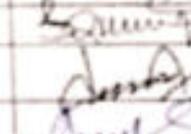
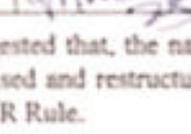
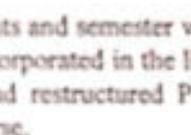


Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (M.P.)
Statute No. 9, Faculty Board of Studies, Section-15 (3)
For M.Sc.(Ag.) in Biochemistry Course
Session 2023-24, Onward

Minutes of the Meeting

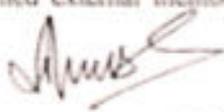
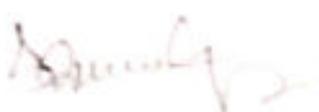
A meeting of Board of Studies for M.Sc.(Ag) in Biochemistry was conducted on dated 25/03/2023 at 11.00 A.M. in the Faculty of Agriculture. The following respected members were presented in the same.

S.N.	Name of the Members	Designation & Address	Committee position	Signature
1.	Dr. D.P. Rai	Dean	Chairman	
2.	Dr. Veeru Prakash	Prof. Biochemistry and Head, Deptt. of Biochemistry and Biochemical Engineering, SHUATS, Naini Prayagraj (UP)	External Expert	
3.	Dr. K.K. Singh	Prof. & Head, Deptt. of Transfer Technology	Member	
4.	Dr. Pawan Sirothia	Head, Department of NRM	Member	
5.	Dr. S.S. Gautam	Associate Prof. (Agril. Statistics)	Member	
6.	Dr. Uma Shanker	Associate Prof., Deptt. of NRM Soil Sc.	Member	
7.	Dr. S.S. Singh	Asstt. Prof., Horticulture	Member	
8.	Prof. H.S. Kushwaha	Professor, Agronomy	Member	
9.	Dr. S.P. Mishra	Head, Deptt. of Crop Science	Member Secretary	

All the Committee Members discussed on the name of course and suggested that, the name of Degree should be M.Sc. (Ag.) in Biochemistry as per the ICAR has revised and restructured Post-graduate on the basis of National Education Policy-2020 as per the ICAR Rule.

1. The Committee Members discussed thoroughly on the course contents and semester wise breakup of the course. The valuable advice of the members were incorporated in the light of course breakup as per prescribed by the ICAR has revised and restructured Post-graduate to finalize the syllabus of M.Sc. (Ag.) in Biochemistry course.
2. Course will be effective from Academic Session 2023-24.

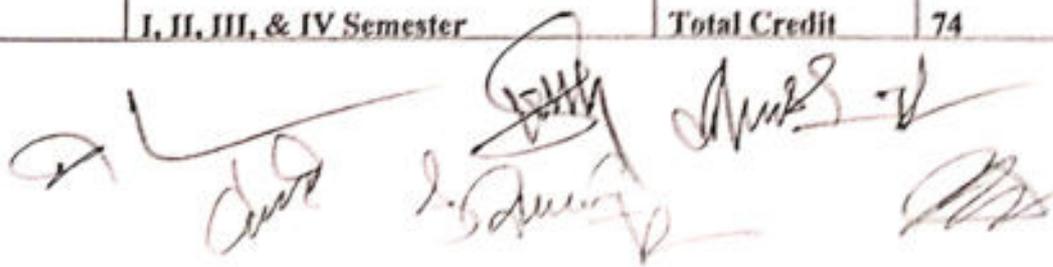
The meeting ended with a vote of thanks to the esteemed external members, faculty members and the chair.


M.Sc. (Ag.) in Biochemistry

Semester wise course distribution

Semester - I				
Sl.	Course	Name of the course	Code	Credit
1.	Major course	Basic Biochemistry	BIOCHEM 501	4(3+1)
2.	Major Course	Techniques in Biochemistry	BIOCHEM 505	4(2+2)
3.	Supporting course	Statistical Methods For Applied Science	STAT- 502	4(3+1)
4.	Common course	Technical Writing And Commutation Skills	PGS-502	1(0+1)
5.	Common course	Basic Concept in Laboratory Techniques	PGS-504	1(0+1)
Total Credit-				14(8+6)
Semester - II				
1.	Major course	Intermediary Metabolism	BIOCHEM 502	3(3+0)
2.	Major course	Molecular Biology	BIOCHEM 504	3(2+1)
3.	Minor course	Seed Production of Vegetable Crops	VSC-508	3(2+1)
4.	Supporting course	Experimental Design	STAT- 511	3(2+1)
5.	Common Course	Library & Information Services	PGS-501	1(0+1)
6.	Common Course	Intellectual property write and its management in Agricultural	PGS-503	1(1+0)
Total Credit-				14(10+4)
Semester - III				
1.	Major course	Enzymology	BIOCHEM 503	3(2+1)
2.	Major Course	Plant Biochemistry	BIOCHEM 507	3(2+1)
3.	Minor Course	Growth and Development of Vegetable Crops	VSC503	3(2+1)
4.	Minor course	Systematics of Vegetable Crops	VSC 510	2(1+1)
5.	Common Course	Agricultural Research. Research Ethics and Rural Development Programme	PGS-505	1(1+0)
6.	Major course	Seminar	BIOCHEM 591	1(0+1)
Total Credit-				13 (8+5)
Semester-IV				
1.	Major course	Nutritional Biochemistry	BIOCHEM 509	3(2+1)
2.	Major course	Masters Research/Thesis	BIOCHEM- 599	30 (0+30)
Total Credit-				33 (2+31)
I, II, III, & IV Semester			Total Credit	74





