

Designer Genes C Practice Exam

Names: _____

Score: _____ /179 **TB: 1 2**

School & Team (A, B, C): _____

Team #: _____

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Part A. Multiple Choice Questions. _____/60 (2pts each)

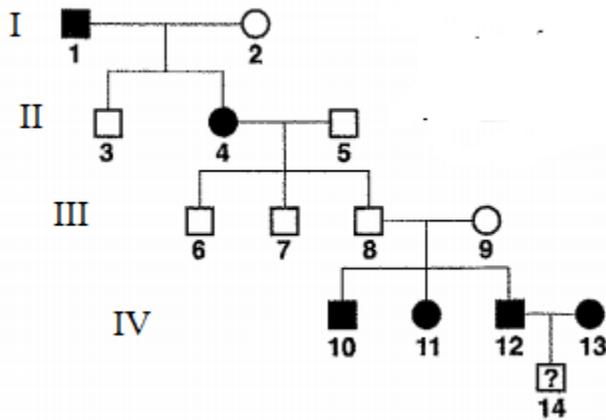
- In humans, color-blindness is a sex-linked, recessive trait. If the female mother is a carrier and the male father has normal vision, which of the following statements is true?
 - The male father has two copies of the allele for normal vision
 - A child of the couple would have a 50% of being color-blind
 - All male offspring of the couple would have color-blindness
 - All male offspring of the couple would have normal vision
 - All female offspring of the couple would have normal vision
- Alice is phenotypically female, but when Doctor Ito took a look at her interphase somatic nuclei, there were no Barr bodies. What statement is likely true?
 - She has Y chromosome(s)
 - She has Turner's syndrome
 - She has Klinefelter's Syndrome
 - Her cells have an abnormal number of autosomal chromosomes
 - She has an extra X chromosome
- Female calico cats can be very colorful. They have fur color genes on their X chromosomes, and parts of their body can be black, parts orange, and parts white. This is an example of-
 - Incomplete Dominance
 - Co-Dominance
 - Both
 - Neither
 - Autosomal dominant
- If the Dystrophin Gene is altered significantly with the deletion of various portions of the DNA, then the protein that is transcribed from this gene-
 - Will still function properly because deletions only affect introns
 - Will not function properly due to the lacking of various sections of the polypeptide once translated
 - Will probably not cause disease within the organism as it is only one protein
 - Genes do not affect proteins; it is proteins that affect genes
 - None of the above
- Look at the picture below:



What mitosis phase is shown above?

- Prophase
 - Metaphase
 - Anaphase
 - Telophase
- Which of the following is the difference between mitosis & meiosis?
 - Mitosis forms four identical, diploid daughter cells, while meiosis forms two different haploid cells
 - Mitosis forms two different haploid cells, while meiosis forms four identical, diploid cells
 - Mitosis forms two identical diploid daughter cells, while meiosis forms four different haploid cells
 - Mitosis forms four different haploid cells, while meiosis forms two identical diploid daughter cells
 - None of the above
 - What is the role of the spindle during mitosis and meiosis?
 - It acts as a template for DNA replication
 - It helps break down the nuclear membrane
 - It forms from centrioles which separate chromosomes
 - It serves as a scaffold to help divide the cell in half

8. Analyzing gene structure, which of the following is NOT commonly found at the eukaryotic transcription initiation complex?
- RNA Polymerase
 - snRNP
 - Transcription Factors
 - Promoter
 - TATA Box
9. RNA Polymerase and DNA Polymerase differ in that-
- RNA polymerase is much more accurate than DNA polymerase
 - RNA polymerase can initiate RNA synthesis, but DNA polymerase requires a primer to initiate DNA synthesis
 - RNA polymerase uses RNA as a template, and DNA polymerase uses a DNA template
 - RNA polymerase binds to single-stranded DNA, and DNA polymerase binds to double-stranded DNA
 - RNA polymerase does not need to separate the two strands of DNA in order to synthesize an RNA copy, whereas DNA polymerase relies on other enzymes to unwind the double helix before it can replicate the DNA.
10. Cytosine makes up 38% of the DNA of a sample. What percent of this sample is Thymine?
- 12%
 - 31%
 - 38%
 - 24%
 - Cannot be determined
11. When DNA Polymerase I was first purified from *E. coli*, it was immediately apparent that this could not be the enzyme that copies most of the DNA of the *E. coli* genome. What property of DNA polymerase I makes it unsuited for this job?
- It does not accurately copy DNA
 - It does not make DNA in the 5' → 3' direction
 - It does not require a primer
 - It does not require a template
 - It is not processive
12. Analyze the pedigree below:

