

BIOLOGICAL FRAMEWORKS FOR ENGINEERS

Exam #1 [Due 11/2/11] by email

Work on this on your own; do not discuss it with other members of the class. You can use any web or printed resources to help, and you can ask the course instructor for clarification help. This exam is due via email to nsniadec@uw.edu by 5:00 pm on the due date.

I. MOLECULAR BIOLOGY

Please choose the correct answer to the following questions

1. Lipids...
 - a. do not dissolve in water
 - b. are typically found in large polymers
 - c. have a charged surface
 - d. are bioreactive molecules
 - e. a and b are correct
2. Proteins...
 - a. are composed of amino acids
 - b. are energy storage molecules
 - c. are structural molecules
 - d. orchestrate the chemical reactions of the cell
 - e. all are correct
 - f. a,b, and c are correct
 - g. a,c, and d are correct
3. Peptide Bonds...
 - a. are found in all biomolecules
 - b. involve a link between a carbon and a nitrogen atom
 - c. are ionic bonds
 - d. results in a hydrophobic molecule
 - e. all are incorrect
4. Nucleic acids...
 - a. include organic bases
 - b. include phosphorylated sugars
 - c. are found in the nucleus
 - d. contain the information structure of the cell
 - e. all are correct
 - f. a, c, and d are correct

5. Duplication of DNA...
 - a. requires an enzyme called reverse transcriptase
 - b. begins with the binding of a splicosome
 - c. involves binding the DNA polymerase onto the DNA
 - d. requires breaking the covalent bonds between nucleotide pairs
 - e. all are correct
6. Mutations...
 - a. are transmitted to future generations if the cells survives
 - b. often results in cells that are not viable or are destroyed by natural killer cells
 - c. only damage the organism if they occur in germ cells
 - d. all are correct
7. mRNA...
 - a. produces transfer RNA which produces protein
 - b. ensures the proper folding of proteins
 - c. "edits" proteins to create the proper amino acid sequence
 - d. contains codons
 - e. all are correct
8. Polymerase chain reaction is a method of...
 - a. building protein polymers
 - b. sequencing DNA
 - c. denaturing, annealing, and extending a DNA fragment
 - d. creating DNA from mRNA populations
9. Electrophoresis...
 - a. can be run through a porous gel
 - b. leads to DNA migration to the anode
 - c. leads to bands of macromolecules separated by size
 - d. can be used to sequence DNA by base pair with dideoxyribose nucleotides
 - e. all are correct
 - f. a,c, and d are correct
10. The complement system...
 - a. is part of the innate immune response
 - b. is initiated by antibodies
 - c. leads to cytolysis or pathogen killing
 - d. depends on the Fc portion of the antibody for the classical pathway.
 - e. all of the above
 - f. a,b, and c are correct

II. GENETIC DISEASES

Go to the OMIM database (www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=OMIM) and search for Sickle Cell Anemia, click on the entry #603903, and use information there and within the NCBI website to answer the following questions regarding this genetic disease. Of course, you can always do Google searches to get additional information....

- A. What is the protein defective in patients with Sickle Cell Anemia?
- B. Explain (in general terms) why the defect in this protein results in the symptoms observed in patients. In other words, what is the role of this protein and how does that affect function in the body?
- C. Identify on which human chromosome is the gene for this protein found?
- D. What type of genetic disease and nature of the mutation that leads to Sickle Cell Anemia?
- E. The gene defective in Sickle Cell Anemia is a recessive gene. What is the probability of a child of a parent with Sickle Cell Anemia inheriting the disease if the other parent does not have the disease?
- G. A microchannel can be on the same order of size as small blood vessels and can be used to integrate different assays. Describe a plan for how a microfluidic or lab-on-chip device could be used to better study or treat Sickle Cell Anemia. Be as thorough as possible in your description.

III. PROTEIN MUTATIONS

- A. Describe the relationship between DNA and proteins by explaining protein synthesis (in one short paragraph) all the way to quaternary structure.
- B. Identify how a point mutation could lead to changes in the
 - 1. primary structure
 - 2. secondary structure
 - 3. tertiary structure, and
 - 4. quaternary level
- C. Explain how a point mutation can affect the function of a protein. What I am expecting is a comprehensive look at the different roles that proteins have and how a single change in a critical part of the protein sequence can greatly impact their structure-function relationship. Please be as thorough as possible in your discussion.