M.Sc (Ag) Biochemistry

CODE	COURSE TITLE	CREDITS
✓BIOCHEM 501*	BASIC BIOCHEMISTRY ✓	3+1
✓BIOCHEM 502*	INTERMEDIARY METABOLISM ✓	3+0
✓BIOCHEM 503*	ENZYMOLGY	2+1
✓BIOCHEM 504	MOLECULAR BIOLOGY ✓	2+1
✓BIOCHEM 505*	TECHNIQUES IN BIOCHEMISTRY ✓	2+2
BIOCHEM 506	IMMUNO CHEMISTRY	2+1
✓BIOCHEM 507	PLANT BIOCHEMISTRY	2+1
BIOCHEM 508	ANIMAL BIOCHEMISTRY	3+0
✓BIOCHEM 509	NUTRITIONAL BIOCHEMISTRY	2+1
BIOCHEM 510	NITROGEN AND SULPHUR METABOLISM	2+1
BIOCHEM 511	BIOCHEMISTRY ON XENOBIOTICS	2+0
BIOCHEM 591	MASTER'S SEMINAR	1+0
BIOCHEM 599	MASTER'S RESEARCH	30

*Core course

70

Credit: 3+1

Course Code: BIOCHEM 501*

Title: BASIC BIOCHEMISTRY

WHY THIS COURSE?

To impart the fundamental knowledge on structure and function of cellular components involved in biological processes and an elementary introduction to the study of molecular biology.

AIM OF THE COURSE

The course is designed to provide elementary knowledge/overview of structure and function of proteins, carbohydrates, lipids, nucleic acids and other biomolecules and their metabolism.

No.	Blocks	Units
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1.	Introduction to Biochemistry	1. Scope and importance of biochemistry
		2. Foundation of life
		3. Water
		4. Physical techniques for structure determination
2.	Structure and function of biomolecules	1. Biomolecules
		2. Immunoglobulins and PR proteins
		3. Plant secondary metabolites
3.	Metabolism – the basics	1. Molecules aiding metabolism
		2. Thermodynamics –principles and energetic of life
4.	Catabolism and its regulation	1. Catabolism of energy molecules
		2. ATP formation
5.	Fundamentals of Molecular biology and genetic engineering	1. Molecular biology processes
		2. Recombinant DNA technology

LEARNING OUTCOMES

With this course, the students are expected to be able to understand the actual chemical concepts and fundamental processes of biology at molecular level.

BLOCK 1: INTRODUCTION TO BIOCHEMISTRY

Unit 1: Scope and importance of biochemistry(One lecture)

Biochemistry as modern science and its various divisions, Scope and importance of biochemistry in agriculture and allied sciences.

Unit 2: Foundation of life(Two lectures)

Fundamental principles governing life, supramolecular structures, significance of weak non covalent interactions in biology

Unit 3: Water(Three lectures)

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Structure of water, ionization of water, acid base concept, pH and buffers, significance of structure-function relationship

Unit 4: Physical techniques for structure determination (Two lectures)

General introduction to physical techniques for determination of structure of biopolymers

BLOCK 2: STRUCTURE AND FUNCTION OF BIOMOLECULES

Unit 1: Biomolecules (Two lectures)

Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids

Unit 2: Immunoglobulins and PR proteins (Two lectures)

Structure, formation and different forms of immunoglobulins, PR proteins and their classification

Unit 3: Plant secondary metabolites (Three lectures)

Structure, classification and function of plant secondary metabolites

BLOCK 3: METABOLISM - THE BASICS

Unit 1: Molecules aiding metabolism (Two lectures)

Structure and biological functions of vitamins and coenzymes, enzymes: classification and mechanism of action, regulation, factors affecting enzyme action. Hormones: animal and plants.

Unit 2: Thermodynamics - principles and energetic of life (Two lectures)

Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

BLOCK 4: CATABOLISM AND ITS REGULATION

Unit 1: Catabolism of energy molecules (Five lectures)

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Important and basic degradative metabolic pathways of carbohydrates, lipids and proteins and their regulation

Unit 2: ATP formation (Three lectures)

Formation of ATP, substrate level phosphorylation, electron transport chain and oxidative phosphorylation, chemiosmotic theory and proton motive force

BLOCK 5: FUNDAMENTALS OF MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Unit 1: Molecular biology processes (Four lectures)

Overview of replication, transcription and translation

Unit 2: Recombinant DNA technology (Three lectures)

Restriction enzymes, DNA cloning, applications of cloning, transgenics

PRACTICALS

1. Preparation of standard and buffer solutions
2. Detection of carbohydrates, amino acids and proteins
3. Extraction and estimation of sugars
4. Extraction and estimation of amino acids
5. Extraction and estimation of proteins
6. Estimation of acid value of fat/oil
7. Estimation of peroxide value of fat/oil
8. Estimation of saponification value in fats and oils
9. Fatty acid composition in fat/oil by GC
10. Estimation of DNA and RNA by spectroscopic methods
11. Estimation of Ascorbic acid
12. Separation of biomolecules by TLC and Paper chromatography
13. Estimation of alpha amylase activity
14. Qualitative tests for secondary plant metabolites.

