

Designer Genes

SSSS 19 - 20

Written by neuro



Score: ____ / ____

Rules:

1. You will be given 50 minutes to complete this test.
2. Record all of your answers on the answer sheet provided. The answer sheet will be the only part of the test that will be graded.
3. Some questions have multiple parts. Parentheses “()” indicate the various parts of each question. Please indicate the parts of the question you are answering on your answer sheet.
4. Point values for each question are indicated by brackets “[]”
5. Answer each question as completely as possible. Partial credit may be provided for partially correct answers.
6. Be clear, concise, and specific with your answers.
7. Good luck.

Part I : Mendelian Genetics & General Heredity

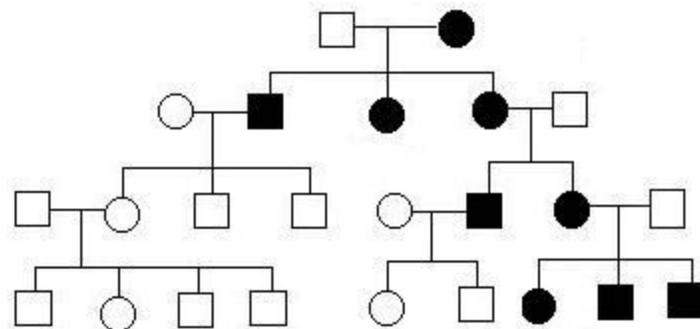
1. Michael is a 32 year old man who has hemophilia and Huntington's disease. However, Michael's mother did not have Huntington Disease. Julia is a 29 year old female who does not have hemophilia and also does not have Huntington's disease. Julia's father however, does have hemophilia. [Note: Huntington's disease is an autosomal dominant trait]

- (A) Construct a dihybrid cross depicting the possible offspring of Michael and Julia. {2 pts}
- (B) What is the phenotypic ratio of the dihybrid cross? {1 pt}
- (C) What is the genotypic ratio of the dihybrid cross? {1 pt}
- (D) What percent of the offspring will be Males that have both Hemophilia and Huntington's disease? {1 pt}
- (E) What percent of the offspring will have Hemophilia, but will not have Huntington's disease? {1 pt}

2. Identify the the names of the following nondisjunction disorders. {0.5 pt ea.}

- (A) Trisomy 21
- (B) Trisomy 23 (XXY)
- (C) Trisomy 23 (XYY)
- (D) Monosomy 23
- (E) Trisomy 13
- (F) Trisomy 18

3.



- (A) Identify the type of inheritance depicted by the pedigree {2 pt}

(B) Suppose Tommy, who is not affected by the trait shown in the pedigree is crossed with Susan, who is affected by the trait. What percentage of their children will also be affected by the trait? {1 pt}

4. Describe the following traits by stating (1) whether they are autosomal or sex linked, and (2) whether they are dominant or recessive. {0.5 pt ea.}

