

Genetics Review - ANSWERS

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.

After it is initiated with the help of an RNA primer, synthesis of the new DNA can be continuous in the leading strand in the direction followed by the replication fork. This is because replication is proceeding in a 5' - 3' direction - the only direction in which DNA polymerase III can synthesize a new strand of DNA. With respect to the lagging strand, a number of primers are progressively attached to the parental strand and each initiates the synthesis of a short Okazaki fragment in the direction opposite to that followed by the replication fork, since only in this way can DNA polymerase III work in a 5' - 3' direction. Each of these primers has to be removed by DNA polymerase I, which also replaces them with the appropriate nucleotides. DNA ligase then joins the Okazaki fragments. All of these additional operations take time.

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

DNA

5' TCA TGC GCA ACA 3'

3' AGT ACG CGT TGT 5'

mRNA

5' UCA UGC GCA ACA 3'

Polypeptide

Ser - Cys - Ala - Thr

tRNA anticodons

3' AGU ACG CGU UGU 5'

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.

The characteristics of VNTR microsatellites (the DNA of which is non-coding) differ widely between different individuals. On the other hand, because variation in base sequence often has such destructive effects on the functional ability of the protein coded for, the sequence of bases in the DNA of genes is often highly conserved and there may be only a few versions of a gene throughout the human population. If your purpose is to demonstrate that it is unlikely that two samples of DNA are identical by chance, it is best to work with DNA that would normally be expected to vary widely between individuals.