Name: _____ Period: _____ Date: _____

DNA Structure MCAS Questions

1. In a molecule of double-stranded DNA, the amount of adenine present is always equal to the amount of
   A. cytosine.
   B. guanine.
   C. thymine.
   D. uracil.

2. Which of the following features of DNA is **most important** in determining the phenotype of an organism?
   A. the direction of the helical twist
   B. the number of deoxyribose sugars
   C. the sequence of nitrogenous bases
   D. the strength of the hydrogen bonds

3. A portion of one strand of a DNA molecule has the sequence shown below.
   ACCTGAAGG
   Assuming there are no mutations in this portion of the DNA, what is the corresponding sequence on the complementary DNA strand?
   A. **ACCTGAAGG**
   B. **GTTCAGGAA**
   C. **TGGACTTCC**
   D. **UGGACUUCC**

4. Which of the following statements **best** describes a DNA molecule?
   A. It is a double helix.
   B. It contains the sugar ribose.
   C. It is composed of amino acids.
   D. It contains the nitrogenous base uracil.

5. DNA is found in the cells of all organisms. The structure of DNA is directly linked to its function.

   a. Describe the function of DNA in organisms.

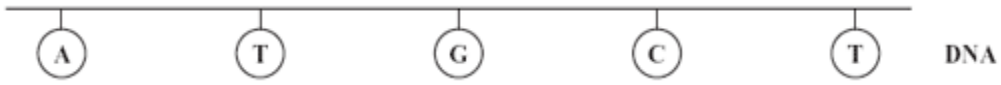
b. In your Student Answer Booklet, draw and label a simple model of DNA that includes the sugar/phosphate backbone and nitrogenous bases.

c. Explain how the structure of DNA enables it to perform the function you described in part (a).

6. In 1950, Erwin Chargaff and colleagues examined the chemical composition of DNA and demonstrated that the amount of adenine always equals that of thymine, and the amount of guanine always equals that of cytosine. This observation became known as Chargaff's rule.

   a. Based on current knowledge of the structure of DNA, explain the basis of Chargaff's rule.

   b. The diagram below represents a single-stranded segment of DNA. In your Student Answer Booklet, write the complementary DNA strand that would form from this strand during replication. Use the letters A, C, G, and T to designate the bases: A = adenine; C = cytosine; G = guanine; T = thymine.



   c. Why is Chargaff's rule so important to DNA's ability to replicate itself accurately?

Name: _____ Period: _____ Date: _____

DNA Replication and Protein Synthesis:

1. Which of the following processes produces the nucleotide sequence UUA from the sequence AAT?

   A. meiosis
   B. replication
   C. respiration
   D. transcription

2. In a eukaryotic cell, which of the following processes directly involves DNA?

   A. translation
   B. cellular respiration
   C. active transport of ions
   D. replication of chromosomes

3. Fireflies produce light inside their bodies. The enzyme luciferase is involved in the reaction that produces the light. Scientists have isolated the luciferase gene.

   A scientist inserts the luciferase gene into the DNA of cells from another organism. If these cells produce light, the scientist knows that which of the following occurred?

   A. The luciferase gene mutated inside the cells.
   B. The luciferase gene was transcribed and translated.
   C. The luciferase gene destroyed the original genes of the cells.
   D. The luciferase gene moved from the nucleus to the endoplasmic reticulum.

4. The mold *Aspergillus flavus* grows on grain. *A. flavus* produces a toxin that binds to DNA in the bodies of animals that eat the grain.

