

DEPARTMENT OF BIOCHEMISTRY
BSc. (Hons.) Biochemistry
Semester IV

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/ Practical		
Metabolism of Amino Acids and Nucleotides (BCH-DSC-401)	4	2L	00	2P	Class XII with Science and Biology	NIL

Learning Objectives

The main objective of the course is to offer detailed and comprehensive knowledge about the synthesis and degradation pathways of amino acids and nucleotides and their importance in the proper functioning of the cells. This course also interrelates the metabolism of these

molecules with respect to health diseases in addition to providing an overview of inhibitors of metabolism for treating the diseases of metabolic disorders.

Learning outcomes

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

1. Explain the importance of nitrogen cycle.
2. Explain the degradation and biosynthetic pathways of amino acids and nucleotides in humans.
3. Discuss the importance of amino acids as precursors to a variety of important biomolecules.
4. Examine the role of inhibitors of nucleotide metabolism as chemotherapeutic drugs
5. Discuss the integration of the amino acid, nucleotide, carbohydrate and lipid metabolism

SYLLABUS OF DSC-10

BCH-DSC-10 : METABOLISM OF AMINO ACID AND NUCLEOTIDES

Semester – IV

THEORY (Credits 2)

Total Hours: 30

Unit I: Overview of Nitrogen and Amino Acid Metabolism (6 Hours)

Nitrogen cycle, incorporation of ammonia into biomolecules, Role of essential and non-essential amino acids in growth and development, Metabolic fates of amino groups. Transamination, role of pyridoxal phosphate, Glucose-alanine cycle, Krebs bicycle, urea cycle, its regulation and inherited defects of urea cycle, Gamma Glutamyl cycle.

Unit II: Catabolism, Biosynthesis and precursor functions of amino acids (10 Hours)

Catabolic pathways of individual amino acids, Glucogenic and ketogenic amino acids. Metabolism of one carbon unit, Overview of amino acid synthesis: Biosynthesis of non-essential amino acids and its regulation, Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methyl malonic acidemia (MMA), homocystinuria, and Hartnup's disease, ***Precursor Functions of Amino Acids:*** Biosynthesis of creatine and creatinine, polyamines (putrescine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA)

Unit III: Biosynthesis and Degradation of Nucleotides
Hours)

(10

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways, Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides, Inhibitors of nucleotide metabolism. Lesch Nyhan Syndrome, Gout and SCID (Adenosine deaminase deficiency), Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides

Unit IV: Integration of Metabolism
Hours)

(4

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

2.3 Practical (Credits 2)

Total Hours: 60

1. Assay of serum transaminase – SGOT and SGPT
2. Estimation of serum urea.
3. Estimation of serum uric acid.
4. Estimation of serum creatinine.
5. Glutamate Dehydrogenase Assay
6. Aspartate Transcarbamylase kinetics
7. Case studies on SCID, Gout and Lesch Nyhan Syndrome.

2.4 Essential readings:

- Berg, J.M., Tymoczko, J.L. and Stryer L., (2012) W.H. Biochemistry (7th ed.), Freeman and Company (New York), ISBN:10: 1-4292-2936-5, ISBN:13:978-1-4292-2936-4.
- Devlin, T.M. (2011) Textbook of Biochemistry with Clinical Correlations (7th ed.), John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4 / BRV ISBN:978-0-470- 60152-5.
- Nelson, D.L. and Cox, M.M. (2017) Lehninger: Principles of Biochemistry (7th ed.) W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10- 1464126119.
- Principles of Biochemistry (2013) 4th ed., Voet, Donald, Voet, Judith & Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.

- Victor Rodwell, David Bender, et al. (2018) ISE Harper's Illustrated Biochemistry Thirty- First Edition, McGraw Hill (A and L Lange series), ISBN-10. 1259837939; ISBN-13. 978-1259837937.

