

Molecular Genetics

Use the following information to answer the next question

When a gene that directs cells of the human anterior pituitary to synthesize HGH is transplanted into bacteria, it will cause the bacteria also to synthesize HGH. This HGH can be used to treat slowed skeletal growth in children.

1. The phenomenon described illustrates that
- A. gene therapy can be used to cure inherited diseases in humans
 - B. DNA is a universal language that can be read by all organisms
 - C. bacteria, like humans, use insulin to regulate their sugar metabolism
 - D. humans have acquired some bacterial genetical traits through symbiotic relationships

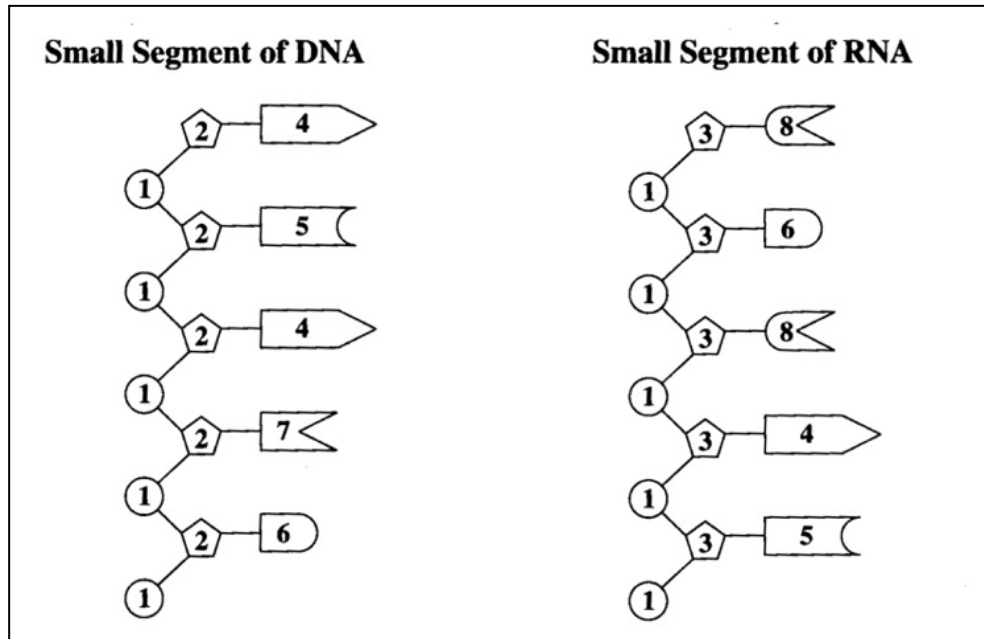
Use the following information to answer the next question

Some Events that Occur in a Cell during the Manufacture of Proteins

- 1** mRNA nucleotides are fused into a long chain
- 2** Amino acids join in a chain
- 3** Double helix of DNA uncoils
- 4** Polypeptide is released
- 5** tRNA anticodons match with mRNA codons
- 6** mRNA attaches to a ribosome

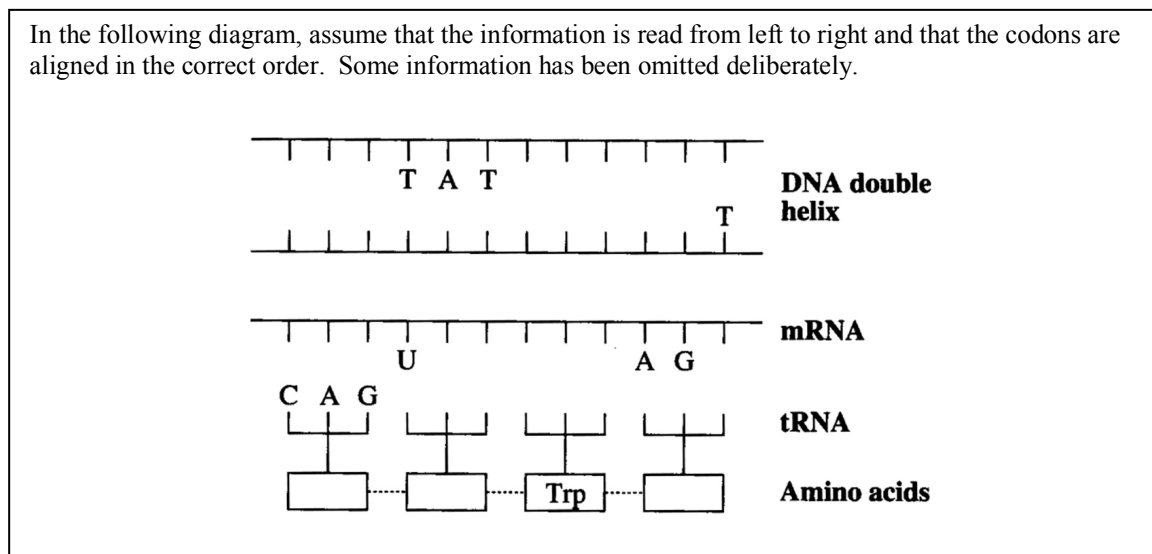
2. The sequence in which these events occur is
- A. 1,3,5,6,4,2
 - B. 1,3,6,5,2,4
 - C. 3,1,5,6,4,2
 - D. 3,1,6,5,2,4