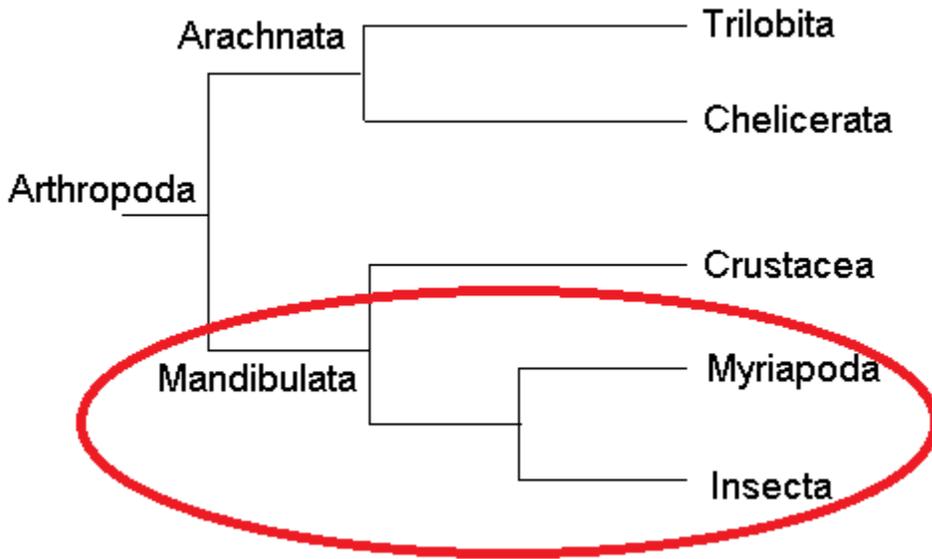


The trait above is inherited via- (2pts)

- Autosomal dominant
 - Autosomal recessive
 - Sex-linked dominant
 - Sex-linked recessive
 - Y-Linked
13. Using the same pedigree from question 12, using “A” as the dominant allele and “a” for the recessive allele,” which of the following predicts the genotype and phenotype of Individual V-14?
- Affected, aa
 - Affected, AA
 - Unaffected, Aa
 - Unaffected, aa
 - Affected, Aa

14. Which of the following is false about pedigree trait inheritance?
- A. In sex-linked recessive traits, typically there will be more males than females infected
 - B. In sex-linked recessive traits, all infected females must have infected fathers
 - C. In autosomal dominant traits, the expression of the trait never skips generations
 - D. In autosomal recessive traits, two infected parents can have a non-infected child
 - E. In a Y-linked trait, only males have the disorder, and infected fathers have infected sons
15. The antibiotic trimethoprim inactivates a bacterial enzyme in folate metabolism that converts DHF to THF, making deficient the THF derivative necessary for the enzyme ThyA to generate deoxythymidine- P_i (thymine nucleotide) from deoxyuridine- P_i (uracil nucleotide). Which of the following can bacteria potentially scavenge from their medium to overcome the effects of trimethoprim?
- A. RNA nucleotides
 - B. ThyA
 - C. DHF
 - D. DNA Nucleotides
 - E. ATP
16. What is the function of modified nucleotides used in Sanger Sequencing?
- A. To enhance polymerase fidelity
 - B. To increase polymerase processivity
 - C. To initiate/prime replication
 - D. To terminate replication
 - E. There are no modified nucleotides in Sanger Sequencing
17. How many total possible different gametes can be made from selfing $AaBbccDDEeFfggHH$?
- A. 4
 - B. 16
 - C. 64
 - D. 256
 - E. 1028
18. Y-linked genes are known as:
- A. Holandric genes
 - B. Heterotic genes
 - C. Yelic Genes
 - D. Heteroandric genes
19. In what substage of Prophase I does crossing over occur?
- A. Leptotene
 - B. Zygotene
 - C. Pachytene
 - D. Diplotene
 - E. Diakinesis
20. Which of the following is true?
- A. Ionic bonds are stronger between mismatched pairs
 - B. Salt bridges are stronger between correctly matched pairs
 - C. Disulfide bonds are stronger between correctly matched pairs
 - D. Hydrogen bonds are stronger between correctly matched pairs
 - E. Hydrogen bonds are stronger between mismatched pairs
21. Which general transcription factor is first to recognize the TATA Box/DNA during transcription?
- A. TFIIE
 - B. TFIID
 - C. TFIIB
 - D. TFIIG
 - E. None of the above

Analyze the following phylogenetic tree:



