

Unit Test: Structure and Function of DNA

Read each question. Circle the letter of the correct answer.

1. DNA is the hereditary molecule that determines hair color in humans. However, the DNA molecule itself is colorless. How does DNA determine the hair color of individuals?
 - A. The sequence of DNA determines the structure of lipids, which direct genotypes
 - B. The sequence of DNA determines the structure of proteins, which direct genotypes
 - C. The sequence of DNA determines the structure of phosphates, which direct genotypes
 - D. The sequence of DNA determines the structure of carbohydrates, which direct genotypes
2. Franklin, Watson, and Crick's model of DNA shows a double helical structure where two strands of DNA run antiparallel to each other. How does this structure cause the number of purines to equal the number of pyrimidines as observed by Chargaff?
 - A. If adenine is on one strand, guanine must be on the other strand.
 - B. If adenine is on one strand, cytosine must be on the other strand.
 - C. If adenine is on one strand, thymine must be on the other strand.
 - D. If thymine is on one strand, cytosine must be on the other strand.
3. A strand of RNA has the sequence AUUGC GCGAA. What explanation can be made about how this strand came to be?
 - A. The RNA strand formed from the rearrangement of the bases in a DNA strand.
 - B. The RNA strand broke off from a DNA strand that had a much longer genetic code.
 - C. The RNA strand was transcribed from a DNA strand with the sequence TAACGCCTT.
 - D. The RNA strand was translated from a DNA strand that had the sequence UAACGCCUU.
4. What evidence would be needed to support an explanation about how RNA is formed from a DNA molecule during protein synthesis?
 - A. evidence that shows adenine from DNA being replaced by uracil in an RNA molecule
 - B. evidence that shows the translation of DNA into RNA during the last stages of the process
 - C. evidence that shows how the double-stranded DNA molecule splits apart into two RNA molecules
 - D. evidence that shows the original DNA strand and the resulting RNA strand after transcription has occurred

5. What is the importance of codons during the process of protein synthesis?
- A. Codons tell the RNA how often it needs to be translated.
 - B. Codons regulate when DNA gets transcribed in the nucleus.
 - C. Codons code for the particular amino acids that get assembled.
 - D. Codons alert the cell when it is time to produce additional ribosomes.
6. Transcription and translation, the two main processes involved in protein synthesis, have distinct molecular inputs and outputs. Which statement about inputs and outputs in these processes is true?
- A. DNA is an input for the process of transcription and an output for the process of translation.
 - B. DNA is an input for the process of translation and is not involved in the process of transcription.
 - C. Messenger RNA is an output for the process of transcription and an input for the process of translation.
 - D. Messenger RNA is an input for the process of transcription and is not involved in the process of translation.
7. The following image models a part of the process of DNA replication, which is performed by enzymes and occurs simultaneously on both the 'leading' and the 'lagging' strand of DNA.



Which component of DNA replication only occurs on the lagging strand of DNA and not on the leading strand?

- A. The enzyme helicase unzips the DNA.
- B. DNA polymerase adds nucleotides to the primer.
- C. An enzyme called ligase binds fragments of DNA together.
- D. New strands complementary to the DNA template are formed.

Read each question. Follow the instructions to answer the questions.

8. If a segment of DNA has the sequence ATCCGA, what would be the complementary mRNA sequence for that segment? Write the correct sequence on the line.

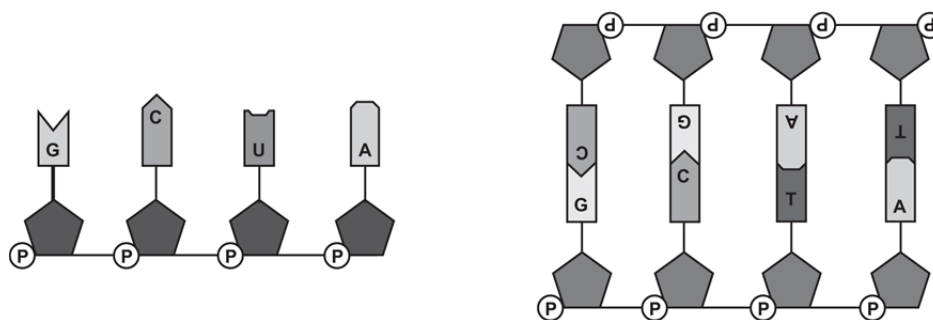
9. Which external factors can affect gene expression in an organism? Circle the letters of all the external factors that can affect gene expression.

- | | |
|--------------------|-------------------------------|
| A. predation | D. drugs and chemicals |
| B. temperature | E. genetic makeup of organism |
| C. amount of light | |

10. Occasionally during replication, the wrong nucleotide is added to the new strand of DNA. If the substitution is not fixed, it can have negative implications for the organism. Number the steps from 1 to 5 to show how DNA replication errors are handled.