(A) Hemophilia

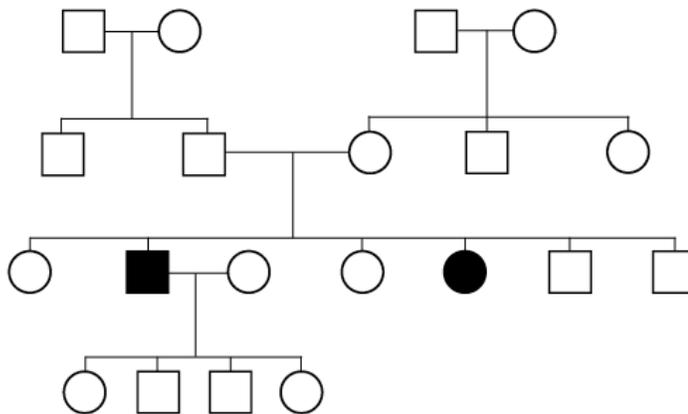
(B) Cystic Fibrosis

(C) Color Blindness

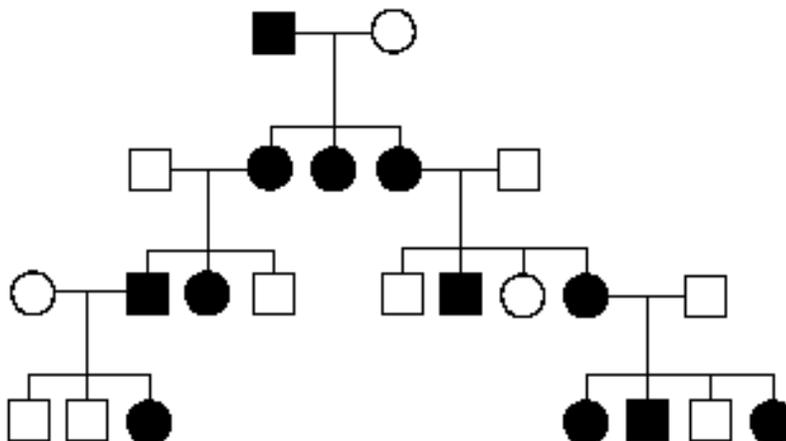
(D) Marfan's Syndrome

5. Analyze the following pedigrees and state the mode of inheritance. {1 pt ea.}

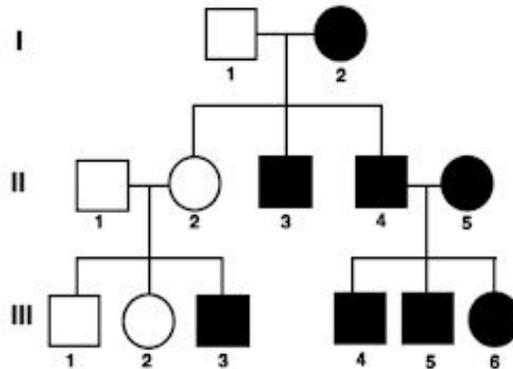
(A)



(B)



(C)



6. Because the nucleic acid contents of cells are usually in their loose, chromatin form within the nuclei of cells, how are scientists able to obtain karyotypes? {2 pts}

Part II : Mutations

7. What type of genetic mutation causes Tay-Sachs Disease? {2 pt}

8. Two strands of mRNA are shown. Strand X undergoes a single nucleotide polymorphism, leading to the sequence in Strand Y. The mutation is bolded. What type of mutation is this (A), and how will it impact the mRNA sequence (B)? {1 pt}

Strand X:

AUGAUAGCUACUAGGGCAACC**A**GACGACGCACGUAG

Strand Y:

AUGAUAGCUACUAGGGCAACC**U**GACGACGCACGUAG

9. Two strands of mRNA are shown. Strand V undergoes a specific type of mutation, leading to the sequence in Strand W. The mutation is bolded. What type of mutation is this? {1 pt}

Strand V:

AUGCGAAGACAG**GAA**UACUUAGCUACGAAGUCGUAA

Strand W:

AUGCGAAGACAG**GAAGAAGAAGAA**UACUUAGCUACGAAGUCGUAA

10. Two strands of mRNA are shown. Strand A undergoes several different types of mutation, leading to the sequence in Strand B. The mutations are bolded. What types of mutations altered Strand A? (Note: There are three different mutations) {2 pt}

Strand A:

AUGGAGC**U**CCGUAGGCGGAUGACA**U**UGUAUAAGUGA

Strand B:

AUGGAGCCCGUAGGCGGAUGACA**U**UGUAUAAGUGA

11. Name three reasons why it is fairly uncommon for mutations to bring out major effects on organisms, despite the fact that mutagens are relatively common. {2 pts}

Part III : Genetic Probability & Calculations

12. Within City X, 49% of the population is homozygous recessive for the gene that regulates eye color. What is the allele frequency for the dominant allele (A), and what percent of the population is heterozygous (B)? {2 pt}

13. In City Z, a city with a population of 198 people, there is a high presence of sickle cell anemia, an autosomal recessive condition. The allele frequency of the recessive allele for sickle cell anemia is 38% within the city. What percent of the population has sickle cell anemia (A), and how many individuals are homozygous dominant for the sickle cell anemia condition (B)? {2 pts}

