

Question 1:

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:

- During transcription, prokaryotes have only 1 RNA polymerase while eukaryotes have 3 different RNA polymerases
- Eukaryotic promoters are more complex, consisting of regions like the TATA box, initiator box, and upstream elements. They rely on transcription factors to recruit RNA Polymerase II.
- Prokaryotic promoters are simpler, with conserved sequences such as the -10 and -35 regions, and the RNA polymerase can directly recognize these sequences without the need for many additional factors.

Question 3:

- 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.
- Transcription and translation of prokaryotes occur simultaneously in the cytoplasm, unlike in eukaryotes, where transcription occurs in the nucleus, and translation happens in the cytoplasm.

Question 4:

- Transcription Factors are specialised 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
- If enhancers did not exist in the eukaryotic transcription process, gene expression would become significantly less efficient and flexible. Enhancers play a critical role in increasing the transcription rate by facilitating the recruitment of transcription factors and RNA polymerase to the promoter region, often over long distances.
- Without them, lack of regulation of gene expression could result in improper protein production, potentially causing developmental disorders or reduced cellular functionality in eukaryotic organisms.