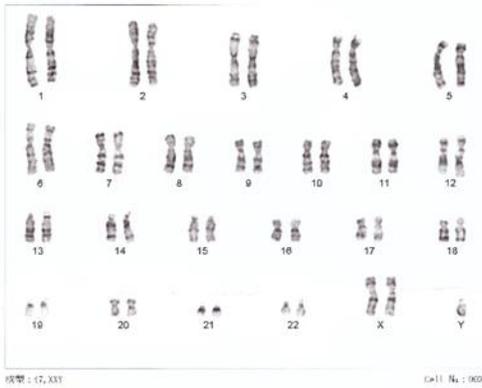
22. According to the diagram above, which is true?
- A. Trilobata is the latest ancestor that all of the other groups have in common
 - B. Arachnata does not possess any derived traits
 - C. Insecta and Crustacea are more closely related than Myriapoda and Insecta
 - D. The latest common ancestor of Trilobita and Chelicerata is Arachnata
 - E. Mandibulata is the sister taxon of Insecta
23. According to the phylogenetic tree above, the species circled in red (Mandibulata, Insecta, and Myriapoda) represent what kind of group?
- A. Paraphyletic
 - B. Monophyletic
 - C. Polyphyletic
 - D. Holophyletic
-
24. Which of the following statements about mitochondria is false?
- A. Because mitochondria are present in the cytoplasm, mitochondrial diseases are transmitted maternally
 - B. Mitochondria contain circular DNA molecules that code for protein and RNAs
 - C. Mitochondria have 2 membranes which are both bacterial-like in nature, reflecting the Endosymbiotic Theory
 - D. Because of the role of the mitochondria in producing cellular energy, mitochondrial diseases often affect the muscles and nervous system
 - E. Many mitochondrial genes encode proteins that play roles in the electron transport chain and ATP synthesis
25. Which of the following is true regarding DNA Replication?
- A. Helicase and Topoisomerase are responsible for synthesis of primers and DNA separation
 - B. DNA Polymerase I and III are primarily responsible for eukaryotic DNA replication
 - C. DNA Primase removes primers and allows DNA Polymerase to initiate replication
 - D. Okazaki fragments are formed in the leading strand because DNA Polymerase can only build 5'→3'
 - E. Uracil is a nucleotide which is used in DNA Replication
26. A cross of a white hen with a black hen produces erminette-color offspring. This type of inheritance-
- A. Polygenic
 - B. Multiple alleles
 - C. Codominance
 - D. Incomplete Dominance

27. Which of the following is not a sex-linked (X-linked) trait/disorder?
- A. Male Pattern Baldness
 - B. Red/Green Colorblindness
 - C. Tay-Sachs Disease
 - D. Duchenne Muscular Dystrophy
 - E. All of the above are sex-linked
28. Red, R, is dominant over the allele for yellow, r, in a group of flowers. A true-breeding parent generation of red flowers is intercrossed with a true-breeding parent generation of yellow flowers. The first filial generation offspring of the parent generation is then made to reproduce again. What percent of the second filial generation would be red flowers?
- A. 100%
 - B. 75%
 - C. 50%
 - D. 25%
 - E. 0%
29. In a trihybrid cross of a population of aliens, blue color (B) is dominant to black color (b). Having round eyes (R) is dominant to flat eyes (r). Being tall (T) is dominant to being short (t). Two aliens both heterozygous for all three traits breed. The percent of offspring that will be black, have round eyes, and be short is roughly (rounded to nearest whole number)... (4pts)
- A. Cannot be determined
 - B. 5%
 - C. 4%
 - D. 14%
 - E. 25%
30. Mary has blood type B-. Mary has three suspects to be the father: John, who is blood type AB-; Barry, who is blood type O-; and Harold, who has blood type A+. If the resulting child has blood type O+, who can be the father?
- A. John, Barry, or Harold
 - B. Barry only
 - C. Harold only
 - D. Barry or Harold

Part B. Short Answers. _____/71pts (in 20 questions)

31. Mitosis is a form of cell division in eukaryotes like us. Is this a sexual or asexual process? Explain (2pts)
32. In oogenesis, how many viable eggs are formed from one primary oocyte? What are the unviable eggs called? (2pts)
33. What is the only type of cell to permanently remain in G₀? (2pts)
34. In bacteria, a specific sequence of AGGAGG binds to the ribosome to begin translation. What is this sequence called? (3pts)

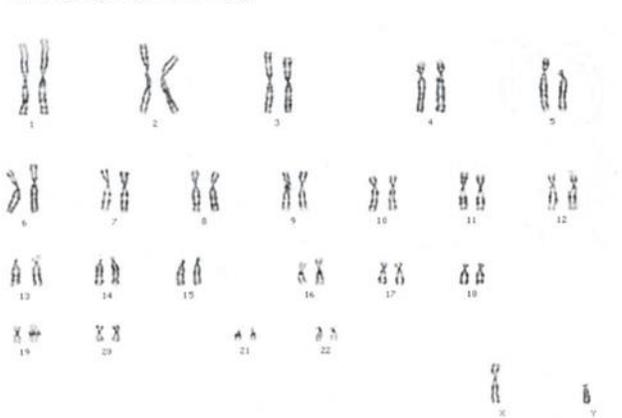
35. Analyze this karyotype:



Identify this disorder and gender of the patient (2pts).

