SEMESTER V
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		
Molecular Cell Biology (BCH-DSC-501)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The course aims to provide advanced knowledge about the function of cellular organelles and the mechanism of protein sorting in the cell. It will also provide details of cellular communications in the cell and understanding of molecular regulation of cell growth and cell death. The course will outline the molecular details of cancer development and treatment.

Learning outcomes

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

1. Explain the process of protein trafficking in the cell and role of various regulatory proteins involved in the process.
2. Discuss the different modes of cellular communication in a multicellular organism

3. Explain the regulatory mechanisms involved in controlling the process of mitosis, meiosis, apoptosis, necrosis and autophagy.
4. Examine the molecular and genetic basis of cancer development and various molecular approaches used for cancer treatment.

SYLLABUS OF DSC-13

Theory (2 Credits)

BCH-DSC-501 : MOLECULAR CELL BIOLOGY SEMESTER - V

Total Hours: 30

Unit I: Protein Sorting and Secretory Pathway (7 Hours)

Overview of the endomembrane system; Co-translational and post-translational targeting of proteins into Endoplasmic Reticulum; Protein Modifications, Folding and Quality Control in ER; Protein targeting to Golgi complex and Lysosomes; Exocytosis; Sorting of Proteins to Mitochondria, Chloroplasts and Peroxisomes.

Unit II: Cellular Signaling (10 Hours)

Chemical signaling- endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Hormone receptors- extracellular and intracellular. G protein coupled receptors, G proteins, second messengers- cAMP, cGMP, IP3, DAG, Ca^{2+}, Effector systems- adenylyl cyclase, guanylyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases-EGF, Insulin and Ras-MAP kinase cascade. Non-receptor tyrosine kinase- erythropoietin receptor JAK-STAT pathway. Intracellular receptor family: Steroid hormone receptor and NO receptors.

Unit III: Cell cycle and Apoptosis (8 Hours)

Overview of the cell cycle; Stages of eukaryotic cell cycle; Events of Mitotic Phase and Cytokinesis; Role of cyclins and cyclin-dependent kinases; Molecular mechanisms of cell cycle regulation and Cell Growth; Meiosis and its regulation; Cell death: Apoptosis, Necrosis and Autophagy; Intrinsic and extrinsic apoptotic pathways; Regulation of apoptotic pathways.

Unit IV: Molecular Basis of Cancer Biology (5 Hours)

Types of cancer; Stages of cancer development; Properties of Cancerous Cells; Genetic basis of cancer; Cancer causing agents: radiations, chemical carcinogens and introduction to viral oncogenes; Role of cancer critical genes: oncogenes and tumor suppressor genes; Molecular approaches for cancer treatment.

2.3 Practical (2 Credits)

Total Hours: 60

1. Isolation of organelles by subcellular fractionation and validation of separated organelles by marker enzymes.
2. Study the changes in heart rate (sympathetic response) on exposure to caffeine (cAMP mediated) in model organisms.
3. Preparation of hepatocyte primary culture and cell enumeration.
4. Study of cell viability/death assay by use of trypan blue and MTT assay.
5. Polyploidy in onion root tip by colchicine treatment.
6. Study of apoptosis through analysis of DNA fragmentation patterns.
7. Identification and study of cancerous cells using permanent slides and photomicrograph.

2.4 Essential readings:

1. Cooper, G.M. (2018). The Cell: A Molecular Approach. (8th ed.). Sinauer Associates Inc: Oxford University Press. ISBN: 9781605357072
2. Karp, G., (2010). Cell and Molecular Biology: Concepts and Experiments (8th ed.). John Wiley & Sons. Inc. ISBN: 978-1-118-65322-7.
3. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of the Cell. (6th ed.). Garland Science. ISBN: 978-0815345244

4. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh. A., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9th ed.). W.H. Freeman & Company (New York). ISBN-13: 978-1319208523/ ISBN-10: 1319208525

Suggested readings:

1. Kleinsmith, L. J., Hardin, H., Wayne G., Becker, M. (2009). The World of the cell (7th ed.). ISBN-13: 978-0805393934 / ISBN-10: 0805393935.

3. Keywords

Protein Sorting, Protein Modification, exocytosis, Cellular communication, autophagy, mitosis, meiosis, Apoptosis, Necrosis, Cancer, Oncogenes, Chemotherapeutics.

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		
Concepts in Genetics and Evolution (BCH-DSC-502)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The aim of the course is to provide an understanding of both classical and modern concepts in the areas of mapping techniques, transmission, molecular, quantitative, population and evolutionary Genetics. Practicals are well correlated with the theory topics and designed to support skill-oriented learning outcomes. The course also works as preparation for further studies in a Master's programme in molecular biology or related topics.

Learning outcomes

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

1. Explain the principles of Mendelian genetics, extensions and applications.
2. Examine the various factors that confer genotypic and phenotypic variability.
3. Correlate human and viral genetics to create linkage and genetic maps.
4. Perform experiments using genetic model system *Drosophila melanogaster*.
5. Analyse biological data using statistical tools
6. Discuss the principles of transmission and inheritance in real life situations.

SYLLABUS OF DSC-14

BCH-DSC-502 : CONCEPTS IN GENETICS AND EVOLUTION SEMESTER - V

2.2 Course Contents

Theory (2 Credits)

Total Hours: 30

Unit I: Mendelian and Non-Mendelian genetics (8 Hours)

Revision of Mendelian Genetics; Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Complementation test using examples from

Drosophila eye colour mutants to differentiate allelic variants from gene interaction. Pleiotropic gene interaction - epistatic and non- epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.