- _____ DNA polymerase detects an error in replication.
- _____ DNA polymerase takes in a single strand of DNA and adds the matching nucleotides to make double-stranded DNA.
- _____ Errors have been limited and replication continues until the entire strand has been copied.
- _____ Replication is halted.
- _____ DNA polymerase removes the incorrect nucleotide and replaces it with the correct one.

11. The model below shows the structure of two molecules. Which statements about the two structures seen in the model are correct? Circle the letters of all the correct statements.



- A. DNA has A, C, G, U, while RNA has A, C, G, T.
- B. DNA is double stranded, while RNA is single stranded.
- C. DNA uses deoxyribose as its sugar, while RNA has ribose as its sugar.
- D. DNA has a 6-carbon sugar as its backbone, while RNA has a 5-carbon sugar.
- E. DNA strands are held together by phosphate, while RNA molecules are bonded by uracil.

12. Luna is studying the different types of RNA that play a role in protein synthesis. Write the letter of each description in the correct box.

mRNA	rRNA	tRNA

- A. forms subunits of ribosomes
B. carries amino acids to ribosomes
C. carries transcribed code for a protein

13. Write the letter of each conclusion in the box next to the scientific discovery that supports it. Some letters may be used more than once.

Oswald Avery observed that when DNA is destroyed, bacteria transformation did not occur.	
Rosalind Franklin took x-ray photographs of DNA that showed an <i>X</i> surrounded by a circle.	
Erwin Chargaff found that different species have similar ratios of purines to pyrimidines in their DNA.	
Alfred Hershey and Martha Chase found that when bacteria are infected by bacteriophages, phosphorus from viral DNA remains in the bacteria.	

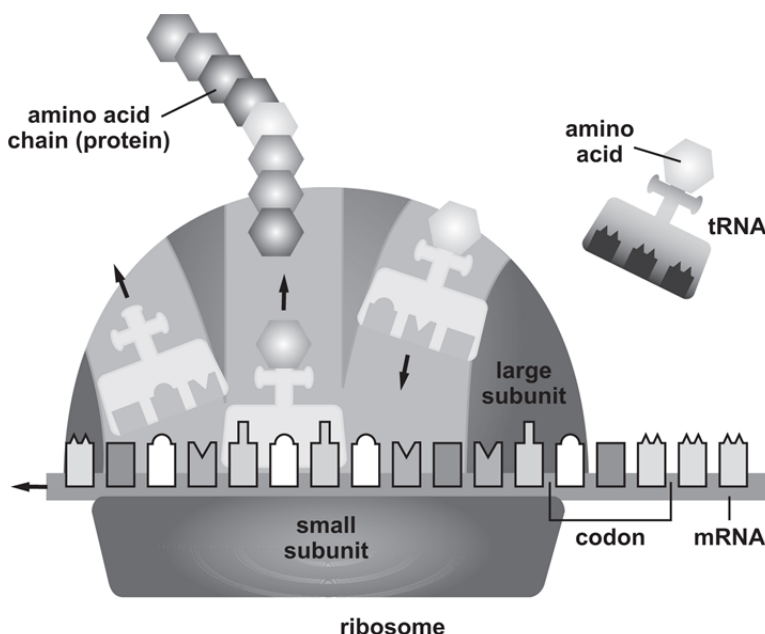
- A. DNA is shaped like a helix.
B. DNA is the hereditary material.
C. DNA bases pair according to rules.

14. Chris is studying the different ways in which a mutation can happen during translation. Write the letters of the terms in the blanks to correctly complete the sentences. Some letters will not be used.

A mutation that happens when a single nucleotide is replaced by a different one is a _____ mutation, also known as a substitution mutation. A mutation caused by the addition of a nucleotide into the DNA sequence is known as a(n) _____ mutation. This is a type of _____ mutation because it causes a change in the reading frame of the DNA.