Use the following information to answer the next two questions.



3. If structure 1, structure 3, and structure 8 were combined to form a molecule, it would be
- A. an amino acid
 - B. a nucleic acid
 - C. a uracil nucleotide
 - D. an adenine nucleotide
4. One likely result of a mutation could be the
- A. replication of the DNA segment
 - B. transcription of the RNA segment
 - C. replacement of structure 3 in the RNA segment with structure 2
 - D. replacement of structure 4 in the DNA segment with structure 7

Use the following information to answer the next question.



5. The first codon in the mRNA strand is

- A. CAG
- B. GTC
- C. CUG
- D. GUC

Use this additional information to answer the next question

Some Amino Acids	
1	Alanine
2	Arginine
3	Cysteine
4	Glycine
5	Isoleucine
6	Lysine
7	Phenylalanine
8	Serine
9	Threonine

Numerical Response

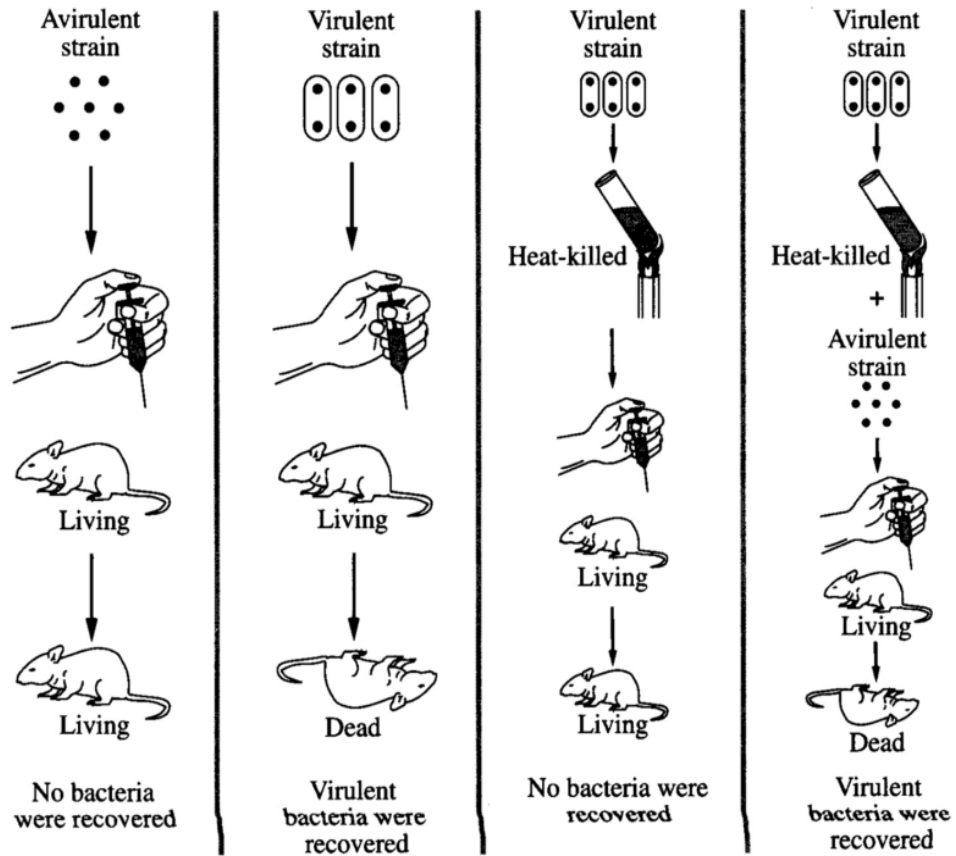
2. The second codon in the DNA double helix is TAT. What is the amino acid coded by this triplet?

