



**SCIENCE OLYMPIAD**  
— AT THE —  
**UNIVERSITY OF FLORIDA**

Northern Regional: January 19<sup>th</sup>, 2019

# Designer Genes C Test

**Name(s):** \_\_\_\_\_

**Team Name:** \_\_\_\_\_

**School Name:** \_\_\_\_\_

**Team Number:** \_\_\_\_\_

**Rank:** \_\_\_\_\_

**Score:** \_\_\_\_\_

*Directions: You will have 50 minutes to complete the test. You may not write on the test. Each question is worth one point unless stated otherwise. The tiebreakers are questions 7, 9, 20, 31, 40, and 44. Good Luck :)*

*Answer the multiple choice questions below. For each question, write A-E on your answer sheet.*

1. Suppose that the hypothetical protein Hrt87 interferes with the ability of kjh6mRNA (also hypothetical) to attach to the ribosome. One would conclude, therefore that Hrt87 is a(n)

- A. transcription factor.
- B. transcription repressor.
- C. operon.
- D. sigma factor.
- E. None of the above

2. The IMMEDIATE (i.e., non-evolutionary) function of meiosis is to:

- A. Promote recombination
- B. Generate genetic variation
- C. Produce a haploid cell(s) from a diploid cell
- D. Produce gametes from a somatic cell
- E. All of the above are true.

3. During meiosis, the sister chromatids separate during

- A. anaphase I.
- B. anaphase II.
- C. the S phase.
- D. synapsis.
- E. telophase II.

4. In an organism with a haploid number of 9, a skin cell has \_\_\_\_\_ chromosomes, a sperm cell at meiotic anaphase II has \_\_\_\_\_ chromosomes, and a newly formed zygote has \_\_\_\_\_ chromosomes.

- A. 18; 18; 18
- B. 9; 9; 9
- C. 9; 18; 9
- D. 18; 9; 9
- E. 18; 9; 18

5. White eyes is a recessive sex-linked trait in fruit flies. If a white-eyed female fruit fly is mated to a red-eyed male, their offspring should be

- A. 50 percent red-eyed and 50 percent white-eyed for both sexes.
- B. all white-eyed for both sexes.
- C. all white-eyed males and all red-eyed females.
- D. all white-eyed females and all red-eyed males.
- E. 50 percent red-eyed males, 50 percent white-eyed males, and all red-eyed females

6. Agouti is a type of coat color pattern in mouse that cannot be expressed in albinos (white mice). Nonalbino mice without the dominant agouti allele (AA $bb$  and A $abb$ ) are black. An agouti mouse that is heterozygous at the albino (A) and agouti (B) loci (AaBb) is mated to an albino mouse that is heterozygous at the agouti locus (aaBb).

What percent of the progeny are likely to be agouti?

- A. 0 percent
- B. 12.5 percent
- C. 37.5 percent
- D. 50 percent
- E. 100 percent

7. The structure of DNA explains which three major properties of genes?

- A. They contain information, direct the synthesis of proteins, and are contained in the cell nucleus.
- B. They contain nitrogenous bases, direct the synthesis of RNA, and are contained in the cell nucleus.
- C. They replicate exactly, are contained in the cell nucleus, and direct the synthesis of cellular proteins.
- D. They contain information, replicate exactly, and can change to produce a mutation.
- E. They encode the organism's phenotype, are passed on from one generation to the next, and contain nitrogenous bases.

8. Single base changes in the coding regions of proteins can cause \_\_\_\_\_ mutations.

- A. missense
- B. nonsense
- C. frame-shift
- D. silent
- E. All of the above

9. If a 5'-to-3' strand of DNA has the sequence GTCTATGCATTA, what would be the sequence of the resulting transcribed RNA?

- A. 5'-GUCUAUGCAUUA-3'
- B. 5'-GTCTATGCATTA-3'
- C. 5'-CAGATACGTAAT-3'
- D. 5'-CAGAUACGUAAU-3'
- E. 3'-GUCUAUGCAUUA-5'

10. Suppose the DNA of a gene contains five motifs (A, B, C, D, and E) in that order. Motifs A, B, and D are located in introns, while motifs C and E are located in exons.

What is the order of the motifs in the mature mRNA transcribed from that sequence?

- A. CE
- B. ABD
- C. BAD
- D. ABDCE
- E. ABCDE

11. In eukaryotes, ribosomes become associated with endoplasmic reticulum membranes when

- A. a signal sequence on the mRNA interacts with a receptor protein on the membrane.
- B. a signal sequence on the ribosome interacts with a receptor protein on the membrane.
- C. a signal sequence at the amino terminus of the protein being synthesized interacts with a receptor protein on the ribosome.
- D. a signal sequence on the protein being synthesized interacts with a signal recognition particle and both bind to the endoplasmic reticulum.
- E. the messenger RNA passes through a pore in the membrane.

12. Suppose that there is a mutation in the lac operon that prevents the repressor from binding to the operator. In the absence of lactose (or allolactose), the genes of the operon will be \_\_\_\_\_.

In the presence of lactose (or allolactose), the genes will be \_\_\_\_\_.

