes) • Regulatory, patenting, and commercialization aspects	**3**

Suggestive Reading Books:

- Industrial Enzymes and Biotechnology by Ajit Sadana
- Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer
- Industrial Microbiology by L. E. Casida
- Principles of Fermentation Technology by Peter F. Stanbury, Allan Whitaker, and Stephen J. Hall
- Biotechnology: A Textbook of Industrial Microbiology by Wulf Crueger and Anneliese Crueger
- Microbial Biotechnology by Alexander N. Glazer and Hiroshi Nikaido

Programme/Class: Certificate	**Year:** Third (III)	**Semester:**Sixth (VI)
Subject: BIOCHEMISTRY		
Couse Code: BSBC-605	**Course Title: VACCINE DEVELOPMENT**	
Course Outcomes (COs)		

- Understand the history and basic immunological principles of vaccines.
- Explain various types of vaccines and their mechanisms of action.
- Demonstrate knowledge of modern vaccine production technologies including recombinant and mRNA-based vaccines.
- Evaluate safety, efficacy, regulatory frameworks, and ethical concerns related to vaccine development.

Credits: 3	**Core Compulsory**

Unit	Topics	No. of Lectures
I	**Introduction to Vaccines and Immunological Basis** • History and evolution of vaccines • Types of immunity: Active and passive • Antigen, antibody, and immune response • Principles of vaccine-induced protection • Herd immunity and community protection • Ideal characteristics of vaccines	**6**
II	**Types of Vaccines and Their Mechanisms** • Live attenuated and inactivated vaccines • Toxoid vaccines • Subunit and conjugate vaccines • Recombinant DNA and vector-based vaccines • DNA and mRNA vaccines • Adjuvants and their role in enhancing immunogenicity	**3**

III	**Vaccine Production Technologies** • Vaccine development pipeline: Discovery to deployment • Cell culture and fermentation in vaccine production • Purification and formulation of vaccines • Cold chain management and delivery systems • Case studies: COVID-19, HPV, Hepatitis B vaccines • Role of bioinformatics and reverse vaccinology	**3**
IV	**Regulatory, Ethical, and Global Aspects** • Clinical trials: Phases I–IV • Safety evaluation and post-marketing surveillance • Regulatory bodies: WHO, FDA, DCGI • Intellectual property rights in vaccine development • Ethical issues in vaccine trials and distribution • Global initiatives: GAVI, COVAX, UNICEF	**3**

Suggestive Reading Books:

- Stanley A. Plotkin et al. – Vaccines, Elsevier
- Ian R. Tizard – Immunology: An Introduction
- Lauren Sompayrac – How the Immune System Works
- Janeway's Immunobiology – Kenneth Murphy
- WHO Guidelines and CDC Vaccine Information Statements

Programme/Class: Certificate	**Year:** Third (III)	**Semester:**Sixth (VI)
Subject: BIOCHEMISTRY		
Couse Code: BSBC-605	**Course Title: STEM CELL BIOLOGY**	
Course Outcomes (COs)		
• The objective of this paper is to familiarize the students with stem cell technology and its applications for betterment of the society. • The course is designed to give a broad view of mammalian stem cells, reviewing where they are found in the body, the different types and how they are cultured. • The topics will cover the basic biology of these stem cells as well as bioengineering and application of these stem cells to potential treatments of human diseases.		
Credits: 3	**Core Compulsory**	

Unit	**Topics**	**No. of Lectures**

I	**Introduction to stem cells** • Definition, properties, proliferation • Culture of stem cells, • Medical applications of stem cells • Ethical and legal issues in use of stem cells.	**3**
II	**Types of stem cells.** • Stem Cell biology and therapy, • Types: Embryonic stem cell, adult stem cell • Stem Cell Biology and Therapy • Embryonic Stem Cells • Culture and the potential benefits of stem cell technology	**3**
III	**Therapeutic applications of stem cells** • Gene Therapy: Introduction, History and evolution of Gene therapy, optimal disease targets, • Failures and successes with gene therapy and future prospects, • Genetic Perspectives for Gene Therapy • Gene Delivery methods: Viral vectors and Non-viral Vectors	**6**
IV	**Ethical Issues associated with stem cell-based regenerative medicine field** • Regulatory and Ethical Considerations of stem cell and Gene Therapy, • Assessing Human Stem Cell Safety • Use of Genetically Modified Stem Cells in Experimental Gene Therapies.	**3**

Suggestive Reading Books:

- Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
- Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
- Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer.

