

Genetics Review

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

_____ 1. The paired bases of a DNA molecule are best described as

- A. covalently linked across the width of the double helix
- B. identical
- C. mirror images
- D. complementary
- E. single-stranded

_____ 2. DNA replication:

- A. results in each cell produced by mitosis and cytokinesis having a complete set of genetic instructions
- B. causes cytokinesis to begin
- C. occurs virtually all the time during the life of a cell
- D. occurs during cytokinesis
- E. has different characteristics in cells producing repair tissue and those producing growth tissue

_____ 3. DNA is stable because hydrogen bonds are formed between

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

_____ 4. When DNA helicase is active, the result is:

- A. annealing of RNA primers to the DNA
- B. formation of phosphodiester bonds
- C. formation of hydrogen bonds
- D. separation of the two strands of the double helix
- E. swivelling of the single separated strands of DNA

_____ 5. During DNA replication, the function of RNA primers is to

- A. open replication bubbles
- B. serve as starting points for DNA strand elongation by DNA polymerase I in the 3' - 5' direction
- C. serve as starting points for DNA strand elongation by DNA polymerase III in prokaryotes
- D. prevent new-separated strands of DNA from rejoining
- E. serve as a binding site for DNA ligase

_____ 6. During DNA replication, one of the new strands of DNA is synthesized continuously, while

the other is synthesized as a number of separate fragments of DNA that are subsequently linked by DNA ligase. This is because

- A. replication starts at many points on the chromosome
- B. RNA primers only anneal to one of the parental strands of DNA
- C. DNA polymerase III only synthesizes DNA in the 3' - 5' direction
- D. one of the parental strands is unwound slower than the other by helicase
- E. DNA polymerase III only synthesizes DNA in the 5' - 3' direction

_____ 7. A DNA nucleotide contains:

- 1. a cyclic nitrogen-containing part
- 2. a single ring containing five carbons
- 3. a part which contains four oxygen atoms surrounding a central atom.

In order, 1, 2 and 3 are

- A. a base, a phosphate group, a sugar
- B. a sugar, a base, a phosphate group
- C. a base, a sugar, a phosphate group
- D. a phosphate group, a sugar, a base
- E. a sugar, a phosphate group, a base

_____ 8. The main support to the DNA molecule is provided by two backbones which run along the two sides of the double helix. These backbones consist of

- A. sugars joined by ester links
- B. phosphates joined by ester links
- C. sugars and phosphates linked together
- D. phosphates and bases linked together
- E. sugars and bases linked together

_____ 9. An enzyme, which excises a mismatched base in a newly synthesized strand of DNA, is called

- A. a primase
- B. a excisase
- C. a polymerase
- D. an exonuclease
- E. a gyrase

_____ 10. Complementary base pairing is the result of

- A. hydrogen bonding
- B. the fact that complementary bases fit together physically
- C. covalent bonding
- D. ionic bonding
- E. the fact that strands of DNA are wound around each other in a double helix

_____ 11. In DNA, phosphodiester bonds join

- A. two phosphate groups
- B. bases and sugars
- C. phosphate groups and sugars
- D. phosphate groups and bases
- E. two sugar molecules

_____ 12. Transcription of the lacZ and lacY genes of the **lac operon** begins when

- A. lactose binds to the operator
- B. RNA polymerase binds to the lacZ gene
- C. the repressor protein binds to the inducer
- D. the repressor is released from the promoter
- E. lactose binds to RNA polymerase

_____ 13. Which of the following correctly describes the order in which cell components become involved in protein synthesis?

- A. DNA polymerase, mRNA, ribosome, tRNA
- B. mRNA, RNA polymerase, ribosome, tRNA
- C. RNA polymerase, mRNA, tRNA, ribosome
- D. RNA polymerase, mRNA, ribosome, tRNA
- E. DNA, rRNA, tRNA, mRNA

_____ 14. The expression of the repressor (lacI) gene, which is part of the **lac operon**

- A. occurs only when RNA polymerase binds to the promoter
- B. causes lactose to pass through the cell membrane
- C. occurs only when lactose is present
- D. results in the removal of the repressor from the operator
- E. is part of the negative control mechanism of the lacZ and lacY genes

_____ 15. DNA acts as a template for transcription.

Which of the following statements regarding the DNA of a gene being expressed is true?

- A. After unwinding, both of the DNA strands act as templates.
- B. After unwinding, only one of the DNA strands acts as a template.
- C. The two strands only act as a template when paired.
- D. In prokaryotes, the binding of RNA polymerase to unwound DNA occurs randomly on either of the two strands.
- E. The strand with the higher cytosine-guanine content acts as the template.

_____ 16. The splicing of the first-formed mRNA transcript by spliceosomes is necessary because

- A. the poly-A tail must be added
- B. introns need to be added

C. the poly-A tail and the cap must be removed

D. the transcript must be freed from the DNA

E. introns need to be removed

_____ 17. Suppose a tRNA molecule bearing the anticodon for cysteine, and with cysteine bound to it, is chemically treated so as to change the cysteine to alanine (the tRNA molecule and the anticodon remain unaltered). Which of the following is likely to be true?

