

UNDERGRADUATE PROGRAMME IN BIOCHEMISTRY

Gene Expression and Regulation

THEORY

- 1. Biosynthesis of RNA in prokaryotes (6 lectures)**
RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, the three stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Inhibitors of transcription and applications as anti-microbial drugs.
[Molecular Biology of the Gene (2008) Watson et al., p377-396; Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p1068-1069]
- 2. Biosynthesis of RNA in eukaryotes (6 lectures)**
Comparison between prokaryotic and eukaryotic transcription. Transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, various types of RNA processing, transcription by RNA polymerase I and III. Inhibitors of eukaryotic transcription and their applications. Comparison of fidelity of transcription and replication.
[Molecular Biology of the Gene (2008) Watson et al., p396-412; Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p1068-1069]
- 3. RNA splicing (5 lectures)**
Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, alternative splicing, exon shuffling, RNA editing.
[Molecular Biology of the Gene (2008) Watson et al., p415-430, p432-435, p446-452]
- 4. The genetic code (3 lectures)**
Degeneracy of the genetic code, wobble in the anticodon, features of the genetic code, nearly universal code.
[Molecular Biology of the Gene (2008) Watson et al., p521-538]
- 5. Biosynthesis of proteins (8 lectures)**
Messenger RNA, transfer RNA, attachment of amino acids to tRNA, the ribosome - initiation, elongation and termination of translation, regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis. Use of antibiotics in understanding protein synthesis and applications in medicine.
[Molecular Biology of the Gene (2008) Watson et al., p457-512; Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p1138-1139]
- 6. Protein targeting and degradation (4 lectures)**
Post translational modifications, glycosylation, signal sequences for nuclear transport, bacterial signal sequences, import of proteins by receptor mediated endocytosis, specialized systems for protein degradation.
[Lehninger: Principles of Biochemistry (2013), Nelson and Cox, p1139-1148]

7. Regulation of gene expression in prokaryotes (8 lectures)

Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon, induction of SOS response, synthesis of ribosomal proteins, regulation by genetic recombination, transcriptional regulation in λ bacteriophage.

[Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p1156-1174; Molecular Biology of the Gene (2008) Watson et al., p568-585]

8. Regulation of gene expression in eukaryotes (8 lectures)

Heterochromatin, euchromatin, chromatin remodeling, regulation of galactose metabolism in yeast, regulation by phosphorylation of nuclear transcription factors, regulatory RNAs, riboswitches, RNA interference, synthesis and function of miRNA molecules, phosphorylation of nuclear transcription factors.

[Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p1175-1186; Molecular Biology of the Gene (2008) Watson et al., p633-658]

Essential Readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
2. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.

PRACTICALS

1. Extraction of total nucleic acids from plant tissue.
2. Diauxic growth curve effect.
3. Isolation of mRNA from yeast by affinity chromatography.
4. Effect of inhibitors on protein synthesis.
5. Accumulation of protein due to proteasome inhibitors.