TEACHING METHODS / ACTIVITIES

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- Classroom lectures (oral + audio-visual)
- Assignment (Reading/Writing)
- Oral presentation by students on specified topics
- Class room quiz

RESOURCES

- Nelson, D. L. and Cox, M. M. 2017. *Lehninger Principles of Biochemistry*. 7th edition. W. H. Freeman & Co Ltd
- Satyanarayana, U. and Chakrapani, U. 2017. *Biochemistry*. 5th edition, Elsevier
- Moran L. A., Horton H. R., Scrimgeour K. G. and Perry, M. D. 2012. *Principles of Biochemistry*. 5th edition Pearson,
- Voet, D. and Voet J. G. 2011. *Biochemistry*. 4th edition John Wiley.
- Pratt, C. W. and Cornely, K. 2014. *Essential Biochemistry*. 3rd Edition. Wiley
- Moorthy, K. 2007. *Fundamentals of Biochemical Calculations*. 2nd edition. CRC Press
- Conn E. E., Stumpf, P. K., Bruening, G. and Doj, R. H. (2006). *Outlines of Biochemistry*. 5th edition. Wiley

Credit: 3+0

Course Code: BIOCHEM 502*

Title: INTERMEDIARY METABOLISM

WHY THIS COURSE?

To understand the interconversion of chemical compounds in the living system, the pathways taken by individual molecules, their interrelationships and the mechanisms that regulate the flow of metabolites through the pathways.

AIM OF THE COURSE

The course is designed to give an insight into the different metabolic pathways, their interrelationship, regulation, metabolic disorders in human and pathway engineering in plants.

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No.	Blocks	Units
1.	Introduction to metabolism	1. Overview of metabolism
		2. Metabolic pathways
2.	Metabolism of energy nutrients	1. Carbohydrate metabolism
		2. Lipid metabolism
		3. Protein metabolism
		4. Energy transduction and oxidative phosphorylation
3.	Sulphur and nucleotide metabolism	1. Sulphur metabolism
		2. Nucleotide metabolism
4.	Metabolic regulation and defects in metabolism	1. Regulation of metabolic pathways
		2. Defects in metabolism

LEARNING OUTCOMES

With this course, the students are expected to learn the set of life-sustaining chemical processes that enables organisms transform the chemical energy stored in molecules into useful form and the process by which organisms respond to stimuli and metabolic disorders.

BLOCK 1: INTRODUCTION TO METABOLISM

Unit 1: Overview of metabolism(Four lectures)

The living cell - a unique chemical system, biochemical reaction types, bioenergetics, bioavailability of nutrients, transport mechanism, signal transduction.

Unit 2: Metabolic pathways(Five lectures)

Catabolism and anabolism, compartments of metabolic pathways, experimental approaches to study metabolism, metabolic profiles of major organs

BLOCK 2: METABOLISM OF ENERGY NUTRIENTS

Unit 1: Carbohydrate metabolism(Five lectures)

68



Major catabolic and anabolic pathways of carbohydrate metabolism, the glyoxylate pathway

Unit 2: Lipid metabolism(Five lectures)

Fatty acid oxidation, ketone bodies, fatty acid biosynthesis, synthesis of triacylglycerols, cholesterol, eicosanoids

Unit 3: Protein metabolism(Three lectures)

General reactions of amino acid metabolism, degradative and biosynthetic pathways of amino acids, urea cycle, amino acids as metabolic precursors.

Unit 4: Energy transduction and oxidative phosphorylation(Four lectures)

Mechanisms of energy transduction, electron transport system, oxidative phosphorylation, control of ATP production

BLOCK 3. SULPHUR AND NUCLEOTIDE METABOLISM

Unit 1: Sulphur metabolism(Five lectures)

Sulphate reduction and incorporation of sulphur in to amino acids

Unit 2: Nucleotide metabolism(Three lectures)

Synthesis and degradation of purine and pyrimidine nucleotides

BLOCK 4: METABOLIC REGULATION AND DEFECTS IN METABOLISM

Unit 1: Regulation of metabolic pathways (Four lectures)

Regulation of carbohydrate, lipid, protein, nucleotide metabolism and oxidative phosphorylation

Unit 2: Defects in metabolism(Four lectures)

Disorders of carbohydrates, lipids, amino acids and nucleic acid metabolism, and inborn errors of metabolism. Metabolic pathway engineering.



TEACHING METHODS / ACTIVITIES

- Classroom lectures (oral + audio-visual)
- Assignment (Reading/Writing)
- Oral presentation by students on specified topics
- Class room quiz
- Case study

RESOURCES

- Nelson, D. L. and Cox, M. M. 2017. *Lehninger Principles of Biochemistry*. 7th edition. W. H. Freeman & Co Ltd
- Satyanarayana, U. and Chakrapani, U. 2017. *Biochemistry*. 5th edition, Elsevier
- Campbell M. K. and Farrell S.O. 2009. *Biochemistry*. 6th edition Thomson Higher Education.
- Moran L. A., Horton H. R., Scrimgeour K. G. and Perry, M. D. 2012. *Principles of Biochemistry*. 5th edition Pearson,
- Voet, D. and Voet J. G. 2011. *Biochemistry*. 4th edition . John Wiley.
- Pratt, C. W. and Cornely, K. 2014. *Essential Biochemistry*. 3rd Edition. Wiley
- Moorthy, K. 2007. *Fundamentals of Biochemical Calculations*. 2nd edition. CRC Press

Credit: 2+1

Course Code: BIOCHEM 503*

Title: ENZYMOLOGY

WHY THIS COURSE?

Being highly specific and incredibly efficient biological catalysts, enzymes are responsible for bringing about almost all of the chemical reactions in living organisms. Otherwise these reactions will take place at a rate far too slow for the pace of metabolism. The course will help students in understanding the physical, chemical and kinetic properties of enzymes.

AIM OF THE COURSE



To impart knowledge about the catalytic role of enzymes, their structures, physico-chemical, kinetic and regulatory properties and mechanism of action.