14. In a cross between an individual who's genotype is XxYYzz and an individual with a genotype of XxYyZZ, what is the probability of the offspring being XXYYZz or XxYyZz? {1 pt}

15. In a cross between an individual with a genotype of PpQqRRss and an individual with a genotype of ppQqRrSS, what is the probability that the individual will be PpQqRrSs or ppqqRRSs? {2 pts}

16. In a cross between a male with genotype AaBBCcddEe and a female with genotype AaBbccddEe, what is the probability that the offspring will have a genotype of AaBBccddEE, AABbCcddEe, or aaBbCCddEE? {3 pts}

Part IV : DNA Replication & Central Dogma

17. In the initial phases of both DNA replication and mRNA translation, what enzyme is responsible for untwisting the DNA and preventing the buildup of tension caused by supercoiling? {1 pt}

18. What subdivisions of DNA polymerase are utilized by the following categories of cells? {2 pt}

(A) Prokaryotes

(B) Eukaryotes

19. What are the two primary functions of Single strand binding protein (SSB) in DNA replication? {1 pt}

20. In eukaryotes, what enzyme is responsible for the elongation of the leading strand (A), lagging strand (B), and the removal of primer (C)? {1 pt}

21. What genetic processes allows a single gene to code for multiple proteins? {1 pt}

22. What structure on DNA allows Transcription factor IID {TFIID} to position itself on the transcription initiation site? {1 pt}

23. About how many base pairs long is an Okazaki fragment in eukaryotes? {1 pt}

24. What is the most prominent “start codon” in eukaryotes and what amino acid does it code for? {1 pt}

25. What are the three stop codons? {1 pt}

26. Polyadenylation involves the addition of what structure to the end of a premature mRNA molecule? {1 pt}

27. Define each of the following and provide an example for each. {2 pt}

(A) Primary Protein Structure

(B) Secondary Protein Structure

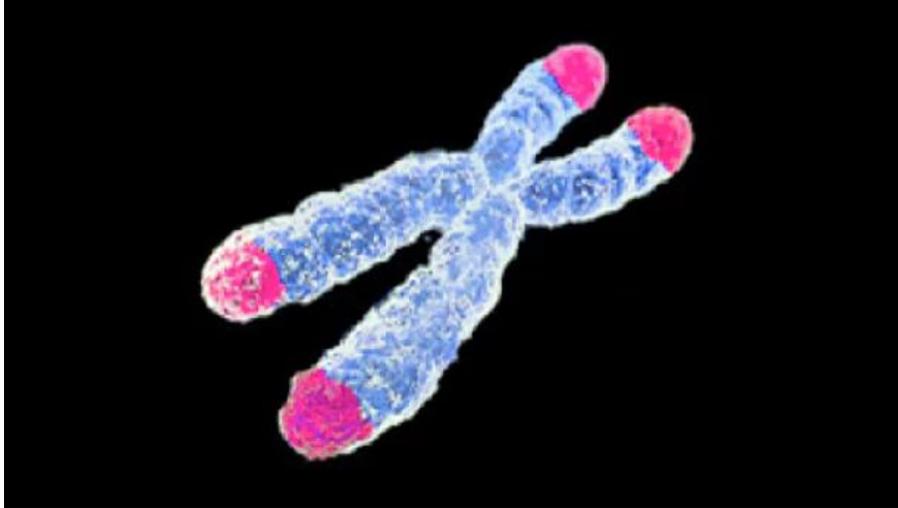
(C) Tertiary Protein Structure

(D) Quaternary Protein Structure

Part V : DNA Structure

28. What is a nucleosome and what does it consist of? {1 pt}

29. Identify the following structure shown in pink (A), and briefly describe its function. {2 pts}



30. What is the structural difference between a nucleotide and a nucleoside? {1 pt}

31. “Linked Genes” are examples of an exception to which Mendelian principle of genetics? {1 pt}