(Record your **answer** in the numerical-response section of the answer sheet.)

Answer: _____

Use the following information to answer the next question

In 1928, a British scientist, Frederick Griffith, performed an experiment by injecting mice with two strains of bacteria. The avirulent bacteria strain did not cause pneumonia, and the virulent bacteria strain caused pneumonia. Below is an illustration of his results.



From *Biology Directions*

6. The results illustrated can be **best** interpreted as showing that
- A. the genetic material was deoxyribonucleic acid
 - B. some of the virulent bacteria had survived heat treatment
 - C. genetic material from the dead virulent bacteria had entered the living avirulent bacteria
 - D. genetic material from the avirulent strain caused the change to the virulent bacteria

Use the following information to answer the next two questions

The tables below represent a portion of a DNA molecule and its corresponding mRNA, tRNA, and polypeptide chain.

DNA:	C	G	T								
	G	C	A				T	G	A		

mRNA:			U	U			A				Y

tRNA:							X			G	C	A

Amino acids:		W	Tryptophan		

7. The nitrogen bases for positions X and Y are, respectively

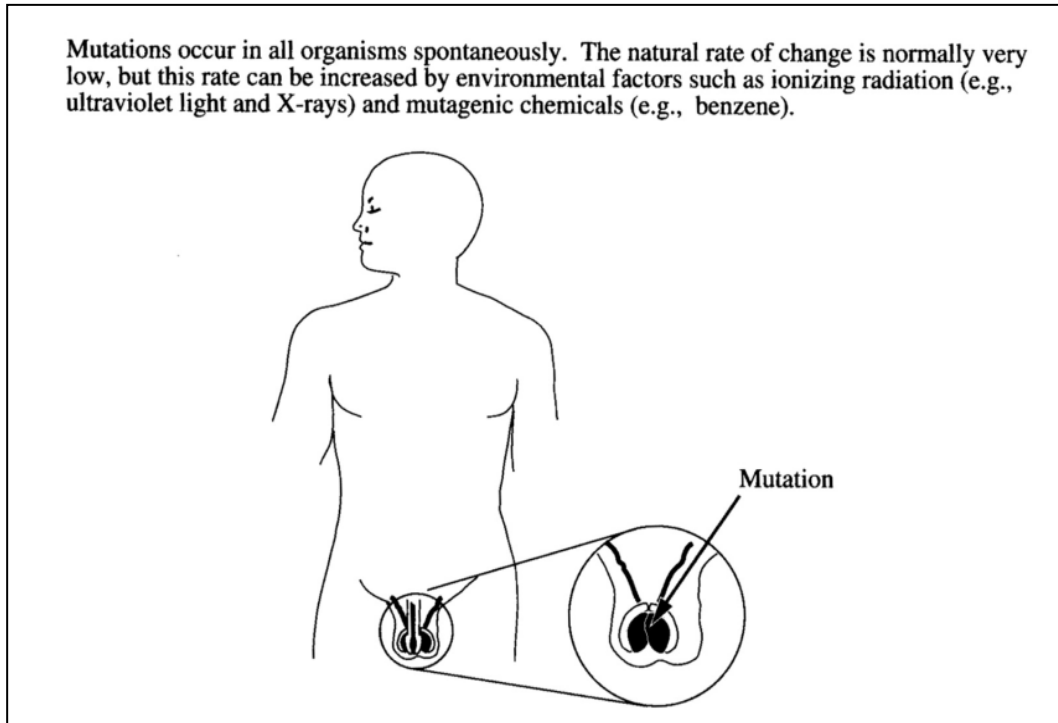
- A. uracil and guanine
- B. uracil and cytosine
- C. adenine and cytosine
- D. thymine and guanine

8. The amino acid labeled W is

- A. methionine
- B. tryptophan
- C. arginine
- D. alanine

Use the following information to answer the next two questions

Mutations occur in all organisms spontaneously. The natural rate of change is normally very low, but this rate can be increased by environmental factors such as ionizing radiation (e.g., ultraviolet light and X-rays) and mutagenic chemicals (e.g., benzene).



