Concept 5: Molecular Genetics

Thinking Questions

1. Compare the two DNA sequences shown below. Transcribe them into mRNA and translate them into an amino acid sequence.

GTG CAC CTC ACT CCA GAG GAG (Normal Hemoglobin)

This is a mistake. should be:

mRNA → CAC|GUG|GAG|UGA|GGU|CUC|CUC

DNA: CAC GTG GAG TGA GGT CTC CTC

amino acids → His | Val | Glu | stop | Gly | Leu | Leu

GTG CAC CTC ACT CCA GTG GAG (Sickle Cell Hemoglobin)

mRNA → CAC|GUG|GAG|UGA|GGU|CAC|CUC

DNA: CAC GTG GAG TGA GGT CAC CTC

amino acids → His | Val | Glu | stop | Gly | His | Leu

   a. Circle any differences there are in the DNA, RNA and amino acid sequences that might exist between these two sequences.

   b. Identify the type of mutation that is represented AND EXPLAIN, IN DETAIL, what effect this would have on the protein/pigment (be sure to mention the types of functional groups on the amino acids and how this would affect shape of the molecule).

Using the corrected DNA - There is a point mutation (missense) in the 6th amino acid. The valine is substituted for ~~valine~~ glutamic acid. Valine is hydrophobic, glutamic acid is polar.

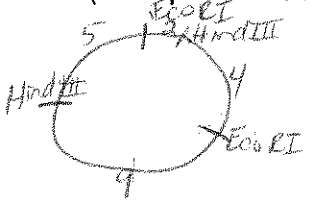
2. In prokaryotic cells, translation begins before transcription is finished. Give two reasons why this would not be possible in eukaryotic cells.

Eukaryotes have a nuclear membrane separating the locations of transcription and translation.
Eukaryotes must process the mRNA transcript prior to translation.

3. The restriction enzyme EcoRI cleaves double-stranded DNA at the sequence 5'-GAATTC-3' and the restriction enzyme HindIII cleaves at 5'-AAGCTT-3'. A 20 kb circular plasmid is digested with each enzyme individually and then in combination, and the resulting fragment sizes are determined by means of electrophoresis. The results are as follows:

EcoRI alone	fragments of 6 kb and 14 kb
HindIII alone	fragments of 7 kb and 13 kb
EcoRI and HindIII	fragments of 2kb, 4kb, 5 kb and 9kb

Make a diagram of the circular molecule and indicate the relative positions of the EcoRI and HindIII restriction sites. (Hint: place one EcoRI site at '12 o'clock' and position the remainder relative to this site.)



(may be flipped)

Molecular Genetics Short Free Response (4 points)

When DNA replicates, each strand of the original DNA molecule is used as a template for the synthesis of a second, complementary strand. Compare and contrast the replication of the two new strands, **listing** and **explaining** at least one similarity and one difference in the methods of synthesis. You may draw a diagram to help answer the question, but be sure to explain your diagram in your answer.

Molecular Genetics Short Free Response – Scoring Guide

SIMILARITIES 2 POINTS MAXIMUM 1 point for similarity, 1 point for elaboration (in parentheses)	• Synthesize DNA in 5' to 3' direction (DNA polymerase III can only work in one direction) • Use RNA primers to initiate replication (primase, DNA polymerase III must have a started sequence to be functional) • Both have RNA primers replaced with DNA (DNA polymerase I)
DIFFERENCES 2 POINTS MAXIMUM 2 points for difference including description of both strands	• One strand is synthesized as one, continuous strand (leading strand), while the other is synthesized in fragments (lagging strand). • Lagging strand must use ligase to connect segments of DNA, while leading strand does not require use of this enzyme.