No.	Blocks	Units
1.	Introduction to enzymes	1. Structure and function of enzymes
		2. Extraction and purification of enzymes
2.	Enzyme structure and function	1. Chemical nature of enzymes
		2. Cofactors and coenzymes
		3. Nature of active site
3.	Enzyme kinetics	1. Single substrate kinetics
		2. Enzyme inhibition
		3. Kinetics of allosteric enzymes
		4. Regulation of enzyme activity
4.	Application of enzymology	1. Industrial application of enzymes
		2. Biotechnological application of enzymes

LEARNING OUTCOMES

After completion of this course students are expected to have knowledge on and insight into the chemical principles of enzyme catalysis, action of enzymes as biocatalysts and factors that influence enzyme activity and understand the kinetics of enzymatic reactions. Students will have experience with purification, handling and characterization of proteins and also get exposure of wide applications of enzymes and their future potential.

BLOCK 1: INTRODUCTION TO ENZYMES

Unit 1: Structure and function of enzyme (Two lectures)

Historic perspective, general properties of enzymes, enzyme compartmentalization in cell organelles, nomenclature and classification of enzymes, ribozymes, isozymes, abzymes

Unit 2: Extraction and purification of enzymes (Two lectures)

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Extraction of soluble and membrane-bound enzymes, purification of enzymes, measurement of enzyme activity

BLOCK 2: ENZYME STRUCTURE AND FUNCTION

Unit 1: Chemical nature of enzyme(Three lectures)

Enzyme specificity, monomeric and oligomeric enzymes, catalytic mechanism, mechanism of enzyme action, pseudoenzymes, enzyme promiscuity.

Unit 2: Cofactors and coenzymes(Two lectures)

Chemical nature and involvement of cofactors and coenzymes in enzyme catalyzed reactions, metal activated enzymes and metalloenzymes, mechanism of enzyme catalyzed reactions without cofactors.

Unit 3: Nature of active site(Two lectures)

Active site, identification of binding sites and catalytic sites

BLOCK 3. ENZYME KINETICS

Unit 1: Single substrate kinetics(Four lectures)

Relationship between initial velocity and substrate concentration, Michaelis-Menten equation, Lineweaver-Burk and Eadie-Hofstee plots, analysis of kinetic data, numerical exercises.

Unit 2: Enzyme inhibition(Two lectures)

Reversible and irreversible enzyme inhibition, uses of enzyme inhibition

Unit 3: Kinetics of allosteric enzymes(Three lectures)

Nature of allosteric enzymes, sigmoidal kinetics, MWC model and allosteric regulation, KNF model and allosteric regulation.

Unit 4: Regulation of enzyme activity(Three lectures)



Feedback regulation, regulatory enzymes, control of enzymatic activity, symmetry and sequential model, reversible covalent modification of enzymes.

BLOCK 4: APPLICATION OF ENZYMOLOGY

Unit 1: Industrial application of enzymes(Three lectures)

Industrial application of enzyme catalysis in sectors like food processing, detergents, biofuels, paper and pulp, biosensors and clinical applications of enzymes

Unit 2: Biotechnological application of enzymes(Two lectures)

Large scale production and purification of enzymes, immobilization of enzymes

PRACTICALS

1. Soluble protein estimation
2. Enzyme assay by taking any model enzyme
3. Isolation and purification of any model enzyme
4. Study of the effect of enzyme and substrate concentrations on enzyme activity
5. Determination of K_m and V_{max}
6. Determination of pH and temperature optima
7. Effect of inhibitors on enzyme activity
8. Determination of pH and temperature stability of enzyme
9. Electrophoretic analysis of isozymes.

TEACHING METHODS / ACTIVITIES

- Classroom lectures (oral + audio-visual)
- Assignment (Reading/Writing)
- Oral presentation by students on specified topics
- Class room quiz
- Case study

RESOURCES

- Palmer, T. and Bonner, P. L. 2007. *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry*. 2nd edition. Woodhead Publishing



- Okotore, R. O. 2015. Essentials of Enzymology. XLIBRIS
- Herald, J. 2016. Essentials of Enzymology. Syrawood Publishing House
- Suzuki, H. 2015. *How Enzymes Work: From Structure to Function*. Jenny Stanford Publishing.
- Bugg, T. D. H. 2012. *Introduction to Enzyme and Coenzyme Chemistry*, 3rd Edition. WILEY
- Guo, Y. 2014. *Enzyme Engineering*. Science Press
- Bisswanger, H. 2011. *Practical Enzymology*. Wiley-Blackwell

Credit: 2+1

Course Code: BIOCHEM 504

Title: MOLECULAR BIOLOGY

WHY THIS COURSE?

Molecular biology is the study of biology at a molecular level. The concepts and techniques of molecular biology are the foundation for the studies of all aspects of biology in modern time. This course is designed to provide an intensive exposure to the theoretical concepts and experimental techniques of molecular biology and the interrelationship of DNA, RNA and protein synthesis and their regulation.

AIM OF THE COURSE

To provide knowledge of life processes at the molecular and cellular levels, including the storage, transfer and regulation of genetic information and specialist theoretical knowledge and practical experience of gene manipulation and the analysis of nucleic acids and proteins.

No.	Blocks	Units
1.	Introduction to nucleic acids	1. History
		2. Properties of nucleic acid
		3. Genes and genome
2.	Synthesis of nucleic acids	1. DNA replication

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		2. Transcription
3.	Protein synthesis	1. Translation machinery
		2. Mechanism of protein synthesis
		3. Post-translational events
4.	Gene manipulation	1. DNA sequencing
		2. Recombinant DNA technology
		3. Techniques in molecular biology

LEARNING OUTCOMES

After completion, the student should be able to explain central cell biological processes and how they are regulated and quality assured and understands how molecular cell biology forms the foundation of biotechnology.