9. Which process would allow a mutation in the location shown to be passed on to the next generation?
- A. Mitosis
 - B. Oogenesis
 - C. Nondisjunction
 - D. Spermatogenesis
10. By causing physical damage to a cellular component, ionizing radiation or chemicals can cause mutations. The site of this damage is
- A. the nuclear membrane
 - B. the protein structure of the ribosome
 - C. one or more amino acids in a crucial enzyme
 - D. one or more nucleotides in the DNA molecule

Use the following information to answer the next question

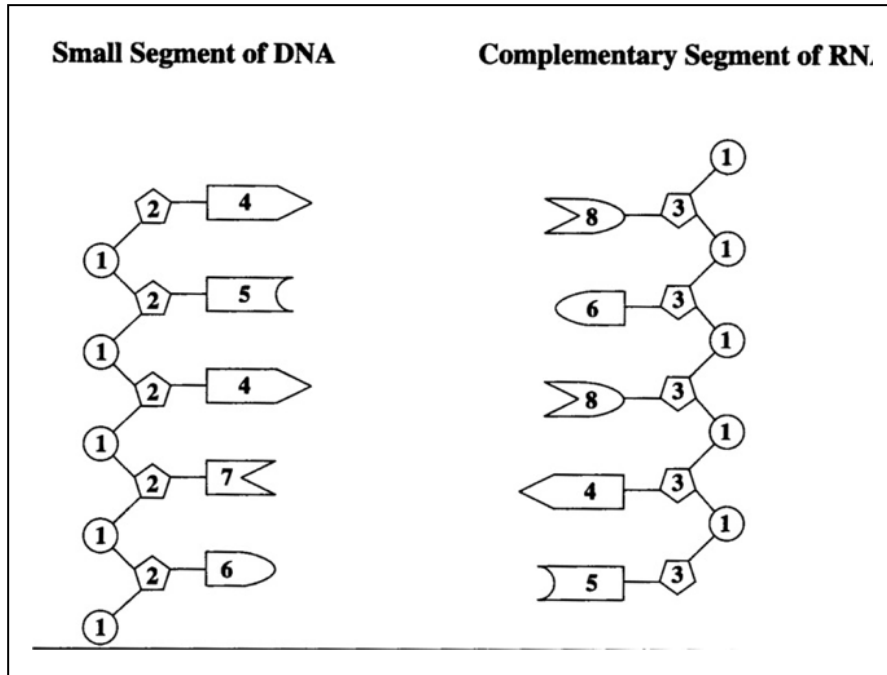
A bacterium has been found that synthesizes a type of plastic called polyhydroxybutyrate (PHB). Researchers can remove genes from this bacterium, “cut” open the DNA in plant cells, and insert the bacterial genes. Plants grown from these transformed cells will synthesize PHB.

-from *Science News*

11. The row that identifies the enzymes likely used by researchers to move the genes from the bacterium to a plant is

Row	Enzyme(s) Used on Bacterial DNA	Enzymes(s) Used on Plant DNA
A.	Ligase only	Ligase and restriction
B.	Restriction only	Ligase only
C.	Restriction only	Restriction and ligase
D.	Restriction and ligase	Restriction only

Use the following information to answer the next question



12. If structure 4 is adenine, then structure 8 is

- A. uracil
- B. adenine
- C. thymine
- D. cytosine

Use the following information to answer the next question

The DNA sense strand shown below is thought to contain the genetic code for part of an enzyme that speeds up the breakdown of alcohol in the liver. (Read the DNA beginning at the left.)

- A - A - G - G - G - C - C - T - T - A - T - C -

13. Which amino acid sequence would be found in a polypeptide that is produced using the coded information in the above DNA sense strand?
- A. Leucine – glycine – glutamate
 - B. Phenylalanine – proline – glutamate
 - C. Leucine – glycine – glutamate – tyrosine
 - D. Asparagine – proline – valine – methionine

Use the following information to answer the next question

Between 50,000 and 100,000 genes are involved to build, run and maintain a human body. Any one of these genes can mutate.

If geneticists locate a harmful mutation, there is hope that one day they will be able to repair the gene both in the affected individual and in his or her gametes.

- from *Turner, 1996*

14. The technology to replace genes in cells of humans is called
- A. gene cloning
 - B. gene therapy
 - C. carrier screening
 - D. DNA fingerprinting

Use the following information to answer the next three questions

The polymerase chain reaction technique (PCR) makes it possible to produce a large number of copies of a specific DNA sequence in a relatively short time. When heated to 94°C, double-stranded DNA molecules separate completely, forming two single strands. Later, after the temperature is lowered and with DNA polymerase present, complementary DNA strands form. The process of heating and cooling can be repeated to produce as many copies of the DNA as is required.