- A. deletion C. insertion
B. frameshift D. point

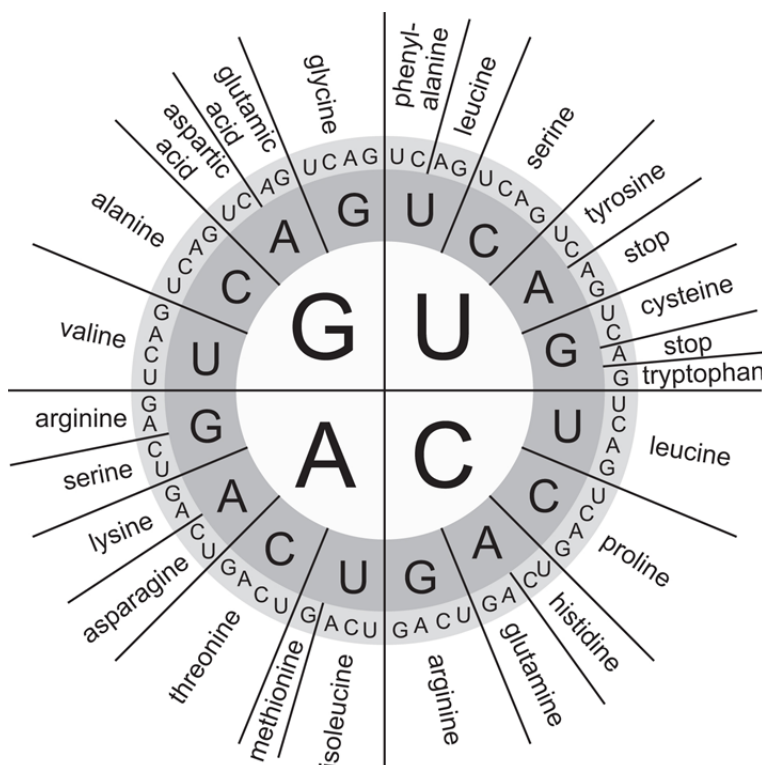
15. The diagram shows the process of translation.



Number the steps from 1 to 5 to show the correct sequence of translating a protein.

- _____ A newly synthesized mRNA molecule is released from the nucleus.
- _____ The ribosome encounters one of the three stop codons that triggers the release of the newly synthesized polypeptide chain.
- _____ A ribosome binds to the mRNA molecule and protein synthesis is initiated at the start codon.
- _____ A tRNA amino acid complex enters the codon next to the start codon. Base pairing occurs, and the two amino acids are linked.
- _____ The ribosome moves one codon forward, making space for a new tRNA amino acid complex to enter, and the process repeats.

16. The mRNA codon chart shown here helps determine the results of transcription and translation.



Using the chart as reference, write one letter in each blank to correctly complete each sentence.

If the original DNA sequence reads TAG, the mRNA codon would be **1.** _____ and the corresponding amino acid would be **2.** _____.

3. _____ in a DNA sequence would correspond to a “stop” codon.

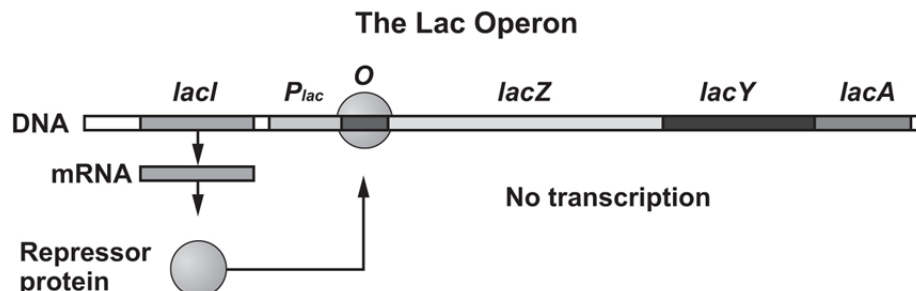
GCC in a DNA sequence after transcription and translation would correspond to the amino acid **4.** _____.

5. _____ in a DNA sequence would lead to the polypeptide chain valine-methionine-phenylalanine.

1. A. UAG B. AUC C. ATC	2. D. stop E. isoleucine F. serine	3. G. ATC H. UAA I. TAG	4. J. threonine K. alanine L. arginine	5. M. GTCATGTTG N. CAGTACAAG O. CAGUACUUG
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Read each statement. Write your answer on the lines.

17. The *lac* operon is used by some prokaryotes to induce the metabolism of lactose. When lactose is absent, the repressor binds to the operator, preventing transcription. The repressor for the *lac* operon is produced by the *lacI* gene, which is on the same chromosome as the *lac* operon, as shown in the diagram.



Suppose a mutation in a bacterium deletes the *lacI* gene so that the lac repressor cannot be produced. Determine what would happen to the expression of the *lacZ* gene.

Suppose a different bacterium has a mutation in the *lacO* region of the operon that causes the repressor protein to bind irreversibly to the operator. Explain how this mutation will affect the bacterium.

18. Two mutations occur in the same gene. One of the mutations involves a single nucleotide being inserted into the gene. The second mutation involves a single nucleotide replacing a different nucleotide.

For each mutation, explain how that mutation may affect the protein that the gene codes for.

Predict which mutation is more likely to prevent the protein from being able to function properly. Explain your prediction.