IV Year

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT												
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Life Science												
Course- B.Sc. Biochemistry												
Batch:2024 -25							**SEM:VII**					
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**
				L	**T**	**P**						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 13	BSBC-701	**Bioethics, biosafetry and IPR**	4	0	0	4	5	10	15	70	100
2	Major 14	BSBC-702	**Computational biology and bioinformatics in research**	4	0	0	4	5	10	15	70	100
3	Practical 7 (based on Major (13+14)	BSBC-703P		0	0	4	2	5	10	15	70	100
4	Major 15	BSBC-704	Medical biochemistry and diagnostics	4	0	0	4	5	10	15	70	100
5	Minor 9	BSBC-705	**Literature review and scientifuc writing**	3	0	0	4	5	10	15	70	100
6	Practical 8 (based on Major 15)	BSBC-706P		0	0	4	2	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT												
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Life Science												
Course- B.Sc. Biochemistry												
Batch:2025-26							**SEM:VIII**					
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**CREDITS**	**Internal Assessment**			**External Assessment**	**Total**
								Attendance (5)	**Quiz/ PPT/ Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
	THEORY and PRACTICAL SUBJECTS			**L**	**T**	**P**						
1	Major 16	BSBC-801	**Research Methodology**	4	0	0	4	5	10	15	70	100
2	Minor 10	BSBC-802	A. Enterpreneurship in Biotechnology B. Enterpreneurship in Biochemistry C. Enterpreneurship in Microbiology	3	0	0	4	5	10	15	70	100
4	Research Project / Dissertation	BSBC-803RP/ DS		2	0	0	12	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							**20**	**15**	**30**	**45**	**210**	**300**

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SYLLABUS MAJOR COURSES

Programme/Class: Certificate	**Year:** Fourth (IV)	**Semester:** Seventh (VII)
Department: BIOCHEMISTRY		
Couse Code: BSBC-701	**Course Title: BIOETHICS, BIOSAFETY AND IPR**	
Course Outcomes (COs)		
After completion of this course, students will be able to: • Understand the principles and levels of biosafety in biotechnological research. • Analyze ethical, legal, and societal issues related to biotechnology and genetic manipulation. • Comprehend the importance, process, and legal framework of patents, especially in biological systems. • Learn about national and international regulatory frameworks for GMOs and biotechnology research. • Gain insight into project formulation, financial analysis, and funding opportunities in biotechnology ventures.		
Credits: 4	**Core Compulsory**	

Unit	Topics	N0. of Lectures
I	**Biosafety** • Introduction and historical perspective of biosafety. • Objectives and risk assessment in biotechnological research. • Regulation of physical and biological contaminants. • Field trials and introduction of GMOs. • Biosafety guidelines in India. • Biosafety levels in plant, animal, and microbial research.	**12**
II	**Bioethics** • Introduction to bioethics. • Ethical issues in biotechnology: legal and socio-economic implications. • Health and safety concerns. • Ethical concerns in gene cloning and environmental engineering. • Human cloning and stem cell research ethics. • Potential benefits and challenges of cloning.	**10**
III	**Patents and Intellectual Property Rights (IPR)** • Basics and essential requirements of patents. • International patenting landscape. • Patenting biological materials. • Significance of patents in India. • Patent application procedures and granting process. • Patent protection for biotechnological inventions. • Overview of Indian Patent Act (1970) and Amendments (2002).	**14**