- from *Klug and Cummings, 1997*

15. If a DNA triplet is CTA, then the complementary DNA triplet is
- A. GAU
 - B. GAT
 - C. CUA
 - D. CTA

16. PCR is similar to process that normally occurs in cells prior to cell division. The row that identifies the site and name of this process is

Row	Site	Process
A.	nucleus	replication
B.	nucleus	transcription
C.	cytoplasm	replication
D.	cytoplasm	transcription

17. Which enzymes would a geneticist use to cut DNA into fragments?

- A. Ligase enzyme
- B. RNA polymerases
- C. DNA polymerases
- D. Restriction enzymes

Use the following information to answer the next question

<p style="text-align: center;">Portion of the Insulin Protein</p> <p style="text-align: center;">Phenylalanine – Valine – Asparagine – Glutamate – Histidine</p> <p>Assume that a mutation occurred in the strand DNA that codes for the portion of protein shown above. The protein was altered in structure and no longer performed its function.</p> <p style="text-align: right;"><i>-from Campbell, 1987</i></p>
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18. Which of the following effects would this mutation have on an individual's body?

- A. A chronic increase in blood sugar after meals
- B. A chronic decrease in blood sugar after meals
- C. A decrease in the body's metabolic rate after meals
- D. An increase in the body's metabolic rate after meals

Use the following information to answer the next question

<p>Erwin Chargaff found that the relative amount of each of the base pairs that make up DNA varies from species to species. He analyzed a sample of DNA from <i>Escherichia coli</i> (a bacterium) and found that 23.6% of the nitrogen base molecules present in this sample were thymine.</p> <p style="text-align: right;"><i>-from Curtis, 1983</i></p>

19. In this sample of *Escherichia coli* DNA, the percentage of the nitrogen base molecules that would be adenine is

- A. 76.4 %
- B. 38.2 %
- C. 23.6 %
- D. 11.8 %

20. The sequence of events that would enable researchers to incorporate the CTX gene into bacterial DNA would be to
- A. first open the bacterial DNA with ligase enzymes, then position the CTX gene in the DNA, and then join the DNA by restriction enzymes
 - B. first open the bacterial DNA with restriction enzymes, then position the CTX gene in the DNA, and then join the DNA by ligase enzymes
 - C. first position the CTX gene in the DNA, then open the DNA with the ligase enzymes, and then join the DNA by restriction enzymes
 - D. first position the CTX gene in the DNA, then open the DNA with restriction enzymes, and then join the DNA by ligase enzymes

Use the following information to answer the next two questions

Some people have condemned the use of food preservatives because they may cause cancer. A researcher has found contradictory evidence that suggest that two widely used food preservatives actually increase levels of natural cancer-fighting agents in laboratory animals. The preservatives BHA and BHT increase the activity of a gene that controls the production of an enzyme. This enzyme helps destroy cancer-causing substances (carcinogens) before they trigger the development of tumours.

-from *Pearson et al, 1983*

21. The most **direct** relationship between a gene and an enzyme is that
- A. an enzyme causes a gene to destroy carcinogens
 - B. the sequence of nucleotides in a gene determines the structure of an enzyme
 - C. each gene contains the code needed to construct many different types of enzymes
 - D. the sequence of amino acids in an enzyme is unrelated to nucleotide sequence in a gene

Use the following additional information to answer the next question

Some Events that Occur Following BHA or BHT Exposure

- 1 The polypeptide folds into an enzyme shape
- 2 tRNAs transport amino acids to the ribosome
- 3 A polypeptide is released from the ribosome
- 4 mRNA leaves the nucleus and attaches to ribosome in the cytoplasm

Numerical Response

4. The sequence of events that results in the production of the cancer-fighting enzyme is _____, _____, _____, and _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next three questions

Researchers have found a gene known as p53. It codes for a protein that binds to specific areas of DNA and activates them. This causes the production of a set of proteins that halts cell division or, in some cells, activates the cell's suicide program (apoptosis). The p53 gene is activated when a cell is damaged and/or undergoes a DNA mutation.