- A. Alanine would be incorporated into the peptide in place of cysteine.
- B. Cysteine would continue to be brought to the ribosome by this tRNA.
- C. Transcription would stop when this tRNA molecule entered the ribosome.
- D. The amino acid bound to this tRNA would not be added to the growing polypeptide.
- E. The result would differ in prokaryotes and eukaryotes.

_____ 18. In the presence of high cellular concentrations of tryptophan

- A. the repressor attaches to the DNA, but transcription proceeds
- B. the repressor binds to tryptophan and then leaves the operator
- C. tryptophan binds to the operator and prevents transcription
- D. tryptophan binds to the repressor, which then binds to the operator
- E. tryptophan binds to the repressor, which binds to the promoter and prevents transcription

_____ 19. The 'one gene: one enzyme' hypothesis had to be refined because

- A. some genes code for lipids and carbohydrates
- B. some genes code for many enzymes
- C. some genes code for structural protein
- D. some genes are transcribed and translated into other genes
- E. some genes consist of protein

_____ 20. If you were shown an electron micrograph of a cell in which mRNA was being translated while it was still being transcribed from the DNA, you would know

- A. the gene product was in high demand at the point in the cell cycle at which the image was captured
- B. the cell was prokaryotic
- C. transcription was occurring extremely fast
- D. the electron micrograph showed the nucleus of the cell
- E. the cell was eukaryotic

_____ 21. The 'Central Dogma' states that the flow of genetic information is in the direction

- A. protein, RNA, protein
- B. RNA, DNA, RNA
- C. protein, RNA, DNA
- D. RNA, DNA, protein
- E. DNA, RNA, protein

_____ 22. The function of the polyadenine tail that is added to mRNA in eukaryotic cells is to

- A. prevent degradation of the mRNA
- B. initiate the binding of the mRNA to the ribosome
- C. help the mRNA to bind to a pore in the nuclear membrane
- D. add a specific amino acid sequence to the polypeptide produced
- E. act as a signal for the termination of translation

_____ 23. A certain protein needs to have a high energy phosphate group added to it in the cytoplasm before it becomes active. This offers the possibility of control at which of the following levels?

- A. transcriptional
- B. operational
- C. post-transcriptional
- D. translational
- E. posttranslational

Short Answer

24. Explain why DNA replication is slightly slower in the lagging strand of DNA than in the leading strand.

25. What is the amino acid sequence of the polypeptide that would be synthesized after transcription and translation of the following piece of template strand DNA?

| | <i>codon translations</i> | |
|-------------------------------|---------------------------|-------------------|
| DNA template | Codon | Amino Acid |
| 5' T C A T G C G C A A C A 3' | AGU | Ser |
| | ACG | Thr |
| mRNA | CGU | Arg |
| 5' | UGU | Cys |
| | UGC | Cys |
| Polypeptide | GCA | Ala |
| | UGA | stop |
| tRNA anticodons | | |

26. DNA 'fingerprinting' techniques that seek to compare samples of DNA with great accuracy, usually concentrate on the comparison of VNTR DNA in the samples rather than the DNA found in the genes. Explain why you think this is so.

Name: _____

GENETIC CHALLENGE WORKSHEET

1. From an extract of human cells growing in tissue culture, you obtain a white fibrous substance. By noting the differences in chemical structure, building blocks, etc. list the features by which you could distinguish whether it was DNA, RNA, or protein.

| DNA | RNA | protein |
|-----|-----|---------|
| | | |

2. If 35% of the nucleotide bases in a double-stranded DNA molecule are Thymine: what percentage of the bases are Cytosine, Adenine, and Guanine?

| | | | |
|---------|-----------|-----------|-----------|
| T = 35% | C = ____% | A = ____% | G = ____% |
|---------|-----------|-----------|-----------|

3. From a hospital patient afflicted with a viral disease, you isolate and culture some cells and then extract the DNA. You find that the DNA from the culture contains two different kinds of DNA, each placed in a different test tube: one is double-stranded human DNA and the other is single-stranded virus DNA. You analyze the percent base composition of the two DNA extracts with the following results:

| | A | C | G | T |
|--------|----|----|----|----|
| Tube 1 | 22 | 28 | 28 | 22 |
| Tube 2 | 35 | 15 | 30 | 20 |

Which tube contains the single-stranded viral DNA? Explain how you know.

4. You have isolated some double-stranded dinosaur DNA from a biting insect preserved in fossilized amber! You then add the appropriate enzymes and manage to transcribe a strand of mRNA from one of the DNA strands. Below is the percentage composition of the bases for the DNA and mRNA:

| | C | G | T | A | U |
|--------------|----|----|----|----|----|
| DNA strand 1 | 15 | 24 | 31 | 30 | 0 |
| DNA strand 2 | 24 | 15 | 30 | 31 | 0 |
| mRNA | 24 | 15 | 0 | 31 | 30 |

Which strand of DNA is the strand from which the mRNA was made? Explain how you know.