BLOCK 1: INTRODUCTION TO NUCLEIC ACIDS

Unit 1: History(One lecture)

Historical development of molecular biology, nucleic acids as genetic material

Unit 2: Properties of nucleic acid(Two lectures)

Nucleic acid structure, chemical and physical properties of nucleic acids, spectroscopic and thermal properties of nucleic acids, DNA supercoiling

Unit 3: Genes and genome(Three lectures)

Concept of genes and genome, genome complexity, genome organization in prokaryotes and eukaryotes, chromatin structure and function, repetitive and non-repetitive DNA, satellite DNA central dogma, genome editing

BLOCK 2: SYNTHESIS OF NUCLEIC ACID

Unit 1: DNA replication(Three lectures)



Modes of replication, DNA polymerases, topoisomerases, DNA ligase, model of replisome, semi conservative replication in prokaryotes and eukaryotes, inhibitors of replication, DNA damage and repair.

Unit 2: Transcription(Three lectures)

Basic principles of transcription, transcription initiation, elongation and termination, RNA processing, RNA interference, siRNAs, miRNAs and other ncRNAs, DNA/RNA editing, regulation of transcription, reverse transcription.

BLOCK 3. PROTEIN SYNTHESIS

Unit 1: Translation machinery (Two lectures)

Ribosomes structure and function, organization of ribosomal proteins and RNA genes, genetic code, aminoacyl tRNA synthases

Unit 2: Mechanism of protein synthesis(Two lectures)

Initiation, chain elongation and termination of translation, energetics, inhibitors of translation

Unit 3:Post-translational events(Two lectures)

Post translational modifications of nascent polypeptide, protein targeting and turnover, regulation of gene expression in prokaryotes and eukaryotes, nucleases and restriction enzymes

BLOCK 4: GENE MANIPULATION

Unit 1: DNA sequencing(Three lectures)

Importance, Sanger method,High-Throughput Sequencing (HTS) techniques, applications of DNA sequencing.

Unit 2: Recombinant DNA technology(Four lectures)

Vectors, isolation of genes, recombinants vector, selection of recombinants, characterization and expression of cloned DNA, transformation, transgenesis, mutation, molecular mechanism of mutation, site directed mutagenesis, *in vitro* mutagenesis.



Unit 3: Techniques in molecular biology(Three lectures)

Polymerase chain reaction (PCR), expression cloning, gel electrophoresis, molecular markers, macromolecule blotting and probing, arrays (DNA array and protein array) – principles and application

PRACTICALS

1. Isolation and purification of DNA and RNA
2. To check the purity of isolated DNA and RNA
3. Restriction fragmentation of genomic DNA
4. Separation of oligos by agarose gel electrophoresis
5. Southern blotting experiments
6. Northern blotting experiments
7. Cloning of DNA fragment in vector
8. Selection of recombinant
9. SSR analysis of DNA
10. cDNA synthesis using RT-PCR
11. Basic tools in bioinformatics analysis

TEACHING METHODS / ACTIVITIES

- Classroom lectures (oral + audio-visual)
- Assignment (Reading/Writing)
- Oral presentation by students on specified topics
- Class room quiz
- Case study

RESOURCES

- Snape, A., Papachristodoulou, D., Elliott, W. H. and Elliott, C. 2014. *Biochemistry and Molecular Biology*. Oxford University Press
- Krebs, J. E., Goldstein, E. S. and Kilpatrick, S. T. 2018. *Lewin's GENES XII*. Jones & Bartlett Learning
- Lodish, H., Berk, A., Kaiser, C. A., Krieger, M. And Bretscher, A. 2016. *Molecular Cell Biology*. W H Freeman & Co

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- Hoffmann, A. And Clokie, S. 2018. *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.
- Primrose SB, Twyman RM and Old RW. 2002. *Principles of Gene Manipulation: 6th Ed.* Wiley
- Karp, G. 2013. *Cell and Molecular Biology*. Wiley
- Neidle, S. 2008. *Principles of Nucleic Acid Structure*. Elsevier Inc
- Watson, J., Baker, T. A., Bell, S. P., Gann, A., Levine, M. and Losick, R. 2014. *Molecular biology of the gene 7th edition*, Pearson

Credit: 2+2

Course Code: **BIOCHEM 505***

Title: **TECHNIQUES IN BIOCHEMISTRY**

WHY THIS COURSE?

Biochemical studies rely on the availability of appropriate analytical techniques and their applications. This course will examine modern methods and technologies that are used in biochemical analysis with emphasis on instrumentation, underlying principles, aims, strategies and current applications.

AIM OF THE COURSE

To provide hands-on experience to different biochemical techniques commonly used in research along with the knowledge on principles and the instrumentation.

No.	Blocks	Units
1.	Separation techniques	1. Chromatography techniques
		2. Electrophoretic technique
		3. Hydrodynamic methods
		4. Centrifugation
2.	Spectroscopic techniques	1. Spectrophotometry



		2. Mass spectroscopy
		3. Atomic absorption spectrophotometry
3.	Microscopy	1. Microscopic techniques
4.	Tracer, imaging, immunochemical and other techniques	1. Tracer techniques
		2. Imaging techniques
		3. Immunochemical techniques
		4. Other techniques

LEARNING OUTCOMES

At the end of the course, the student will acquire the basic knowledge of the main biochemical methods used in the separation, identification, characterization and analysis of biomolecules.