Name: _____ Date: _____

19. The experiments performed by Avery and colleagues showed that the phenotype of virulent bacteria could be passed on to other bacteria if the strain's proteins were destroyed but could not be passed on if the strain's DNA had been destroyed.

Explain what this discovery suggests about the roles of protein and DNA in inheritance in bacteria.

Despite the results of this study, scientists were reluctant to accept that the findings would also apply to animals.

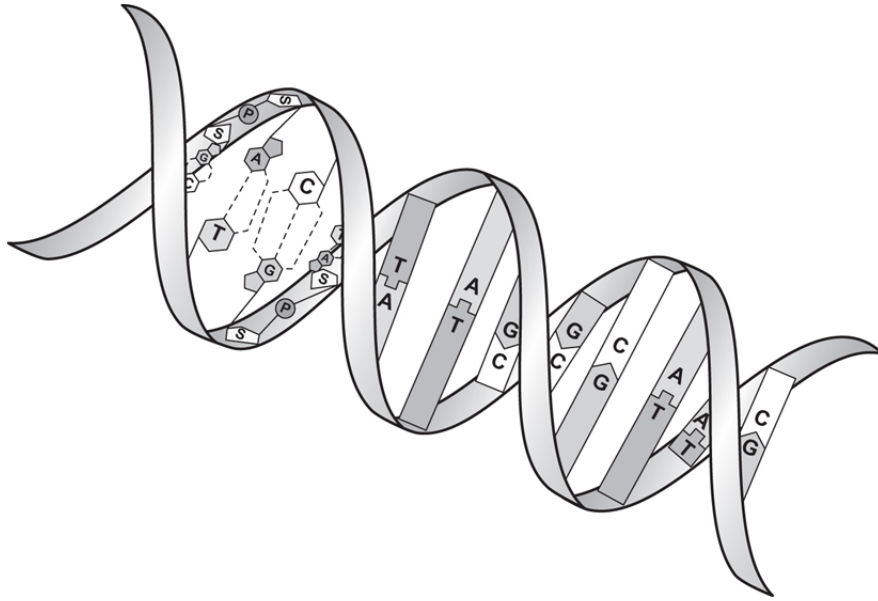
Explain why scientists of the time were reluctant to accept that Avery's findings also applied to animals.

20. A scientist is comparing the processes of DNA replication and transcription in eukaryotes.

Explain two ways that DNA replication and transcription are different.

Explain one way that DNA replication and transcription are similar.

21. The following image shows the current model of DNA, attributed to James Watson and Francis Crick.



Using the model, describe the structure of DNA in terms of nucleotides, covalent bonds, sugars, phosphates, bases, and hydrogen bonds.

Explain the importance of the hydrogen bonds to the function of a DNA molecule.

Directions: Read the passage, then answer the questions that follow.

Protein Production in Photosynthetic Plankton

A student is studying photosynthetic plankton. One group of organisms he studied was cyanobacteria, which are photosynthetic prokaryotes. Another group of organisms he studied was brown algae, which are photosynthetic eukaryotes. He compared the cellular processes involved in protein production in the two groups of organisms.

22. The student studied the role of promoters in the two groups of organisms. Which observation should the student have made? Circle the letter of the correct answer.
- A. The promoter is a protein found only in the cyanobacteria.
 - B. The promoter is a DNA sequence found only in the brown algae.
 - C. The promoter is a DNA sequence that aids in transcription in both groups of organisms.
 - D. The promoter is a protein that aids in initiating translation in both groups of organisms.
23. The student compared the process of gene expression in the two groups of organisms. Which difference should the student have observed? Circle the letter of the correct answer.
- A. The brown algae use DNA to code for proteins, but the cyanobacteria use only RNA.
 - B. Ribosomes are used to produce proteins in the cyanobacteria but not in the brown algae.
 - C. Transcription in the brown algae occurs in the nucleus, but in the cyanobacteria it occurs in the cytoplasm.
 - D. The brown algae use both translation and transcription to produce proteins, but the cyanobacteria use only transcription.
24. Which expression best describes how cyanobacteria regulate expression of genes in prokaryotic cells? Circle the letter of the correct answer.
- A. by limiting transcription
 - B. by preventing cell division
 - C. by terminating all protein synthesis
 - D. by altering proteins after translation

Name: _____ Date: _____

Unit 6

Unit Test A

25. Write an X in the correct box to show whether each explanation about gene expression is true or false.

Explanation	True	False
A. It is the activation of certain genes at certain times that causes cells to differentiate.		
B. Cells turn off particular genes when they are no longer needed for the cells to function.		
C. The cyanobacteria perform cell differentiation at a much higher level than the brown algae.		
D. It is the removal of certain genes from an organism that causes its cells to become differentiated.		