IV	**Regulatory Framework in Biotechnology** • Regulation of recombinant DNA technology (RDT) research. • Food and ingredient regulation. • Regulatory framework for GMOs in India. • Recombinant DNA Guidelines (1990). • Guidelines for Transgenic Plant Research (1998). • Prevention of Food Adulteration Act (1955). Food Safety and Standards Bill (2005).	**12**
V	**Project Management and Financial Analysis** • Concept of project: types, identification, formulation, design. • Network analysis and project reporting. • Project appraisal methods. • Financial analysis: ratio analysis, investment evaluation, break-even and profitability analysis. • Budgeting and planning. • Biotechnology funding: financing options, venture capital, and funding mechanisms in India.	**12**

Suggestive Reading Books:

- Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
- Intellectual property rights and Bio-Technology (Biosafety and Bioethics), Anupam Singh,
- Sasson A, Biotechnologies and Development, UNESCO Publications.
- Singh K, Intellectual Property rights on Biotechnology, BCIL, New Delhi
- Regulatory Framework for GMOs in India (2006) Ministry of Environment and Forest.

Programme/Class: Certificate	**Year:** Fourth (IV)	**Semester:** Seventh (VII)
Department: BIOCHEMISTRY		
Couse Code: BSBC-702	**Course Title: COMPUTATIONAL BIOLOGY AND BIOINFORMATICS IN RESEARCH**	
Course Outcomes (COs)		
After completion of this course, students will be able to: • Understand the foundations and history of bioinformatics and computational biology. • Gain familiarity with major biological databases and their applications. • Learn sequence alignment, database searching, and genome annotation tools. • Perform phylogenetic and sequence similarity analyses using online tools like BLAST and FASTA. • Interpret biological data for research applications using computational tools.		
Credits: 4	**Core Compulsory**	

Unit	Topics	N0. of Lectures
I	**Introduction to Bioinformatics and Databases** • Introduction and history of bioinformatics. • Concept of homology in biological sequences. • Sequence information sources: EMBL, GenBank, Entrez, UniGene. • Types of biological databases: Primary and Secondary. • Nucleotide sequence databases: EMBL, DDBJ, GenBank. • Overview and structure of databases and their web access.	**12**
II	**Protein Databases and Data Generation** • Protein databases: PDB, SWISSPROT, TREMBL. • Understanding the structure and retrieval of data. • Data generating techniques in bioinformatics. • Challenges in data management and interpretation.	**10**
III	**Sequence Alignment and Analysis** • Detecting Open Reading Frames (ORFs). • Basics of sequence assembly. • Mutation and substitution matrices. • Pairwise sequence alignment: Concepts and applications. • Introduction to BLAST, online use, and interpretation. • Multiple sequence alignment basics.	**12**
IV	**Database Searching and Genome Annotation** • Database searching tools: SRS, Entrez. • Sequence similarity searches using BLAST and FASTA. • Data submission methods. • Genome annotation: Pattern recognition, repeat finding. • Gene identification tools and their applications.	**12**
V	**Phylogenetics and Comparative Analysis** • Sequence and phylogeny analysis overview. • Detecting ORFs and interpreting sequence data. • Use of BLAST and sequence assembly review. • Pairwise and multiple sequence alignments. • Phylogenetic analysis and interpretation of evolutionary relationships.	**14**

Suggestive Reading Books:

- Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications.
- Oxford University Press.
- Wünschiers, R. (2004). Computational Biology: Unix/Linux, data processing and
- programming. Springer.
- Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. Garland Science.