BLOCK 1: SEPARATION TECHNIQUES

Principles and applications of separation techniques

Unit 1: Chromatography techniques (Four lectures)

Principles and applications of paper, thin layer, gel filtration, ion-exchange, affinity, column chromatography, HPTLC, GC, HPLC and FPLC

Unit 2: Electrophoretic technique (Two lectures)

General principles, paper and gel electrophoresis, native and SDS-PAGE, 2D-PAGE, capillary electrophoresis

Unit 3: Hydrodynamic methods (Two lectures)

Hydrodynamic methods of separation of biomolecules such as viscosity and sedimentation coefficient, - their principles

Unit 4: Centrifugation (Two lectures)

General principles of sedimentation, type, care and safety aspects of centrifuge preparative and analytical centrifugation,



BLOCK 2: SPECTROSCOPIC TECHNIQUES

Unit 1: Spectrophotometry(Three lectures)

Principles and applications of UV-visible, Fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X-Ray spectroscopy

Unit 2: Mass spectroscopy(Three lectures)

MS/MS, LC-MS, GC-MS, MALDI-TOF, applications of mass spectrometry in biochemistry

Unit 3: Atomic absorption spectrophotometry(Two lectures)

Principle, function and instrumentation of atomic absorption spectrophotometry

BLOCK 3. MICROSCOPY

Unit 1: Microscopic techniques(Two lectures)

Principles and applications, light, UV, phase contrast, fluorescence and electron microscopy, flow cytometry.

BLOCK 4: TRACER, IMAGING, IMMUNOCHEMICAL AND OTHER TECHNIQUES

Unit 1: Tracer technique(Two lectures)

Tracer techniques in biology: concept of radioactivity, radioactivity counting methods with principles of different types of counters, concept of α , β and γ emitters, scintillation counters, spectrometers, autoradiography, applications of radioactive tracers in biology.

Unit 2: Imaging techniques(Two lectures)

Principles and applications of phosphor imager, MRI and CT scan.

Unit 3: Immunochemical technique(Two lectures)

Production of antibodies, immunoprecipitation, immunoblotting, immunoassays, RIA and

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80



Unit 4: Other techniques (Two lectures)

Cryopreservation, polymerase chain reaction (PCR), FACS

PRACTICALS

1. Expression of concentration in terms of dilution, molarity, normality, percent expression
2. pH measurement and buffer preparation
3. Determination of absorption maxima of biomolecules
4. Estimation of biomolecules through spectrophotometry and other methods
5. Separation of carbohydrates and amino acids by paper chromatography
6. Separation and analysis of fatty acids/lipids by GC
7. Separation/estimation of biomolecules through HPLC and FPLC
8. Separation of proteins using ion exchange, gel filtration and affinity chromatography
9. Electrophoretic separation of proteins and nucleic acids
10. Centrifugation- differential and density gradient
11. $(\text{NH}_4)_2\text{SO}_4$ precipitation and dialysis
12. Use of radioisotopes in metabolic studies
13. PCR
14. ELISA
15. Western blotting/ Dot blotting

TEACHING METHODS / ACTIVITIES

- Classroom lectures (oral + audio-visual)
- Assignment (Reading/Writing)
- Oral presentation by students on specified topics
- Class room quiz
- Case study

RESOURCES

- Boyer, R. 2011. *Biochemistry Laboratory: Modern Theory and Techniques* 2nd Edition. Pearson

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Credit: 2+1

Course Code: BIOCHEM 507

Title: PLANT BIOCHEMISTRY

WHY THIS COURSE?

Harnessing sunlight, plants produce a diverse array of chemical compounds to survive in challenging ecological niches. Plant-derived metabolites are major sources of human food, fibre, fuel, and medicine. This course covers topics related to plant metabolism and discusses how plants generate carbon and energy sources by photosynthesis and synthesize various compounds through complex networks of metabolic pathways.

AIM OF THE COURSE

To provide an understanding of metabolic processes in plants and the role of different photosynthetic pathways in plant growth and development.

No.	Blocks	Units
1.	Photosynthesis	1. Photosynthetic machinery
		2. Carbon reduction
2.	Conversion of photosynthates	1. Synthesis of major biomolecules
		2. Nitrogen and sulphur metabolism
3.	Growth and development	1. Germination and fruit ripening
		2. Phytohormones
4.	Secondary metabolites	1. Biochemistry of plant secondary metabolites

LEARNING OUTCOMES

Successful completion of this course will provide students with fundamental knowledge of biochemistry and specific knowledge of compounds and biochemical pathways that occur in plants.

BLOCK 1: PHOTOSYNTHESIS

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Unit 1: Photosynthetic machinery (Three lectures)

Structure and function of plant cell and its organelles, phytochromes, chloroplast morphology structure, structure and chemistry of photosynthetic pigments, light reaction of photosynthesis

Unit 2: Photosynthesis – the process (Four lectures)

Carbon reduction in C₃, C₄ and CAM plants, photorespiration, sucrose-starch interconversion

BLOCK 2: CONVERSION OF PHOTOSYNTHATES

Unit 1: Synthesis of major biomolecules (Three lectures)

Biosynthesis of structural carbohydrates, storage proteins and lipids.

Unit 2: Nitrogen and sulphur metabolism (Five lectures)

Basic concepts of nitrogen and sulphur metabolism : biological nitrogen fixation, nitrate assimilation in plants, sulphur chemistry and function, reductive sulphate assimilation pathway, sulphated compounds

BLOCK 3: GROWTH AND DEVELOPMENT

Unit 1: Germination and fruit ripening (Four lectures)

Biochemistry of seed germination – stages, requirements, metabolism and mobilization of storage material; Biochemistry of fruit ripening – ripening process, cell wall degrading enzymes, role of ethylene and regulation of ethylene production.