32. If a geneticist refers to “Chromosome 21p”, then they are referring to which portion of the 21st chromosome? {1 pt}

33. What are pyrimidines and purines in regards to DNA structure (A), and what base pairs are classified as pyrimidines / purines (B)? {2 pt}

34. What is the kinetochore, on what larger structure is it located, and what is its function? {1 pt}

35. What is a “Barr Body” and in what individuals do they form. {2 pt}

36. What infamous disease involves the production of anti-histone antibodies in affected individuals? {1 pt}

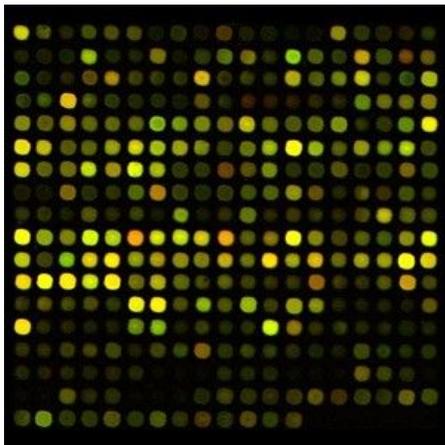
37. Define the term “aneuploidy”. {1 pt}

38. In the following image, identify the name of the dark bands on the chromosome (A) and the light bands (B). {2 pt}



Part VI : Genetic Laboratory Technology

39. Dideoxy nucleotides are utilized for what form of genetic sequencing? [1 pt]
40. Describe the process of RFLP analysis for genetic fingerprinting. {2 pt}
41. A genetic scientist wants to find out the specific sequence of amino acids found in a particular protein. Which of the following techniques should he use? {1 pt}
- (a) Northern Blotting
 - (b) Southern Blotting
 - (c) Western Blotting
 - (d) Eastern Blotting
42. In the PCR technique, from what microorganism is the polymerase derived from and where is this organism found? {2 pt}
43. In regards to your answer from #42, why do scientists use the polymerase from this particular organism in order to perform PCR? {2 pts}
44. A genetic engineer performs a test to identify the extent of the expression of certain proteins. The results of the test are shown below. What test did the genetic engineer conduct? {2 pts}



45. Describe gene therapy briefly. {2 pt}
46. In the CRISPR Cas9 complex, sgRNA is made up of what two components? {1 pt}
47. What is the main goal of site-targeted mutagenesis? {1 pt}
48. In the CRISPR Cas9 system, the SpyCas9 protein falls under what category of enzymes? {1 pt}

49. Why is PCR such a necessary and popular technique? {1 pt}

50. What proteins are often used to produce viral plasmid vectors? {1 pt}

Part V : The Cell Cycle

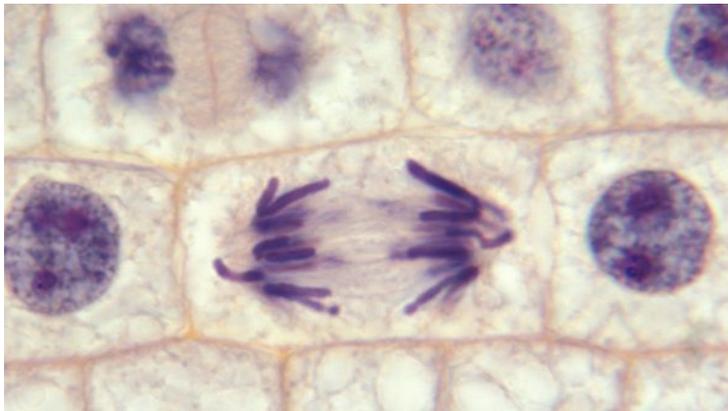
51. What is the name of the column in the center of the cell in which the chromosomes line up during the metaphase? {1 pt}

52. In what phase of the cell cycle are karyotypes usually taken? {1 pt}

53. How long does mitosis typically last within a cell? {1 pt}

54. Describe nondisjunction in meiosis. {2 pt}

55. What stage of mitosis is being represented below? {1 pt}



Part VI : Miscellaneous

56. What is phylogenetics? {1 pt}

57. What is epigenetics? {1 pt}