DEPARTMENT OF BIOCHEMISTRY

Category-I

BSc. (Hons.) Biochemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Metabolism of Lipids	04	02	0	02	Class XII with Science	NIL

Learning Objectives

The aim of this course is to give students an exhaustive understanding of lipid metabolism, enzymes involved in various catabolic and anabolic pathways of lipids, and their regulation. The course will also discuss the significance of such pathways in the context of metabolic disorders.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the concepts of metabolism of lipids, characteristics of metabolic pathways and strategies used to study these pathways.
- Apply the knowledge of various catabolic and anabolic pathways in lipid metabolism and their regulation.
- Describe the diseases caused by defects in metabolism with emphasis on metabolic control.

SYLLABUS OF DSC-7

2.2 Course

Contents Theory

Unit 1. Digestion absorption and transport of lipids (04 Hours)

Digestion and absorption of lipids, Structure, classification and biogenesis of lipoproteins, Endogenous and exogenous pathways, Lipoprotein cycle.

Unit 2. Degradation of lipids (10 Hours)

Fatty acid oxidation: Activation of fatty acids, transport to mitochondria, β oxidation of saturated, unsaturated, odd and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal β oxidation, ω oxidation and α oxidation. Ketone-body synthesis and utilization and its regulation. Ketone body metabolism in diabetes and starvation.

Unit 3. Synthesis of lipids (12 Hours)

Transport of mitochondrial Acetyl groups to cytosol, Fatty acyl synthase complex, Synthesis of saturated and unsaturated fatty acids, Regulation of fatty acid metabolism. Fatty acid elongation systems, role of mixed function oxidases in fatty acid desaturation. Synthesis of triacylglycerol, glycerophospholipids and sphingolipids.

Unit 4. Cholesterol metabolism (4 Hours)

Biosynthesis of cholesterol and its regulation. Fates of cholesterol, cholesterol transport. Familial Hypercholesterolemia, Dyslipidemia, and atherosclerosis.

2.3 Practical: 60 Hours

1. Isolation of lipids and determination of phospholipid/ cholesterol ratio from egg yolk
2. Separation of Phospholipids by TLC
3. Estimation of Ketone bodies in blood/urine
4. Total Cholesterol estimation and HDL-Cholesterol estimation
5. Triglyceride estimation and lipid profile
6. Case studies: Obesity, Dyslipidaemia, Metabolic syndrome, Fasting, Ketosis

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8th ed.). New

York, WH: Freeman and Company. ISBN-10: 1319381493

: 1319381499 ISBN-13-978

2. Devlin, T.M. (2011). Textbook of Biochemistry with Clinical Correlations (7th ed.). New York, John Wiley & Sons, Inc. ISBN:978-0-470-28173-4.
3. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN:978-1-11809244-6.

Suggested readings:

1. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). *Biochemistry* (9th ed.). New York, WH: Freeman ISBN-13: 9781319114671
2. Denise R Ferrier (2018) Lippincott Illustrated Reviews Biochemistry, 7th Edition Publisher. Wolter Kluwer; ISBN-10. 8184739141.

4. Keywords

Lipids, Lipoproteins, triacylglycerol, Fatty acid oxidation, multienzyme complex, desaturases, ketone bodies, cholesterol

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DSC-8 : BIOENERGETICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course	Eligibility criteria	Pre-requisite of the

		Lecture	Tutorial	Practical/ Practice		course (if any)
Bioenergetics	04	02	00	02	Class XII with Science	NIL

Learning Objectives

The objective of the course is to provide students with the basic understanding of thermodynamic principles, bioenergetics and the roles of high energy compounds in metabolism. The course will also provide an understanding of the biological oxidation reduction reactions. The course will introduce students to the detailed molecular mechanisms of oxidative phosphorylation and structural as well as functional aspects of ATP synthase. The course will provide an in-depth knowledge of photophosphorylation.

Learning outcomes

On successful completion of the course students will be able to:

- Describe the basic tenets of thermodynamics and energy transformations that are taking place in the cell
- Explain the biological oxidation-reduction reactions and the mechanisms of electron transfer by electron carriers.
- Appreciate the concept of chemiosmotic theory and the mechanism of oxidative phosphorylation and ATP synthesis.
- Elaborate the basic mechanisms photophosphorylation in plants and microbes.

SYLLABUS OF DSC-8

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE) BCH-DSC-302: BIOENERGETICS

Semester – III

Unit I: Principles of Thermodynamics (6 Hours)

Laws of thermodynamics, Thermodynamic quantities: Gibbs free energy, enthalpy, entropy, Free energy change. Standard free energy change, equilibrium constant, actual free energy change, coupled reactions, energy charge, phosphorylation potential, ATP cycle. Chemical

basis of high standard free energy change of hydrolysis of ATP, phosphoenolpyruvate, 1,3 bisphosphoglycerate, phosphocreatine and thioesters. Bioluminescence.

Unit II: Biological Oxidation-reductions (4 Hours)

Redox reactions, reduction potentials, standard reduction potential and its relationship with standard free energy change, Nernst equation. Universal electron carriers-NADH and $FADH_2$.

Unit III: Oxidative phosphorylation (10 Hours)

Mitochondria as the site of oxidative phosphorylation, electron carriers in mitochondria, structural and functional organization of the mitochondrial respiratory chain, proton motive force, chemiosmotic hypothesis, inhibitors and uncouplers of mitochondrial electron transport chain. Structure of FoF1 ATP synthase and mechanism of ATP synthesis. Shuttle systems in mitochondria: Malate-aspartate and Glycerol 3-phosphate. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis Alternative respiratory pathways in plants.