1. Keywords

Metabolism, essential and non-essential amino acids, Nucleotides, Biosynthesis, Salvage pathway, metabolic disorders, HGPRT, Adenosine deaminase

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

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		
Hormones: Biochemistry and Function (BCH-DSC-402)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The course is designed to enable the students to understand and appreciate the delicate network and balance of hormones required for the healthy functioning of the human body. The course emphasizes on studying the different types of hormones along with their physiological action. The students will be taught the consequences of any hormonal imbalances (over and underproduction of hormones) with special emphasis

on human diseases. It provides an understanding of the different endocrine factors that regulate metabolism, growth, electrolyte and mineral homeostasis, glucose homeostasis, stress physiology and reproductive function. It also prepares a student for postgraduate studies in any course related to molecular medicine.

Learning outcomes

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

1. Explain the molecular mechanism and signaling pathways mediating Hormone Action
2. Describe the physiological role of each hormone in regulating growth, appetite, metabolism and reproduction
3. Examine the regulatory mechanisms regulating Hormone secretion and release.
4. Discuss the basis of endocrine diseases taking case studies.

SYLLABUS OF DSC-11

BCH-DSC-11 : HORMONES : BIOCHEMISTRY AND FUNCTION

Semester – IV

2.2 Course Contents

Theory (2 credits)

Total Hours: 30

Unit 1: Introduction to hormones and Hypothalamic- hypophyseal system: (5 Hours)

Introduction to hormones; Hypothalamic - pituitary axis- anatomy, histology, vasculature, and secretions. Physiological and biochemical actions of hypothalamic hormones and Anterior

pituitary hormones; Hormone feed- back regulatory cascade. Posterior pituitary hormones – structure, physiology and biochemical actions of AVP and Oxytocin; Diabetes insipidus.

Unit 2: Hormones regulating growth, energy metabolism and calcium homeostasis (10

Hours) Regulation of Growth: growth hormone and somatomedin, Endocrine disorders - gigantism, acromegaly, dwarfism, pygmies.

Thyroid gland- Biosynthesis of thyroid hormone and its regulation: Role of TRH, TSH in T₄ synthesis and response. Physiological and biochemical action of Thyroxine. Pathophysiology of thyroxine secretion: Goiter, Graves' disease, cretinism, myxedema.

Regulation of calcium homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca^{2+} regulation involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Unit 3: Hormones regulating glucose homeostasis, stress physiology and electrolyte balance: (10 Hours)

Hormones of the Pancreas: structure, synthesis, regulation of release, incretins, physiology and biochemical actions of insulin and glucagon. Role of these hormones in blood glucose homeostasis; Pathophysiology - diabetes type I and type II. GIT hormones: Secretin, gastrin and incretins.

Physiology and action of Aldosterone; the Renin Angiotensin System. Physiology and Biochemical actions of Cortisol; Role of POMC and CRH in cortisol synthesis; Adrenal medullary hormones: epinephrine and norepinephrine. The Fight or flight response; Dual receptor hypothesis. General adaptation syndrome: acute and chronic stress response. Pathophysiology – Addison’s disease, Conn’s syndrome, Cushing syndrome.

Unit 4: Reproductive hormones: (5 Hours)

Male and female sex hormones. Interplay of hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone based Contraceptives.

2.3 Practical (2 Credits)

1. Glucose tolerance test.
2. Estimation of serum Ca^{2+} .

Total Hours: 60

3. Determining the thyroid profile by estimating T_4 and TSH under normal and pathophysiological conditions. Or Estimation of estrogen during different days of the menstrual cycle.
4. Presentation Assignments on GI Tract hormones and Adipokines
5. HCG based pregnancy test.
6. Estimation of serum electrolytes.
7. Case studies: Diabetes Insipidus, Acromegaly and dwarfism, Diabetes Mellitus, Rickets, Osteoporosis, Cushing syndrome

2.4 Essential readings:

1. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
2. Sherwood, L. (2012) Introduction to Human Physiology 8th edition; Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.
3. Victor Rodwell, David Bender, et al. (2018) ISE Harper's Illustrated Biochemistry Thirty- First Edition, McGraw Hill (A and L Lange series), ISBN-10. 1259837939; ISBN-13. 978-1259837937

Suggested readings:

1. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
2. Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elsevier India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052

3. Keywords

Hypothalamic-hypophyseal axis, hormones, calcium and glucose homeostasis, hormonal disorders.

