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?

During DNA replication, the synthesis of new strands begins with RNA primers that are later removed. For circular chromosomes, the gap left by the primer is filled during replication. However, for linear chromosomes, this removal results in the shortening of DNA with each replication cycle. Over time, this would lead to the loss of essential genetic material.

The telomeres at the ends of eukaryotic chromosomes consist of a six base pair sequence repeated about 2,000 times. During each replication cycle, the chromosomes are shortened due to the loss of the 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 recognize 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.

Eukaryotes	Prokaryotes
Have three distinct RNA polymerases RNA Polymerase I: Synthesizes rRNA. RNA Polymerase II: Synthesizes mRNA, requiring transcription factors for initiation. RNA Polymerase III: Synthesizes tRNA and 5S rRNA.	Have a single RNA polymerase that synthesizes all RNA types.
Promoters are complex, featuring elements like the TATA box and upstream regulatory sequences. Transcription factors recruit RNA Polymerase II to initiate transcription.	Promoters are simpler, with conserved -10 (TATAAT) and -35 (TTGACA) regions. RNA polymerase recognizes and binds directly to these sequences with the help of sigma factors.

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 the process of removing introns (non-coding regions) from the primary RNA transcript and joining exons (coding regions) to produce a functional mRNA molecule. Splicing ensures the mRNA can be translated into a functional protein. This is necessary because introns would disrupt the reading frame.

Prokaryotes: In prokaryotes, there are lack of introns, thus RNA splicing does not occur. The absence of introns allows prokaryotic transcription and translation to occur simultaneously in

the cytoplasm, unlike in eukaryotes, where transcription occurs in the nucleus, and translation happens in the cytoplasm.

Question 4:

How do enhancers and transcription factors work together in the regulation of

eukaryotic gene expression?

Enhancers of Eukaryotes:

Enhancers are sequences involved in gene regulation, especially during development or in different cell types. They enhance the rate of transcription as a result of binding certain specific transcription factors. Often, they lie at some distance from the gene (thousands of bp away), although they are sometimes found close to the genes they control. Enhancers may be located either upstream or downstream from the promoter! When an enhancer switches a gene ON, the DNA between it and the promoter loops out.

Transcription Factors:

TF are specialized proteins that regulate gene expression by controlling transcription. They have four domains needed for the following functions:

1. Binding to a specific sequence on the DNA.
2. Binding to the RNA polymerase II complex.
3. Getting into the nucleus where the genes are kept.
4. Responding to a stimulus which signals that the gene should be turned ON