Unit VI: Photophosphorylation (10 Hours)

Harvesting light energy. General features of photophosphorylation, historical background and Hill's reaction. Role of photosynthetic pigments and light harvesting systems in plants and microbes. Photophosphorylation in purple and Green sulfur bacteria. Photophosphorylation in plants. Molecular architecture of Photosystem I and Photosystem II. The Z-scheme of photosynthetic electron flow. Oxygen evolving complex, cyclic photophosphorylation and its significance, ATP synthesis by photophosphorylation, efficiency of photophosphorylation, Bacteriorhodopsin.

2.3 Practical: - 60 Hours

1. Study the photosynthetic O_2 evolution in hydrilla plant.

2. Isolation of chloroplast from spinach leaves.
3. Estimation of chlorophyll content.
3. Study the Hill reaction by using artificial electron acceptor.
4. Estimation of the activity of PS-II.
5. Separation of photosynthetic pigments by TLC.
6. Isolation of mitochondria from liver and assay of mitochondrial marker enzyme SDH.

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8thed.). New York, WH: Freeman and Company. ISBN: 13: 978-1319381493 / ISBN- 10:1319381499.
2. Berg, J.M., Tymoczko, J.L., Gatto G.J., Stryer L. (2019) *W.H:* Freeman and Company, ISBN:10: 1319114679, ISBN:13:978-1319114671

3. Garret, R.H., Grisham, C.M. (2016). Biochemistry (6thed.). Boston, Cengage Learning. ISBN-10: 1305577205, ISBN-13: 978-1305577205

Suggested readings:

1. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9th ed.). New York, WH: Freeman & Company. ISBN-13: 978-1319208523, ISBN-10:1319208525.
2. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN : 978-1-11809244-6.

3. Keywords

Thermodynamics, free energy, oxidative phosphorylation, ATP synthase, photophosphorylation

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DSC-9: MEMBRANE BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Membrane Biology	04	02	00	02	Class XII with Science	NIL

Learning Objectives

The objective of the course is to provide students with the basic understanding of membrane composition, structure-function relationship and properties of membranes. The course will also provide an understanding of the various types of membrane transporters and their molecular mechanisms. This course also provides understanding of molecular mechanisms involved in vesicular transport processes and membrane fusion.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the general composition and structure of biomembranes.
- Describe the basic properties of membranes such as membrane fluidity.
- Elaborate various types of membrane transport mechanisms.
- Apply the knowledge gained about the molecular mechanism of vesicular transport and membrane fusion to understand the functioning of cells.

SYLLABUS OF DSC-9

Theory

Hours – 30 Hours

Unit I: Membrane composition and structure **(10 Hours)**

Composition of membranes: Lipids -Phospholipids, Glycolipids, sterols; Proteins - Peripheral Proteins, Integral Membrane Proteins and Lipid-Anchored proteins, and carbohydrates.

Historical background and various membrane models. Overview of membrane functions.

Comparison of the composition of various cellular and subcellular membranes. Lateral and transverse asymmetry in membranes. Role of Flippase, Floppase and Scramblase.

Model systems to study membranes - Lipid Monolayers, Planar Bilayer and Liposome, and their application. Polymorphic Lipid-Water Systems. The various determinants of polymorphic phases: CMC, lipid shape, critical packing parameter.

Unit II: Membrane dynamics (5 Hours)

Membrane fluidity: lateral, transverse and rotational motion of lipids and proteins. Factors affecting membrane fluidity- composition, barriers (tight junctions), cytoskeleton interactions,
microdomains – rafts, caveolae. Fence and gate model. Study of RBC membrane architecture.
Homeoviscous Adaptation. Techniques to study membrane dynamics: FRAP, TNBS, SPT.

Unit III: Membrane transport (9 Hours)

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport glucose transporter and anion transporter. Primary active transporters- P-type ATPases, V- type ATPases, F-type ATPases. Secondary active transporters - lactose permease, Na+ - glucose symporter. ABC family of transporters – MDR and CFTR. Group translocation and bacteriorhodopsin. Ion channels: voltage-gated ion channels (Na+ and K+ channel) and ligand-gated ion channels (acetylcholine receptor), and aquaporins. Ionophores: valinomycin, gramicidin. Relationship of membrane transport and diseases.

Unit IV: Vesicular transport and membrane fusion (6 Hours)

Vesicular transport. Vesicles, Clathrin-Coated Vesicles and COP-Coated Vesicles (COPI and COPII). Molecular Mechanism of Vesicular Transport. Membrane Fusion (dynamin protein, Rab proteins, NSF/ SNAP complex, SNARE proteins). Receptor Mediated Endocytosis: LDL, Transferrin

2.3 Practical:

Total Hours : 60 Hours

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Isolation of membrane phospholipids and separation by TLC.
3. Effect of temperature, pH, detergents, and ionic strength on Tonoplast membrane of beetroot.
4. Determination of CMC of detergents, neutral and ionic
5. Preparation of RBC ghost cell.
6. Separation of RBC membrane proteins by SDS-PAGE.
7. Demonstration of Histidine uptake from the intestinal membrane.

2.4 Essential readings:

1. Garret, R.H., Grisham, C.M. (2016). Biochemistry (6th ed.). Boston, Cengage Learning. ISBN-10: 1305577205, ISBN-13: 978-1305577205

2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9th ed.). New York, WH: Freeman & Company. ISBN-13: 978-1319208523, ISBN-10:1319208525.
3. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8th ed.). New York, WH: Freeman and Company. ISBN: 13: 978-1319381493 / ISBN- 10:1319381499.
4. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN: 978-1-11809244-6.
5. Wardhan, R., Mudgal, P. (2017). Text Book on Membrane Biology (1st ed.). Singapore, Springer. ISBN-10: 9811071004, ISBN-13: 978-9811071003

3. Keywords:

Membrane structure composition, membrane fluidity, membrane transport, vesicles, membrane fusion

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.