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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		
Gene	4	2L	0	2P	Class XII	NIL

Organization, Replication and Repair (BCH-DSC- 403)					with Science and Biology	
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Learning Objectives

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides an understanding of DNA replication, recombination, mutations and repair processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

Learning outcomes

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

1. Analyse the structure of DNA and various forms of DNA and learn about organisation of genome in various life forms, supercoiling of DNA and its significance
2. Perform isolation of DNA and analyse the purity of isolated DNA sample
3. Evaluate the molecular basis of processes like DNA replication, recombination and transposition and demonstrate the significance of these processes
4. Perform various methods of DNA estimation
5. Discuss the various ways in which the DNA can be damaged leading to mutations, lesions and repair mechanisms

SYLLABUS OF DSC-12

BCH-DSC-12 : GENE ORGANIZATION, REPLICATION AND REPAIR

Semester – IV

2.2 Course Contents

Theory (2 Credits)

**Unit I: Structure of DNA and genomic organization
(8 Hours)**

**Total Hours: 30
(8**

Watson and Crick model of DNA, various forms of DNA, Supercoiling of DNA, linking number, Topoisomerases, Topoisomerase inhibitors and their clinical importance, Definition

of a gene, organization of genes in viruses, bacteria and eukaryotes, concept of split genes, introns, exons, satellite DNA, highly repetitive DNA.

Unit II: Replication of DNA (10 Hours)

The chemistry of DNA synthesis, DNA polymerase, the replication fork, enzymes and proteins in DNA replication, *E coli* DNA polymerases, stages of replication: initiation, elongation, origin of replication, relationship between replication and cell division, replication in eukaryotes, end replication problem, telomerases. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine.

Unit III: Recombination and transposition of DNA (6 Hours)

Homologous recombination, enzymes in homologous recombination, site-specific recombination, recombinases. Transposition, DNA transposition by cut and paste and replicative mechanism.

Unit IV: Mutations and DNA Repair (6 Hours)

Importance of mutations in evolution of species, Types of mutations, DNA damage by hydrolysis, alkylation, oxidation and radiation. Mutations caused by base analogs and intercalating agents. Ames test. Replication errors and their repair, mismatch repair system. Repair of DNA damage-direct reversal of DNA damage, base excision repair, nucleotide excision repair, translesion DNA synthesis. DNA repair diseases.

2.3 Practical (2 Credits)

1. DNA estimation by DPA
2. Separation of nitrogenous bases by paper chromatography
3. To plot the ultraviolet absorption spectrum of DNA
4. Isolation of chromosomal DNA from *E coli* cells
5. Determination of DNA concentration and purity by UV absorption.
6. Determination of the melting temperature of DNA

Total Hours: 60

7. Demonstration of the mechanism of Transposition and Recombination (Dry Lab)
8. Ames test
9. Exercise with *in silico* tools (NCBI, GenBank, EMBL, DDBJ, NBD, BLAST and Clustal omega)

2.4 Essential readings:

- Lehninger: Principles of Biochemistry (7th ed.) (2017) Nelson, D.L. and Cox, M.M W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
- Molecular biology of the gene: (7th ed), (2014) Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. International). Pearson.

Suggested readings:

- Genetics - A Conceptual Approach,) (6th ed). (2012), Pierce, B.A. W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-
- Lewin's Gene X (10th edition) (2018). Lewin, B., Krebs, J.E., Kilpatrick, S.T., Goldstein, E.S., Bartlett Learning publishers, LLC, ISBN: 978-0-7637-6632-0.
- The Cell: A Molecular Approach (7th ed.) (2009). Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland (Washington DC), Sinauer Associates, MA. ISBN:978-0- 87893- 3030.
- *Biochemistry* (6th ed.) (2016). Garrett, R. H., & Grisham, C. M. Brooks Cole. ISBN: 9781305882409

3. Keywords

DNA, Double helix, Supercoiling, Recombination, Transposition, DNA Repair

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