Course: Bioethics, Biosafety and IPR and Computational biology and bioinformatics lab (Practical VII of Major 13 and 14)

List of Practical

1. Project designing and writing
2. Review the literatures of accepted patents
3. Development of creative ideas for commercialization of technology
4. Sequence information resource
5. Understanding and use of various web resources: EMBL, GenBank, Entrez, Unigene, Protein information resource (PIR)
6. Understanding and using: PDB, Swissport, TREMBL
7. Using various BLAST and interpretation of results.
8. Retrieval of information from nucleotide databases.
9. Sequence alignment using BLAST.
10. Multiple sequence alignment using Clustal W.

Programme/Class: B.Sc	**Year: IV**	**Semester: VII**
Subject: BIOCHEMISTRY		
Couse Code: BSBC-704	**Course Title:** MEDICAL BIOCHEMISTRY AND DIAGNOSTICS	

Course Outcomes (COs)

This course provides a clinical understanding of biochemical processes and disease conditions. After completion of this course, students will be able to—

- Understand the principles of clinical biochemistry and laboratory quality control.
- Interpret biochemical parameters in carbohydrate, protein, lipid, and nucleic acid disorders.
- Learn sample collection and handling for clinical investigations.
- Recognize biochemical markers in metabolic and genetic diseases.

Credits: 4	**Core Compulsory**

Unit	**Topics**	**N0. of Lectures**
I	• Approaches to Clinical Biochemistry: Concepts of accuracy, precision, sensitivity, and reproducibility. Quality control and determination of normal range. Collection and processing of blood and urine samples. Use of anticoagulants, preservatives, and methods for transport of biological samples.	9

II	• Disorders of Carbohydrate Metabolism: Normal fasting and post-prandial blood glucose levels. Mechanism of blood glucose homeostasis, hypoglycemia and hyperglycemia, renal threshold value. Diabetes mellitus: types, diagnosis, features, metabolic defects, complications. GTT, galactosemia, fructosuria, glycogen storage diseases.	9
III	• Disorders of Protein Metabolism: Clinical significance and variation of plasma and serum proteins. Phenylketonuria, alkaptonuria, albinism, tyrosinosis. Urea cycle disorders. Significance of non-protein nitrogen: BUN and creatinine. Clearance tests and abnormal urinary constituents.	9
IV	• Disorders of Lipid and Nucleic Acid Metabolism: Hypertriglyceridemia, hypo-/hyperlipoproteinemia. Atherosclerosis: features and complications. Lipid storage diseases, fatty liver. Gout: types, etiology, features. Brief overview of lysosomal storage diseases.	9

Suggestive Reading Books:

1. Textbook of Biochemistry for Medical Studentsby*D.M. Vasudevan, Sreekumari S.*
2. Essentials of Biochemistryby*Satyanarayana and Chakrapani*
3. Clinical Chemistry: Principles, Techniques, and Correlationsby*Michael L. Bishop, Edward P. Fody, Larry E. Schoeff*
4. Tietz Textbook of Clinical Chemistry and Molecular Diagnosticsby*Carl A. Burtis, David E. Bruns*
5. Harper's Illustrated Biochemistryby*Victor W. Rodwell, David Bender, Kathleen M. Botham, et al.*
6. Clinical Biochemistry: Metabolic and Clinical Aspectsby*William J. Marshall, Márta Lapsley, Andrew Day, Ruth Ayling*

Course: Medical Biochemistry Lab (Practical of Major 3)

Practical List

- Estimation of Serum Transaminases (ALT and AST)
- Urine Analysis (Physical, Chemical & Microscopic Examination)
- Lipid Profile Estimation (Total Cholesterol, HDL, LDL, Triglycerides)
- Estimation of Total Serum Proteins (Biuret Method)
- Estimation of Serum Creatinine (Jaffe's Method)
- Estimation of Serum Urea (Diacetyl Monoxime Method)
- Estimation of Blood Glucose (Glucose Oxidase/Trinder Method)

Programme/Class: Certificate	**Year:** Fourth (IV)	**Semester:** Eight (VIII)
Department: BIOCHEMISTRY		
Couse Code: BSBC-801	**Course Title: RESEARCH METHODOLOGY**	
Course Outcomes (COs)		

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

- Understand the fundamentals and objectives of research and the various types and methodologies used.
- Formulate research problems, hypotheses, and design appropriate research studies.
- Learn data collection methods, basic data analysis, and representation techniques.
- Gain skills in scientific writing, documentation, and use of referencing tools and software.
- Understand the ethical aspects of research and learn how to apply for research funding.