- A. on; off
- B. on; on
- C. off; on
- D. off; off
- E. None of the above; in both cases the presence or absence of the co-repressor would dictate whether the genes are on or off.

13. Proteins are synthesized starting at the \_\_\_\_\_, in the \_\_\_\_\_ direction along the mRNA.

- A. A site; 3'-to-5'
- B. 5' cap; 5'-to-3'
- C. N terminus; 3'-to-5'
- D. poly A tail; 3'-to-5'
- E. N terminus; 5'-to-3'

14. Which of the following genomes is most likely that of a free-living prokaryote?

- A. A genome that is 300 million bp long with over 50 percent repetitive DNA and many introns
- B. A genome that is 16,000 bp long and arranged in a circle
- C. A genome that is 3 million bp long, arranged in a single circular chromosome, and has little repetitive DNA
- D. A genome that is 3 million bp long, is arranged in many linear chromosomes, and has many introns
- E. B and C

15. DNA, because it has a \_\_\_\_\_ charge, moves to the \_\_\_\_\_ end of the field in gel electrophoresis; \_\_\_\_\_ DNA molecules migrate the most quickly.

- A. positive; positive; smaller
- B. positive; positive; larger
- C. positive; negative; smaller
- D. negative; positive; larger
- E. negative; positive; smaller

*Answer the short answer questions below. For each question, write your response on your answer sheet.*

16. How do Cdk's become activated?

17. What is it called when non-homologs swap genes?

18. What is an observable physical feature called?

19. What is a test cross?

20. What does the term genomic totipotency mean?

21. How are binary fission and mitosis similar? How are they different?

22. What is the difference between necrosis and apoptosis?

*Use these terms to answer the following two questions. For each question, write your response on your answer sheet.*

- A. incomplete dominance
- B. multiple alleles
- C. pleiotropy
- D. epistasis
- E. penetrance

- 23. The ability of a single gene to have multiple phenotype effects.
- 24. The phenotype of the heterozygote differs from the phenotypes of both homozygotes.

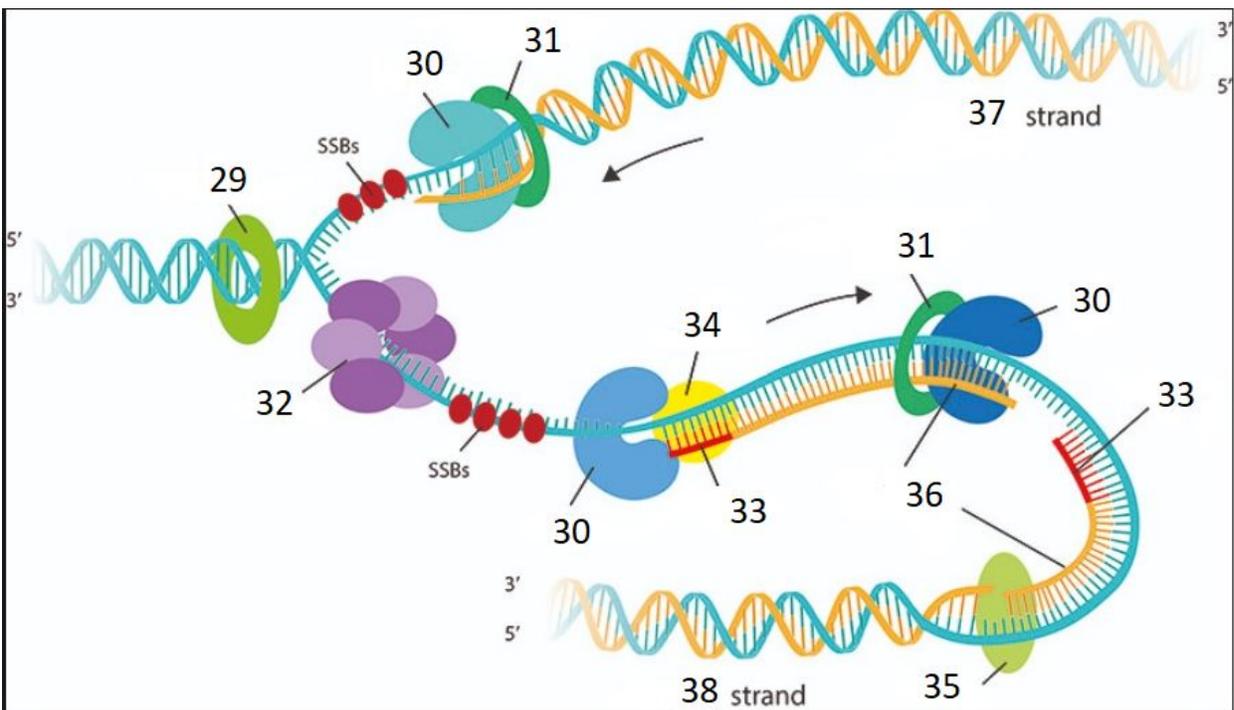
*Answer the multiple choice questions below. For each question, write A-E on your answer sheet.*