Unit 2: Phytohormones (Three lectures)

Different classes of phytohormones, their biosynthesis and mode of action

BLOCK 4: SECONDARY METABOLITES

Unit 1: Biochemistry of plant secondary metabolites (Six lectures)

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Biochemistry and significance of plant secondary metabolites - phenolics, terpenoids, alkaloids, cyanogenic glycosides and glucosinolates, effect of biotic and abiotic factors on plant metabolism and plant defense system.

PRACTICALS

1. Fractionation of cell organelles,
2. Estimation of starch,
3. Assay of ADPG pyrophosphorylase/starch synthase,
4. Assay of PAL/SOD
5. Assay of PPO/LOX,
6. Estimation of individual amino acids,
7. Qualitative tests of secondary metabolites (alkaloids, sterols etc.)
8. Content and composition of carotenoids, anthocyanin and chlorophylls
9. Determination of polyphenols/phenolics
10. Fractionation of storage proteins
11. Estimation of glucosinolates
12. Estimation of cyanogenic compounds.

TEACHING METHODS / ACTIVITIES

- Classroom lectures (oral + audio-visual)
- Assignment (Reading/Writing)
- Oral presentation by students on specified topics
- Class room quiz
- Case study

RESOURCES

- Buchannan, B.B., Grisseem, W. and Jones, R.L. (eds.). 2000. *Biochemistry and Molecular Biology of Plants*. 2nd edition. WILEY Blackwell
- Heldt, H-W. 2010. *Plant Biochemistry and Molecular Biology*. 4th ed. Oxford University Press
- Goodwin TW & Mercer EI. 2005. *Introduction to Plant Biochemistry*. 2nd edition. CBS
- Heldt, H-W. and Piechulla, B. 2010. *Plant Biochemistry*. 4th Edition. Elsevier
- Harinda, Makkeand Klaus. 2007. *Plant Secondary Metabolites*. Springer

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Unit 2: Nutrients and their biochemistry(Seven lectures)

Water, electrolyte and acid-base balance, structure, function and mechanism of major trace elements, vitamins, energy nutrients and biochemistry of respiration, bioactive peptides and functional oligosaccharides.

Unit 3: Hormones and their role(Seven lectures)

Hormones of thyroid, hypothalamus, pituitary, pancreas, adrenals and sex hormones, Membrane receptors of hormones, signal transduction.

Unit 4: Immune system(Seven lectures)

Immune systems, immunoglobulins, monoclonal antibodies, formation of antibody, antibody diversity, complement system – classical and alternate, major histocompatibility complexes, cell mediated immune response, mechanisms of immunity.

TEACHING METHODS / ACTIVITIES

- Classroom lectures (oral + audio-visual)
- Assignment (Reading/Writing)
- Oral presentation by students on specified topics
- Class room quiz
- Case study

RESOURCES

- Bradley, A. 2018. Animal Physiology and Biochemistry. 1st edition. Edtech Press
- R A Agarwal, R. A., Srivastava, A. K. and Kumar, K. 2010. Animal Physiology and Biochemistry. Fifth revised edition. S. Chand
- Rodwell, V. A., Bender, D. A., Botham, K. M., Kennelly, P. J. and Weil, P. A. 2018. *Harper's Illustrated Biochemistry*, 31st edition. McGraw-Hill Education

Credit: 2+1

Course Code: BIOCHEM 509

Title: NUTRITIONAL BIOCHEMISTRY



WHY THIS COURSE?

Nutritional biochemistry deals with the structural and functional characteristics of macro and micronutrients in food consumed by humans. The course will expand understanding of the biological roles of nutrients and their metabolism using basic knowledge in physiology, biochemistry, cell biology and molecular biology. It will integrate information on the roles of nutrients in nutrition and health.

AIM OF THE COURSE

To impart knowledge regarding the biochemical aspects of various nutrients and their interactions in foods during processing, storage and deterioration.

No.	Blocks	Units
1.	Nutritional biochemistry	1. Fundamentals of human nutrition
		2. Biochemical functions of nutrients
		3. Bioavailability of nutrients
		4. Food sensitivity

LEARNING OUTCOMES

On successful completion of this course students should be able to critically analyse and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition, provide nutritional advice based on sound scientific findings, discuss the efficacy and appropriate use of functional foods and critically evaluate nutrition information appearing in popular magazines and other forms of media.

BLOCK 1: NUTRITIONAL BIOCHEMISTRY

Unit 1: Fundamentals of human nutrition (Seven lectures)

Fundamentals of human nutrition, concept of balanced diet, biochemical composition, energy and food value of various food grains (including cereals, pulses, oilseeds), fruits and vegetables. Physico-chemical, functional and nutritional characteristics of carbohydrates, proteins and fats and their interactions (emulsions, gelation, browning etc.). Digestion and

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absorption, digestive secretions, their characteristic features and control, protection of microflora of the GI tract

Unit 2: Biochemical functions of nutrients(Seven lectures)

Biochemical functions of nutrients, macro- and micronutrients- carbohydrates, fats and proteins, vitamins, water soluble and fat soluble vitamins, mineral and phytonutrients, prebiotics and probiotics, enzymes and metabolic protein factors, cofactor role, electrolytic function, constituents of skeletal tissues, interrelationship in nutrient functions, mineral deficiency diseases; nutraceuticals, antinutritional factors, biochemistry of postharvest storage.

Unit 3: Bioavailability of nutrients(Seven lectures)

Factors affecting bioavailability of nutrients, biological value of proteins; effect of cooking, processing and preservation of different food products on nutrients, energy- and micronutrient malnutrition, deficiency diseases of macro and micronutrients.