Unit II: Linkage, crossing over and mapping techniques (9 Hours)

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications, detection of linked loci by pedigree analysis in humans, LOD score, somatic cell hybridization for positioning genes on chromosomes and physical maps using molecular markers.

Unit III: Molecular genetics (8 Hours)

Sex determination: Genetic basis of sex determination in Humans, *Drosophila melanogaster* and *C. elegans*. *Non-nuclear inheritance and Epigenetics:* Extra nuclear inheritance, tests for organelle heredity and maternal effect; Mechanism of dosage compensation; X chromosomal inactivation in humans and *Drosophila melanogaster.* Epigenetic mechanisms of transcriptional regulation. Monoallelic expressions and Genomic imprinting.

Unit IV: Quantitative and Evolutionary Genetics (5 Hours)

Inheritance of complex traits, analysis of quantitative traits, quantitative trait loci (QTL), narrow and broad sense heritability, and their identification. Hybrid vigor and transgressive inheritance.

Molecular evolution - analysis of nucleotide and amino acid sequences, homologous sequences, molecular phylogenies, phenotypic evolution and speciation, Understanding the concept of fitness with respect to evolutionary genetics.

2.3 Practical (2 Credits)

1. Understanding Mendelian genetics (dry lab).

Total Hours :60

2. Monohybrid crosses in *Drosophila* for studying autosomal/sex-linked inheritance.
3. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.

4. Smear technique to demonstrate sex chromatin in buccal epithelial cells/neutrophils.
5. Understanding Hardy-Weinberg principle. PTC testing in a population and calculation of allelic and genotype frequencies.
6. Understanding chromosomal structure.
   - The study of normal and abnormal human karyotype (dry lab).
   - understanding polyploidy by studying karyotypes in plants
7. Study of human pedigrees (dry lab).

2.4 Essential readings:

1. Principles of Genetics (2015) 7th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 9781119142287
2. Genetics - A Conceptual Approach (2020), 7th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN: 978-01346047

Suggested readings:

1. An Introduction to Genetic Analysis (2017), 11th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN: 1464109486

2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2019). Concepts of Genetics. Edition 12. Benjamin Cummings.

3. Keywords

Complementation, Allelic and gene interaction, Gene mapping, Non-nuclear inheritance and Epigenetics, Sex determination, Quantitative and Evolutionary Genetics

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	Credits	Credit distribution of the course	Eligibility criteria	Pre-requisite of the

& Code		Lecture	Tutorial	Practical/ Practice		course (if any)
Gene Expression and Regulation (BCH-DSC-503)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The objective of the course is to introduce to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem-solving skills.

Learning outcomes

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

1. Analyse the processes of transcription and translation in prokaryotes and eukaryotes
2. Discuss the features of the genetic code and various experimental approaches used to crack the code
3. Perform estimation of RNA by orcinol method
4. Discuss the molecular basis of RNA processing and RNA splicing
5. Perform isolation of RNA from bacteria and plant cells
6. Evaluate the various ways in which transcription and translation are regulated

SYLLABUS OF DSC-15

BCH-DSC-503 : GENE EXPRESSION AND REGULATION
SEMESTER - V

2.2 Course Contents

Theory (2 credits)

Total Hours: 30

Unit I: Transcription in Prokaryotes and Eukaryotes (10 Hours)

Transcription cycle in bacteria, Sigma factor, bacterial promoters and RNA Polymerases, various stages of RNA synthesis- initiation, elongation and termination, rho-dependent and rho- independent termination. Introduction of basal eukaryotic transcription machinery: three classes of eukaryotic RNA polymerases – I, II and III, and their respective promoters. Details of transcription by RNA polymerase II, features of RNA polymerase II core promoters. Inhibitors of eukaryotic and prokaryotic transcription and their applications.

Unit II: RNA Processing (4 Hours)

Various types of mRNA processing- polyadenylation and capping, brief overview of rRNA and tRNA processing. Chemistry of RNA splicing, the spliceosome machinery, group I and group II introns, alternative splicing.

Unit III: Translation (7 Hours)

Salient features of the genetic code, triplet nature, degenerate, wobble hypothesis, codon usage bias. Experimental approaches used to decipher the genetic code. Messenger RNA, transfer RNA, charging of tRNA. Structure of the ribosome. Three stages of translation-initiation, elongation and termination in prokaryotes and eukaryotes.

Unit IV: Regulation of gene expression (9 Hours)

Concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of *lac* and *trp* operon, riboswitches. Eukaryotic gene regulation by chromatin remodelling, regulation of galactose metabolism in yeast, action of enhancers and insulators, working of activators and repressors, synthesis and mechanism of action - siRNA and miRNA.

2.3 Practical (2 Credits)

1. Quantitative estimation of RNA by Orcinol Method
2. Extraction of total RNA from bacteria /yeast
3. To study growth curve and diauxic growth curve in *E. coli*
4. To study inducible promoter activity by reporter assay

5. To study the effect of inhibitors on protein synthesis
6. DNA Footprinting (Dry Lab)

Total Hours: 60

2.4 Essential readings:

1. 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.
2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008) *Watson: Molecular Biology of the Gene* (7th ed.), Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN-13: 9780321762436

Suggested readings:

1. Lewin, B., Krebs, J.E., Kilpatrick, S.T., Goldstein, E.S., (2018) *Lewin's Gene X* (10th edition). Bartlett Learning publishers, LLC, ISBN: 978-0-7637-6632-0.

3. Keywords

RNA, Transcription, Translation, Genetic code, Gene expression, Operon

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