- 25. Skin color in fish is inherited via a single gene with four different alleles. How many different genotypes would be possible in this system?
  - A. 3
  - B. 6
  - C. 8
  - D. 10
  - E. 16
  
- 26. The genotype of F1 individuals in a tetrahybrid cross is AaBbCcDd. Assuming independent assortment of these four genes, what are the probabilities that F2 offspring would have the AaBBccDd genotype?
  - A. 1/8
  - B. 1/16
  - C. 1/32
  - D. 1/64
  - E. 1/128
  
- 27. Julia has a sibling with Tay Sachs (a recessive trait). Neither Julia, nor her parents has the disease, and none of them has been carrier tested. However, Julia's husband, Steve, fathered a child with Tay Sachs in a previous marriage. Based on this incomplete information, calculate the probability that if Julia and Steve have a child, the child will have Tay Sachs.
  - A. 1/4
  - B. 1/6

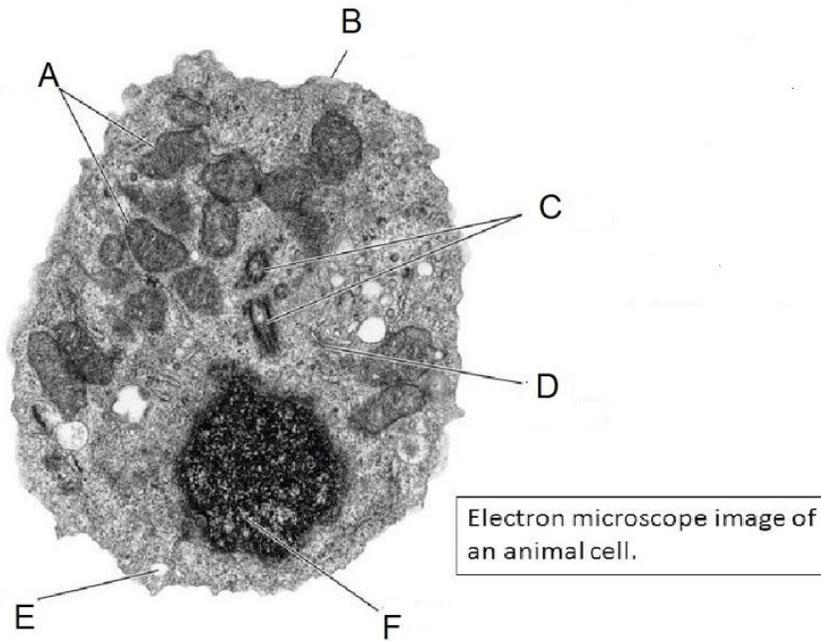
- C. 1/9
- D. 1/18
- E. 1/24

28. The simplest infectious biological systems are
- A. viroids.
  - B. bacteria.
  - C. viruses.
  - D. both A and B
  - E. both B and C

*For questions 29-38, refer to the diagram below. Identify each structure and record your answer on your answer sheet.*



For question 39, refer to the image below.



39. Which cell structure (A-F) contains 70S ribosomes?

- A. A
- B. C
- C. C and F
- D. A and F
- E. A, E, and F

40. What does the S stand for in '70S'?

- A. Strand
- B. Sequence
- C. Siskel
- D. Svedbergs
- E. Sturtevant

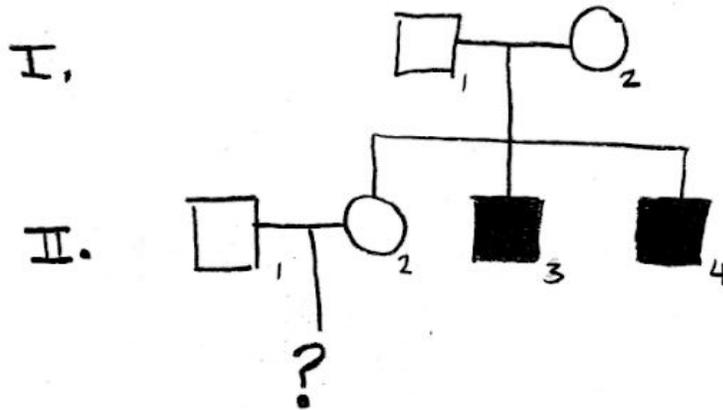
41. The presence of 70s ribosomes in animal cells led what evolutionary theory about the origin of eukaryotic cells?

- A. Symbiogenesis
- B. Endosymbiotic Theory

- C. Both A and B are correct
- D. None of the above are correct

Answer the free response questions 42-45 below. For each question, write your answer on your answer sheet. Be as detailed as possible to earn more points.

For question 42, refer to the image below.



42. II-2 in the pedigree has two siblings with red-green color blindness, an x-linked recessive disorder. If II-2 has a son, what is the probability that he will be red-green colorblind? What is the probability if II-2 has a daughter? (4 pts)

43. Describe the major stages of mitosis? What happens in each phase? (5 pts)

44. What are two types of errors in meiosis? What happens in each of them? (5 pts)

45. What are two processes of meiosis that result in differences in the genetic make-up of daughter cells? What happens in each of them? (5 pts)