Unit 4: Food sensitivity(Seven lectures)

Food sensitivity: immunologically mediated food sensitivity, nature and properties of antigens in foods, mechanism of induction of all allergic reactions, diagnostic tests for food, hypersensitivity, non-immunologically mediated food sensitivity, food sensitivity due to metabolic diseases, gastrointestinal diseases, food additives, pharmacologic agents, food toxins and poisonous and psychological factors.

PRACTICALS

1. Estimation of amylose and amylopectin
2. Estimation of resistant starch
3. Estimation of $\omega 3$, $\omega 6$ and trans fatty acid
4. Estimation of phenols in plant tissue/sample
5. Estimation of carotenoids
6. Estimation of amylase, trypsin and chymotrypsin inhibitor activities
7. Estimation of Vitamin C in fruits
8. Estimation of reducing & non reducing sugar in fruits
9. Estimation of protein contents

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10. Estimation of dietary fibre
11. Determination of limiting amino acids
12. Estimation of phytate/ oxalate
13. Estimation of total antioxidant activity by different methods
14. Estimation of curcumin.

TEACHING METHODS / ACTIVITIES

- Classroom lectures (oral + audio-visual)
- Assignment (Reading/Writing)
- Oral presentation by students on specified topics
- Class room quiz
- Case study

RESOURCES

- Damodaran S. and Parkin KL (ed.) 2017. *Fennema's Food Chemistry*. CRC Press
- Gibney MJ, Lanham-New SA, Cassidy, A and Voster HH (ed.) 2009. *Introduction to Human Nutrition*. Wiley-Blackwell
- Trueman, P. 2007. *Nutritional Biochemistry*. MJP Publishers
- Cox, C. 2015. *Nutritional Biochemistry : Current Topics in Nutrition Research*. Apple Academic Press Inc.
- Haugen, S. and Meijer, S. 2010. *Handbook of Nutritional Biochemistry : Genomics, Metabolomics & Food Supply*. Nova Science Publishers Inc..

Credit: 2+1

Course Code: **BIOCHEM 510**

Title: **NITROGEN AND SULFUR METABOLISM**

WHY THIS COURSE?

Nitrogen and sulfur compounds are continuously synthesized, degraded and converted into other forms in nature. They coexist in the biosphere as free elements or in the form of oxyanions which are to be reduced before undergoing anabolic processes to form N and S



containing compounds. This course will provide the students a fundamental understanding of their reduction, assimilation and metabolism in plants.

AIM OF THE COURSE

To impart knowledge of general nitrogen and sulfur metabolism in plants and the assimilatory pathways.

No.	Blocks	Units
1.	Nitrogen and sulfur metabolism	1. Nitrogen metabolism
		2. Sulfur metabolism

LEARNING OUTCOMES

Students will get an insight into the nitrogen and sulfur metabolism in plants and the coordination between nitrogen (N) and sulfur (S) assimilation

BLOCK 1: NITROGEN AND SULFUR METABOLISM

Unit 1: Nitrogen metabolism (Eighteen lectures)

Nitrogen cycle, assimilation of inorganic nitrogen, nitrate uptake and transporters, enzymology of nitrate reduction - Nitrate reductase (NR) and Nitrite reductase (NIR), NR regulation, nitrate signaling.

Assimilation of inorganic nitrogen and N-transport amino acids - glutamine synthetase (GS), glutamate synthase (GOGAT), glutamate dehydrogenase (GDH), aspartate amino transferase (AspT) and asparagine synthetase (AS), interaction between carbon metabolism and amino acid synthesis, biosynthesis of amino acids.

Nitrogen fixation - an overview, enzymology of nitrogen fixation - nitrogenase, *nif* genes and their regulation, symbiotic nitrogen fixation - biochemical basis of rhizobial infection, nodule development. Mechanism of creation of microaerobic environment for nitrogen fixation. metabolic exchange between host plant and bacteroids.

Unit 2: Sulphur metabolism (Ten lectures)

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Overview of sulfate assimilation, sulfur chemistry and function, sulfate uptake and transport, reductive sulfate assimilation pathway, synthesis and function of sulfur containing amino acids, glutathione and its derivatives, role of sulfated compounds in metabolism.

PRACTICALS

1. Estimation of nitrite content,
2. Estimation of nitrate content,
3. *In vivo* assay of nitrate reductase activity,
4. *In vitro* assay of nitrate reductase activity,
5. *In vitro* assay of nitrite reductase activity,
6. *In vitro* assay of glutamine synthetase activity,
7. *In vitro* assay of glutamate synthase and glutamate dehydrogenase activity,
8. Estimation of ureides and amides,
9. Assay of nitrogenase activity by acetylene reduction method,
10. Estimation of hydrogen evolution by legume nodules,
11. Estimation of cysteine, methionine, pyruvate and glutathione,
12. Assay of APS activity.

TEACHING METHODS / ACTIVITIES

- Classroom lectures (oral + audio-visual)
- Assignment (Reading/Writing)
- Oral presentation by students on specified topics
- Class room quiz
- Case study

RESOURCES

- Bothe, H. and Trebst, A. (eds.). 1981. *Biology of Inorganic Nitrogen and Sulfur*. Conference proceedings. Springer-Verlag
- De Kok et al. 2012. *Sulfur Metabolism in Plants*. Part of the *Proceedings of the International Plant Sulfur Workshop* book series. Springer
- Bray CM. 1983. *Nitrogen Metabolism in Plants*. Longman.
- Bidwell, R.G.S. 1983. *Plant Physiology: A Treatise*, Vol. 8: Nitrogen Metabolism. Academic Press

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