Chapter 5 - CASE STUDY QUESTIONS

Question 1:

Explain the role of telomerase in the maintenance of eukaryotic chromosomes. Why is it essential for cells with linear chromosomes?

Question 2:

Describe the differences between eukaryotic and prokaryotic transcription processes, focusing on the role of RNA polymerases and promoters.

Question 3:

What is the significance of RNA splicing in eukaryotic gene expression, and how does it differ from the transcription process in prokaryotes?

Question 4:

How do enhancers and transcription factors work together in the regulation of eukaryotic gene expression?

Question 1:

Explain the role of telomerase in the maintenance of eukaryotic chromosomes. Why is it essential for cells with linear chromosomes?

Telomerase is an enzyme that adds repetitive nucleotide sequences, called telomeres, to the ends of eukaryotic linear chromosomes. During DNA replication, the lagging strand synthesis leaves a gap at the ends of chromosomes (due to the inability of DNA polymerase to fully replicated the 3' end. Without telomerase, these gaps would lead to progressive shortening of chromosomes, eventually resulting in the loss of RNA primer. Telomerase cancels this loss out by adding a few of the six base pair chunks. Telomerase carries with it a small part of RNA complementary to the six base pair telomere repeat. This allows it to recognise the telomeres and reminds it what sequence to make

Question 2:

Describe the differences between eukaryotic and prokaryotic transcription processes, focusing on the role of RNA polymerases and promoters.

Aspect	Eukaryotes	Prokaryotes
RNA polymerases	Eukaryotes have three distinct RNA polymerases · RNA Polymerase I → synthesizes rRNA · RNA Polymerase II → synthesizes mRNA & some small RNAs · RNA Polymerase III → Synthesizes tRNA and 5 S rRNA	Prokaryotes have a single RNA polymerase responsible for synthesizing all RNA types
Promoters	Eukaryotic promoters are complex, containing elements like TATA box, enhancers, and proximal control elements. These elements interact with numerous transcription factors to regulate gene expression.	Prokaryotic promoters are simpler, with -10 and -35 regions recognized directly by the sigma factor associated with RNA polymerase
Transcription - Associated Proteins	Transcription requires a large complex of transcription factors and co-activators to initiate RNA synthesis	The sigma factor alone guides RNA polymerase to the promoter for initiation

Question 3:

What is the significance of RNA splicing in eukaryotic gene expression, and how does it differ from the transcription process in prokaryotes?

RNA splicing is a process where introns are removed . exons are joined together to form a mature mRNA transcript. This process enhances eukaryotic gene expression by allowing for alternative splicing, leading to multiple proteins from a single gene and contributing to protein diversity and adaptability. In contrast, prokaryotes lacks introns, and transcription is directly coupled with translation. mRNA in prokaryotes does not undergo splicing , and the absence of nucleus ensures simultaneous transcription and translation.

Question 4:

How do enhancers and transcription factors work together in the regulation of eukaryotic gene expression?

Enhancers are regulatory DNA sequences that control gene expression, especially during development or in specific cell types. They increase transcription rates by binding specific transcription factors (TFs). Enhancers can be located thousands of base pairs away, upstream or downstream, and activate genes by looping the DNA to bring the enhancer closer to promoter. Transcription factors are specialized proteins with four key roles which are binding specific DNA sequences, interacting with the RNA polymerase II complex, , entering the nucleus where genes are located, responding to signals to turn genes on or off. For example, MyOD, muscle-specific TF, activates genes needed for muscle cell development while remaining inactive in other cell types. Enhancers and TFs together ensure precise, cell-type-specific gene regulation.