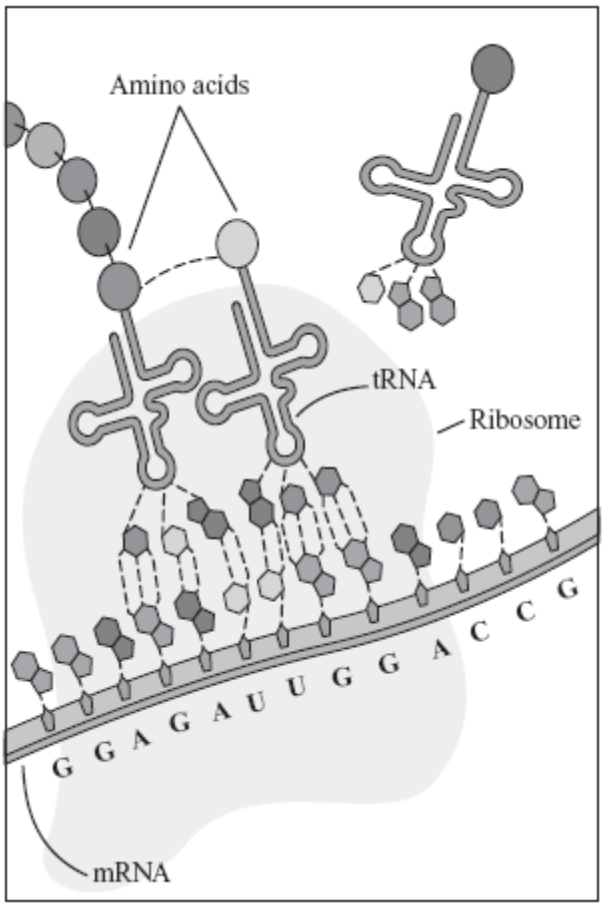
   The binding of the toxin to DNA blocks transcription, so it **directly** interferes with the ability of an animal cell to do which of the following?

   A. transport glucose across the cell membrane into the cytoplasm
   B. produce ATP using energy released from glucose and other nutrients
   C. transfer proteins from the endoplasmic reticulum to Golgi complexes
   D. send protein-building instructions from the nucleus to the cytoplasm and ribosomes

5. Individuals with one form of lactose intolerance do not produce the enzyme lactase because the gene coding for the production of lactase is shut off in their cells. This means that which of the following processes does **not** occur for the gene?

   A. hydrogenation
   B. mutation
   C. replication
   D. transcription

6. The diagram below represents part of a process that occurs in cells.



   Which process is represented?

   A. meiosis
   B. osmosis
   C. replication
   D. translation

Name: _____ Period: _____ Date: _____

Mutations

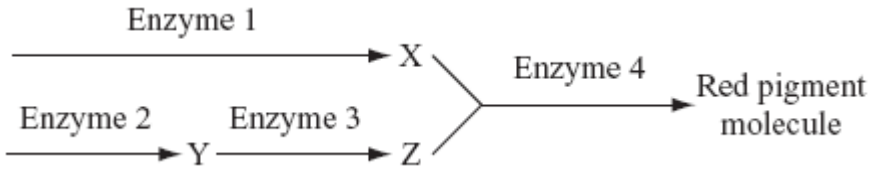
1. Hemoglobin is a protein that carries oxygen in red blood cells. The hemoglobin molecules produced by some people have one specific amino acid that is different from the amino acid at that position in normal hemoglobin.Which of the following is the **most likely** cause of this amino acid variation?

   A. The hemoglobin gene contains a mutation.
   B. An error occurs during the folding of the hemoglobin protein.
   C. Enzymes replace the amino acid once the hemoglobin is produced.
   D. An additional amino acid is mistakenly inserted into the hemoglobin during translation.

2. During DNA replication, the wrong nucleotide was inserted in the DNA sequence. Which of the following terms describes this situation?

   A. mutation
   B. regeneration
   C. transcription
   D. translation

3. The diagram below shows the final steps of a biochemical pathway used by the bacterium *Serratia marcescens* to produce a red pigment molecule. Letters X, Y, and Z represent intermediate molecules produced in the pathway. Four enzymes are also involved in the pathway, as shown.



   A mutant strain of *S. marcescens* produces molecules X and Y but does not produce the red pigment molecule or molecule Z.

   Based on this result, it can be concluded that there must be a mutation in the gene coding for which enzyme?

   A. enzyme 1
   B. enzyme 2
   C. enzyme 3
   D. enzyme 4

4. Which of the following **best** describes the result of a mutation in an organism's DNA?

   A. The mutation may produce a zygote.
   B. The mutation may cause phenotypic change.
   C. The mutation causes damage when it occurs.
   D. The mutation creates entirely new organisms.

5. In phenylketonuria (PKU), an enzyme that converts one amino acid into another does not work properly. Which of the following is the **most likely** cause of this genetic condition?

