M Sc biotechnology course of study

Course Title:Molecular Biology
Course No.: BT 512
Credits: 3

Objectives
At the end of the course the students should be able to:

- describe NAs and the process of protein synthesis
- explain the mechanism of DNA replication
- explain, how the expression of DNA is controlled inside a cell
- Describe the role of protein structure on its functions
- explain how proteins are synthesized and their intracellular transport

Course Description

Introduction to Molecular Biology. 1 hr

Prelude, Discovery of the role of DNA, biochemistry and genomic revolution, building blocks of DNA, Base-paring of DNA, double helical structure of DNA, DNA has hereditary material- its stability and storage of genetic information, RNA and its basic role in the cell, Genetic code, genetic terminology, and possible of mechanism of evolution, RNA directed polypeptide synthesis, Proteins are cellular functional units.

The Structure of DNA and Genome Organization. 5 hrs

Building blocks of nucleic acids, Chemical structure of DNA, its chemical and physical properties.Organization of cellular DNA in prokaryotes and eukaryotes. Proteins interactions with DNA and chromosomal organization, satellite DNAs, repeated DNA sequence. Heterochromatin and euchromatin, mobile DNA.

RNA structure and the Versatility of RNA. 2 hrs

Chemical difference between DNA and RNA, types of RNA-rRNA, mRNA, tRNA, snRNA, dsRNA, and other RNA, Structure of RNA- modification of bases, RNA folding and its importance, RNA hereditary material, stability of RNA genomes, RNAi- introduction, mechanism and applications.

From Gene to Protein. (Central Dogma) 1 hr

Gene expression in outline: Accessing of genome, Assembly of the transcription initiation complex, synthesis of RNA, Processing of RNA, RNA degradation, Assembly of the translation initiation complex, Protein synthesis, protein folding and protein processing, protein degradation).

Genome replication
Topological problems: 2 hrs

Watson-Crick scheme for DNA replication, topological problem and its solution, Meselson-Stahl experiment, DNA topoisomerase and its types, variations in semiconservative theme

The replication process:

a.Initiation of genome replication (formation of replisome and various components involved in initiation of replication, replication fork formation and its components): Differences in

Initiation of replication between *E. coli,* yeast and higher eukaryotes.

1 hr

b. Elongation of replication: Template dependent synthesis of DNA, DNA polymerase of bacteria and eukaryotes, Priming of DNA synthesis in bacteria and eukaryotes, bacterial replication fork, eukaryotes replication fork and its variations on the bacterial theme, termination of replication, termination of E coli genome,

2 hrs

c. Maintaining the ends of a linear DNA: Okazaki fragments, synthesis of telomeric DNA, Senescence of telomere length, extension of human chromosome by telomerase, shorting chromosomes leading to cancer and aging

2 hrs

d. Regulation of Eukaryotic genome replication: Coordination of genome replication and cell division; control within S phase, **3 hrs**

DNA Mutation, Repair and Recombination.

Mutation:

1. Introduction and causes of mutations: Genomes are dynamics, Difference between mutation and recombination, causes of mutations, Types of mutations, Errors in replication causes the mutations, effects of tautomerism on base-paring, replication slippage, trinucleotide repeat expansion, **2 hrs**
2. Mutation caused by chemical and physical mutagens: base analogs, deaminating agents, Alkylating agents, Intercalating agents, Ionizing radiation, Heat **1 hr**

3. The effects of Mutations: The effects of mutation on genomes, Mutation detection, The effects of mutations on multicellular organisms: loss of function, gain of function; the effects of mutations on microorganisms; Hypermutation and the programmed mutations,

2 hrs

DNA Repair: **2 hrs**

Types of repair: Direct repair; Excision repair: Base excision repair, Nucleotide excision repair in E. coli and eukaryotes; Mismatch repair: single and double-stranded- break repair; Bypassing DNA damage during genome replication, Non-homologous end-joining in humans, SOS response in E. coli; Defects in DNA repair causes human disease including cancer.

Recombination: **3 hrs**

Homologous recombination: Holliday junction; Meselson-Radding modification, RecBCD pathway, Ruv proteins, Site-specific recombination, double strand break model for recombination in yeast, Transposition and its types: replicative and conservative transposition, Transposition of retroelements,

Transcription in Prokaryotes. **3 hrs**

Overview of RNA synthesis, Gene structure and transcription in prokaryotes, *E. coli* RNA polymerase and roles of subunits, functions of σ subunit of RNA polymerase, elongation, mechanism for the termination of transcription (factors involved in termination), post transcriptional processing of RNA, inhibitors of transcription, Elongation and termination.

Transcription in Eukaryotes **4 hrs**

Eukaryotic RNA polymerases and their sub units, Cis and Trans acting elements, Transcription promoters & enhancers, Eukaryotic transcription factors and their roles, hnRNA, Post transcriptional processing of mRNA and modification, alternative processing of mRNA, splicing, Processing of rRNA and tRNA, RNA editing, recently discovered small RNAs, Ribozymes,

Synthesis and Processing of the Proteome. **3 hrs**

(mRNA and Genetic code: standard and variations; codon anti codon interactions), The role of tRNA in protein synthesis Role of Ribosome in Protein synthesis (Ribosome structure, The players... mRNA, tRNA, activating enzymes, initiation of translation in bacteria and eukaryotes, elongation of polypeptide in bacteria and eukaryotes and termination of polypepetide synthesis in bacteria and eukayrotes), Post translation modifications (Protein folding, Proteolysis, Protein chemical modification) Protein trafficking and degradation, inhibition of protein synthesis (antibiotic).

Regulation of gene expression **9 hrs**

Control of protein synthesis in bacteria and eukaryotic cell; Role of promoter; TBPs (TATA-binding proteins) structure/functions, TAFs (TBP-associated factors) structure and functions, Control in transcription level: transcriptional activators and repressors. Structures and functions of activators and repressors, Signal transduction and the control of transcriptional regulators, RNA processing, RNA degradation; antisense RNA. Gene silencing, Regulation of eukaryotic cell cycle. Gene regulation during early stage of development, environment and hormonal regulation.