-from *Seachrist, 1996*

22. The normal function of the p53 gene is likely to
- A. encourage a cell to undergo mitosis
 - B. encourage a cell to undergo meiosis
 - C. prevent an abnormal cell from reproducing
 - D. prevent the transcription of a cell suicide gene

Use the following additional information to answer the next two questions

Research on the p53 gene was initially done with cancer cells obtained from a laboratory animal. These cells were grown in a petri dish. A cell with two normal *p53* alleles was found to have normal cell division. Cells with one normal and one mutated *p53* allele were also found to have normal cell division. Cells that had mutations in both *p53* alleles were unable to control cell division and were associated with cancer.

23. The initial research findings described above
- A. demonstrate that the activated p53 gene causes cancer in lab animals
 - B. demonstrate that the p53 protein causes the formation of cancer cells
 - C. indicate that the normal p53 gene is responsible for preventing cancer in all mammals
 - D. indicate that the normal p53 gene is responsible for preventing cancer under laboratory conditions
24. Gene therapy that might stop in controlled cell division due to the mutant *p53* allele would require
- A. one functional *p53* allele to be successfully inserted into cancer cells
 - B. two functional *p53* alleles to be successfully inserted into cancer cells
 - C. one functional *p53* allele to be successfully removed from cancer cells
 - D. two functional *p53* alleles to be successfully removed from cancer cells
25. Which of the following rows correctly describes a DNA molecule?

Row	Components	Backbone	Molecules that form the links between two strands
A.	amino acids, sugars, and bases	sugars and bases	amino acids
B.	amino acids, sugars, and bases	sugars and amino acids	bases
C.	phosphates, sugars, and bases	sugars and bases	phosphates

D.	phosphates, sugars, and bases	sugars and phosphates	bases
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Use the following information to answer the next question

A section of template DNA contains the following proportions of bases:

adenine – 20% thymine – 30% cytosine – 10% guanine – 40%

26. The proportions of three of the mRNA nucleotides produced from this DNA are
- A. 20% adenine, 30% uracil, and 10% cytosine
 - B. 40% cytosine, 20% adenine, and 30% uracil
 - C. 20% uracil, 40% cytosine, and 10% guanine
 - D. 20% thymine, 30% adenine, and 10% guanine

Use the following additional information to answer the next four questions

A deletion mutation in mitochondrial DNA causes Kearns – Sayre syndrome (KSS). A large sample of different types of somatic cells was removed from a male with KSS, tested, and found to contain the deletion. The only type of mitochondrial DNA that was found in somatic cells from the man's mother was mitochondrial DNA that did not have the KSS deletion.

27. A reasonable hypothesis to explain these results is that the mutation in the mitochondrial DNA that caused KSS in the man first occurred in the
- A. mother's oocytes
 - B. man's somatic cells
 - C. man's spermatocytes
 - D. mother's somatic cells
28. Mitochondrial DNA and nuclear DNA both code for the formation of proteins. Which of the following statements about protein synthesis is **true**?
- A. A mRNA anticodon binds with an amino acid codon, which results in the placement of a specific tRNA molecule in the polypeptide chain.
 - B. A mRNA anticodon binds with a tRNA codon, which results in the placement of a specific polypeptide molecule in the amino acid chain.
 - C. A tRNA anticodon binds with an mRNA codon, which results in the placement of a specific amino acid molecule in the polypeptide chain.
 - D. A tRNA anticodon binds with a polypeptide codon, which results in the placement of a specific mRNA molecule in the amino acid chain.

Use the following additional information to answer the next question

In an individual with KSS, part of the coding strand of mitochondrial DNA that has been deleted has the following base sequence.

ACC TCC CTC ACC AAA

29. The third amino acid coded for by this segment of mitochondrial DNA is

- A. lysine
- B. threonine
- C. glutamate
- D. phenylalanine

Use the following additional information to answer the next question

Over time, mitochondrial DNA accumulates non-lethal mutations at a constant rate. There is a higher degree of variation in mitochondrial DNA in earlier populations than in more recent populations. Scientists have taken samples of mitochondrial DNA from people living on different continents and compared the number of mitochondrial DNA mutations in these samples. They used this data as evidence to determine the order in which Earth's continents were populated.

44. In this study, the manipulated variable was the

- A. amount of mitochondrial DNA tested
- B. time of migration from one continent to another
- C. amount of variation in mitochondrial DNA base sequences
- D. geographic location of subjects whose sample of mitochondrial DNA was tested