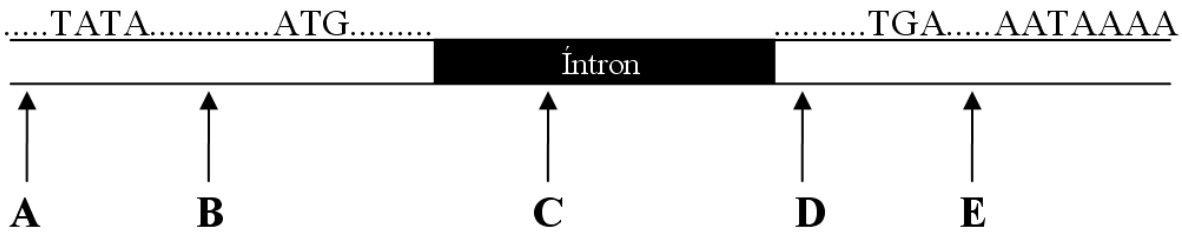
1. The figure below represents a eukaryotic gene. Circle the position(s) (A-E) in which the insertion of a single base pair would induce a frameshift mutation. Justify your answer.



RE: Region D

Region D is within the region of the gene that will in fact be translated into a protein, the inclusion of a base pair changes the phase with which the codons are interpreted;

Region A comes even before the promoter region of the gene and is not included in the transcribed mRNA;

Region B comes before the initiation codon of translation by the ribosome;

Region C is contained in an intron which is removed in the transcription process;

Region E: is after the codon that signals the completion of the translation.

2. Indicate the main functions of the proteins: myosin, immunoglobulin, reverse transcriptase, hemoglobin, and insulin.

RE:

Myosin is a protein that, when bound to actin, produces muscle contraction.

Immunoglobulin are antibodies, specific proteins that attack and inactivate foreign agents entering the body.

Reverse transcriptase is the enzyme responsible for RNA transcription and DNA formation in the retrovirus life cycle.

Hemoglobin is the protein that transports oxygen from the lungs to the cells.

Insulin is a hormone secreted by the pancreas that participates in glucose metabolism.

3. Mixtures of peptides are analyzed by first separating the mixture into its components through ion-exchange chromatography. Peptides placed on a cation-exchange resin containing sulfonate ($–SO_3^-$) groups flow down the column at different rates because of two factors that influence their movement: (1) ionic attraction between the $–SO_3^-$ on the column and positively charged functional groups on the peptides, and (2) hydrophobic interactions between amino acid side chains and the strongly hydrophobic backbone of the polystyrene resin.

Considering the following dipeptides:

Asp–Glu
Asp–Lys
Arg–Gly
Glu–Gly
Arg–Lys

A) Indicate the protonation state and the net charge of each dipeptide at a pH 7.0 buffer.

B) Determine the order of elution of each dipeptide from a cation-exchange column using a pH 7.0 buffer.

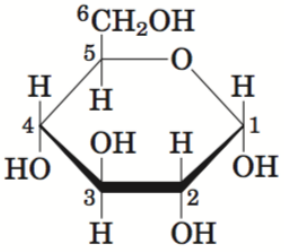
RE:

Dipeptide	Ionization State	Net Charge	Order of Elution
Asp–Glu	Negatively charged	-2	1
Asp–Lys	Neutral	0	3
Arg–Gly	Positively charged	+1	4
Glu–Gly	Negatively charged	-1	2
Arg–Lys	Positively charged	+2	5

4. Sucrose, a major product of photosynthesis in green leaves, is synthesized by a battery of enzymes. The substrates for sucrose synthesis, D-glucose and D-fructose, are a mixture of α and β anomers as well as acyclic compounds in solution. Nonetheless, sucrose consists of α-D-glucose linked by its carbon-1 atom to the carbon-2 atom of β-D-fructose.

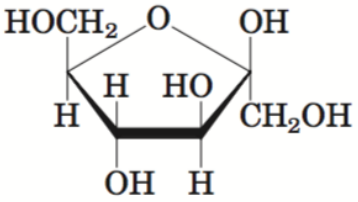
A) Draw the structures of α-D-glucose and β-D-fructose

RE: α-D-glucose



α-D-Glucopyranose

β-D-fructose



β-D-Fructofuranose

B) How can the specificity of sucrose be explained in light of the potential substrates?

RE: Enzymes display stereo-specificity. The enzymes of sucrose synthesis are able to distinguish between the isomers of the substrates and link only the correct pair.

5. Unsaturated fatty acids are typically biosynthesized by a unique dehydrogenation reaction called desaturation.

A) Why are most unsaturated fatty acids found in phospholipids in the cis rather than the trans conformation?

B) Draw the structure of a 16-carbon fatty acid as saturated, trans monounsaturated, and cis monounsaturated.

RE:

The presence of a cis double bond introduces a kink that prevents packing of the fatty acid chains. Cis double bonds maintain fluidity. Trans fatty acids have no structural effect, relative to saturated fatty acids, and so they are rare.

Saturated	trans monounsaturated	cis monounsaturated