Credits: 4	**Core Compulsory**

Unit	**Topics**	**N0. of Lectures**
I	**Introduction to Research Methodology** • Definition and objectives of research. • Types of research: Basic, Applied, Quantitative, Qualitative. • Characteristics of good research. • Scientific method and hypothesis formulation. • Literature review and identifying research gaps.	**10**
II	**Research Design and Planning** • Research problem formulation. • Variables: Independent, Dependent, Confounding. • Experimental and control groups. • Sampling methods: Probability and non-probability. • Study designs: Experimental, Observational, Case study, Cross-sectional, Longitudinal.	**12**
III	**Data Collection and Analysis** • Types of data: Primary and Secondary. • Methods: Survey, Observation, Interviews, Experimental methods. • Tools: Questionnaires, Lab instruments, Databases. • Data presentation: Tables, Graphs, Charts. • Basics of statistical analysis: Mean, Median, Mode, Standard Deviation, t-test, Chi-square test (introductory). • Use of software: MS Excel, GraphPad.	**14**
IV	**Scientific Writing and Communication** • Structure of scientific documents: Reports, Theses, Articles. • Components: Abstract, Introduction, Methodology, Results, Discussion, Conclusion. • Referencing styles: APA, MLA, Vancouver. • Use of reference managers: Zotero, Mendeley. • Avoiding plagiarism, importance of originality. • Oral and poster presentation skills.	**12**

V	**Ethics in Research and Funding** • Research ethics and scientific misconduct. • Informed consent and confidentiality. • Role of Institutional Ethics Committees (IEC). • Biosafety and bioethics in biotechnology. • Overview of major funding agencies: DBT, DST, UGC, CSIR, ICMR. • Guidelines for preparing and submitting research proposals.	**12**
Suggestive Reading Books: • Kothari R.C. (2005): Research Methodology, 2nd Edition, New Age International Publisher Ltd., New Delhi.		

MINOR COURSES SYLLABUS

Programme/Class: Certificate	**Year:** Fourth (IV)	**Semester:**Seventh (VII)
Subject: BIOCHEMISTRY		
Couse Code: BSBC-705	**Course Title: LITERATURE REVIEW AND SCIENTIFIC WRITING**	
Course Outcomes (COs)		
• Understand the purpose, types, and process of literature review in scientific research. • Acquire skills in searching, retrieving, and critically analyzing scientific literature using databases and tools Develop competence in organizing scientific information, paraphrasing, and avoiding plagiarism. • Learn principles of scientific writing for different formats including articles, reports, and reviews. • Apply referencing styles, citation methods, and ethical standards in scientific communication.		
Credits: 3	**Core Compulsory**	
Unit	**Topics**	**No. of Lectures**
I	• Purpose and significance of literature review • Types of literature review: Narrative, Systematic, Meta-analysis, Scoping reviews • Steps in conducting literature review • Identifying research gaps and framing research questions • Importance of literature review in research proposal development	**3**