36. Analyze this karyotype:

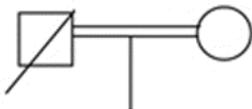
a) Karyotype (G banding)



a) Identify this disorder and how you could tell (4pts)

b) On the top of this karyotype, there is a process in parenthesis called (G banding). G-Banding is used to stain chromosomes to visualize chromosomes. What does the G stand for in G-Banding? (2pts)

37. Look at this pedigree symbol:



What do the two lines indicate (only the technical term will be accepted)? (2pts)

38. Sickle Cell Anemia is a horrible disease affecting hemoglobin's oxygen-binding affinity and causes a variety of problems. One would think that natural selection would weed such a disease out. However, in Africa and tropical areas, this is not the case. Why is sickle cell anemia still prevalent in places like Africa? (4pts)
39. Where are wobble base pairs most commonly found, and what pair of nucleotides do they typically involve? (4pts)
40. What kind of biotechnology was used for the Human Genome Project? (2)
41. Which of Mendel's principle does gene linkage violate? (2)
42. In order to incorporate recombinant DNA into plasmids, why must reverse transcription be used to create cDNA? (3)
43. What is the function of a polylinker in plasmid selection and incorporation? (3)
44. Fill-in-the-blank: Fathers _____ pass hemophilia A to their sons. (2)
45. Today, Doctor Ito decided to take a DNA microarray test on his patient, Sofia. Sofia has recently been diagnosed with lung cancer. Doctor Ito takes a biopsy of cancerous lung tissue, sample A, and normal lung tissue, sample B. Doctor Ito prepares a microarray. Afterwards, he sees that for all 15 genes he tested, sample A has brighter fluorescent results on the microarray than sample B. What does this result mean? (5pts)
46. However, Doctor Ito decides to switch a new method, RNA-Seq, or WTSS. What does WTSS stand for, and what advantages does it have over regular microarrays? Name 2 advantages. (5pts)

Part C. Long Answer. _____/48 (in 5 questions)

51. Doctor Ito is a genetic scientist as well! He is a master of all trades. So, he decides to cross his male rabbit and his female rabbit pet. The two traits he's looking at are Fur Color and Happiness. For Fur Color is either Black (B), which is dominant, or White (b), which is recessive. Happiness is either Happy (H), which is dominant, or sad (h), which is recessive. He is trying to determine whether or not these genes are linked or not.

- a) Write a null hypothesis for this experiment. (2)

- b) If 32 offspring are produced, and both male and female rabbits are heterozygous for both traits, what is the EXPECTED number of offspring with each phenotype? (4)

- c) The real number of offspring are as follows:
23 Happy, Black rabbits
2 Happy, white rabbits
1 sad, Black rabbit
6 sad, white rabbits
Calculate a chi square for this result. Round to two decimal places. (5) – **Tie Breaker 2**

d) Look at the chart below.

Probability level (alpha)

df	0.5	0.10	0.05	0.02	0.01	0.001
1	0.455	2.706	3.841	5.412	6.635	10.827
2	1.386	4.605	5.991	7.824	9.210	13.815
3	2.366	6.251	7.815	9.837	11.345	16.268
4	3.357	7.779	9.488	11.668	13.277	18.465
5	4.351	9.236	11.070	13.388	15.086	20.517

Based on this table and the chi square, are these genes linked or not? Why? (4)

52. Being good at Ornithology is a dominant trait (O). Johnny has genotype Oo, but is not good at Ornithology! Why could this be? Give two reasons. (6)

53. This long-answer discusses CpG Islands. What are CpG islands, and where are they usually found? What does methylation do, and how is it related to the frequency of the CG sequence? (8)

54. Using the mRNA codon chart and given the template strand, find the- (8pts)

Template strand of DNA: 3' – TAC CGA TGG – 5'

Coding Strand of DNA (complementary): 5' - _____ -3'

mRNA: 5' - _____ - 3'

tRNA (anticodons): _____

Amino Acid Sequence: _____

55. Analyze the following segment of DNA:

3' → TAC GAA TCA ATG → 5'

The same segment of DNA was exposed to mutagens.

3' → TAC CGA ATU AAT G → 5'

Answer the following questions:

(a) What kind of mutation occurred? Choose ALL that apply. (2pts)

- A. Point Mutations C. Insertions E. Frameshifts
B. Substitutions D. Deletions

(b) What is the name of the process that led to the formation of a “Uracil” in the DNA segment? What happens in this process? (3pts)

(c) Based on your knowledge, what are mutagens and what is an example? (2pts)

(d) What was the original amino acid chain, and what is the new amino acid chain? (2pts)

Original: _____

New: _____

(e) Based on your knowledge, would it be better for an insertion/deletion to occur earlier on in the gene or later on in the gene? Why? (2pts)