   A. an error in the transcription of the gene for the enzyme
   B. a mutation in the DNA sequence that codes for the enzyme
   C. an excess of the amino acids necessary to produce the enzyme
   D. a structural variation in the amino acid modified by the enzyme

Name: _____ Period: _____ Date: _____

Sickle Cell DNA MCAS Questions

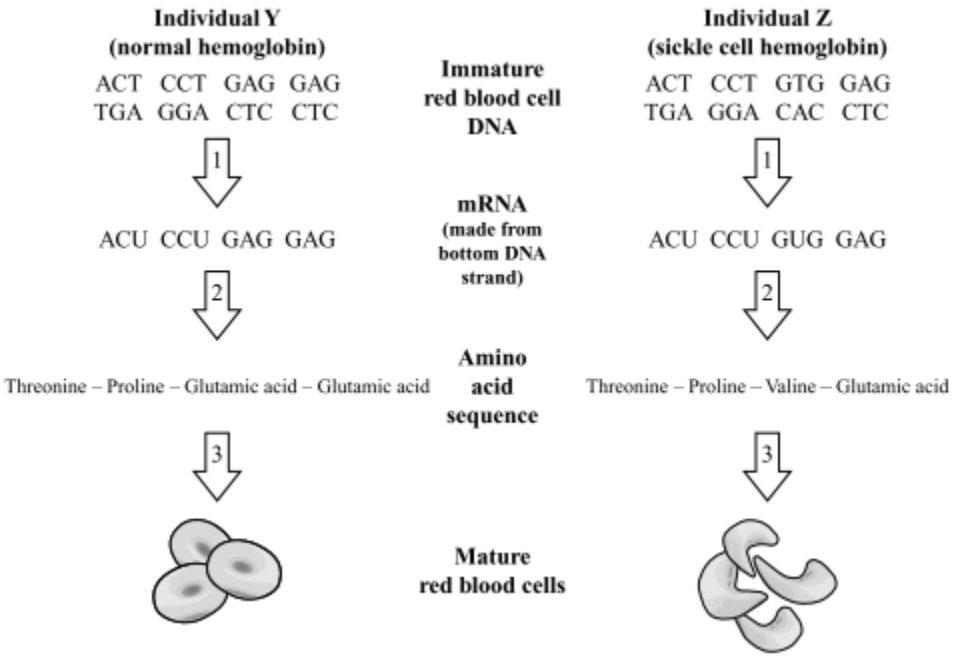
Sickle cell anemia is an autosomal recessive genetic disorder that affects thousands of people in the United States and millions worldwide. Sickle cell anemia commonly occurs in groups whose ancestors came from Africa, as well as South America, Cuba, Central America, Saudi Arabia, India, and the Mediterranean.

Sickle cell anemia is caused by a change in the hemoglobin protein in red blood cells. Sickle cell anemia results in paleness, fatigue, shortness of breath, and increased heart rate due to a deficiency in the oxygen-carrying component of the blood. When oxygen levels are low in an affected individual, the red blood cells become deformed into a curved, sickle shape. People with sickle cell anemia can experience swelling, pain, infection, and organ damage.

All individuals have two alleles for the gene that codes for the hemoglobin protein (Hb). Individuals with two **Hb A** alleles have normal, round red blood cells. Heterozygous individuals, with one **Hb A** allele and one **Hb S** allele, do not experience symptoms of the disease, but they may produce some sickle-shaped red blood cells. Individuals with two **Hb S** alleles have sickle cell anemia.

The diagrams to the right represent some of the steps in the formation of hemoglobin in two individuals, Y and Z. In these diagrams, only a small part of the hemoglobin gene sequence is represented.

Individual Y has two **Hb A** alleles and therefore produces normal red blood cells. Individual Z has two **Hb S** alleles and therefore produces sickle-shaped red blood cells.



1) Which of the following statements **best** summarizes a change that is represented by the arrows labeled "3" in the diagrams?

   A. A nucleus is formed in each cell.
   B. Each cell divides to form two daughter cells.
   C. A chain of amino acids is folded to form a protein in each cell.
   D. Proteins are transported through the plasma membrane of each cell.

2) Which of the following statements best describes why the change in only one DNA base of the hemoglobin gene results in a different protein product of the gene?

A. The change prevents mRNA from being made.
B. The change alters the amino acid sequence of the protein.
C. The change causes the blood cells to divide in an uncontrolled way.
D. The change creates a second strand of mRNA for each RNA molecule.

3) Which of the following statements **best** compares individual Y and individual Z in terms of genotype and phenotype?

A. The individuals have the same genotype and the same phenotype.
B. The individuals have the same genotype but different phenotypes.
C. The individuals have different genotypes but the same phenotype.
D. The individuals have different genotypes and different phenotypes.