II	• Types of scientific publications: Primary, Secondary, and Tertiary • Scientific databases: PubMed, Scopus, Web of Science, Google Scholar • Search strategies: Keywords, Boolean operators, Filters • Use of Reference Management Tools (Mendeley, Zotero, EndNote) • Critical appraisal of research articles (using checklists or frameworks)	**6**
III	• Structure of scientific articles: IMRAD format (Introduction, Methods, Results, Discussion) • Abstract writing and graphical abstract basics • Paraphrasing, Summarizing, and Synthesizing literature • Avoiding plagiarism: Tools and Techniques (Turnitin, iThenticate) • Writing style: Clarity, Conciseness, Consistency, and Coherence • Citation Styles: APA, MLA, Vancouver, Harvard, and Chicago • In-text citations and Reference list preparation • Ethical standards in scientific publishing: Authorship, Conflicts of Interest, Data Integrity	**3**
IV	• Components of a Technical Report: Title page, Executive summary, Introduction, Body, Conclusion • Writing Research Proposals: Background, Objectives, Methodology, expected outcomes, Budget • Scientific Presentations: Oral, Poster, and Digital Presentations • Common mistakes in scientific writing and how to avoid them • Peer Review Process: Submission, Review, and Revision stages • Copyrights, Licensing, and Open Access Publishing • Case Studies on Ethical Issues in Scientific Writing	**3**

Suggestive Reading Books:

- Day, R.A. & Gastel, B. — How to Write and Publish a Scientific Paper (Cambridge University Press)
- Hofmann, A.H. — Scientific Writing and Communication: Papers, Proposals, and Presentations (Oxford University Press)
- Glasman-Deal, H. — Science Research Writing for Non-Native Speakers of English (World Scientific)
- Lang, T.A. & Secic, M. — How to Report Statistics in Medicine (American College of Physicians)
- Peat, J., Elliott, E., Baur, L., & Keena, V. — Scientific Writing: Easy When You Know How (BMJ Books)

Programme/Class: B.Sc	**Year:** IV	**Semester:** VIII
Subject: BIOCHEMISTRY		
Couse Code: BSBC-802	**Course Title: ENTREPRENEURSHIP IN BIOCHEMISTRY**	
Course Outcomes (COs)		

Course Outcomes (COs):

This course introduces the foundational and practical aspects of entrepreneurship in the field of biochemistry. After completion of this course, students will be able to –

- Understand the fundamentals of entrepreneurship with relevance to biochemistry-based ventures.
- Generate innovative ideas from biochemical research and develop them into commercial products.
- Learn the process of business planning and identifying opportunities in biochemistry-related industries.
- Understand the regulatory, ethical, and legal considerations for bioscience businesses.
- Explore successful case studies and gain insights into biotech enterprise management.

Credits: 4	**Core Compulsory**

Unit	Topics	N0. of Lectures
I	• **Introduction to Entrepreneurship in Biosciences:** Definition, concept, and importance of entrepreneurship, Types of entrepreneurs – technopreneurs, agripreneurs, biopreneurs, Entrepreneurship ecosystem in India and globally, Historical perspective of biochemistry-based enterprises, Traits and competencies of successful entrepreneurs.	12
II	• **Ideation and Innovation in Biochemical Research:** Sources of innovative ideas in biochemistry, Translating lab research into commercial ideas, Product development in enzymes, proteins, diagnostics, bioreagents, etc., Role of innovation and IP (Intellectual Property), Role of research and development (R&D) in biochemistry-based startups.	12
III	• **Business Development and Planning:** Business opportunity identification in biochemistry, Steps for developing a business plan, SWOT analysis, risk assessment, Market research and segmentation in bioproducts, Funding sources – venture capital, grants, angel investors, incubators.	12

IV	• **Regulatory, Ethical and Legal Framework:** Biosafety and bioethics in biochemistry-based products, Regulatory compliance – FDA, CDSCO, FSSAI, etc., Intellectual property rights (IPR): patents, trademarks, copyrights, Technology transfer and licensing, Case studies: Bio-pharma, bio-diagnostics, nutraceuticals.	12

Suggestive Reading Books:

1. Entrepreneurship in Biotechnology: Managing for Growth from Start-Up to Public Company by Craig Shimasaki
2. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies By Craig Shimasaki
3. Innovation and Entrepreneurship by Peter F. Drucker
4. Innovation and Entrepreneurship in Biotechnology: Concepts, Theories and Cases by Damian Hine and John Kapeleris