Designer Genes Tryout Test 2018-2019

Carmel Science Olympiad

Name: _____

Score: __/ 105 Rank: _____

(Do NOT complete score and rank, for officer use only)

Directions:

- You will have 40 minutes to individually complete this test.
- Allowed materials
  - One double sided 8.5" x 11" sheet of notes
- No penalty for guessing
- Each MCQ is worth 1 pt or more depending on level of difficulty, SAQ pts are marked next to the question (mostly, it's done where you obtain 2 points for every right answer, or part of an answer)
- Tiebreakers are marked with an asterisk (*)
- Write legibly or **I will not bother to grade your test**
- Don't cheat.
- If you need more space to answer any of the questions, ask the person proctoring this test for extra paper
  - Write down your name and the question number on the extra sheet
  - Staple it to your test when you're done
  - Indicate that the answer continues to another sheet of paper on the original test
- Good luck, you got this!

1. What is the most common start codon? *(1 pt)*

AUG

2. Which amino acid is this? *(1 pt)*

a. Serine
b. Arginine
c. Therocine
d. Methionine

3. What are the criteria for Hardy-Weinberg equilibrium? *(10 pts)*

A large breeding population, random mating, no change in allele frequency due to mutation, no immigration or emigration, no natural selection

4. Name and explain three basic differences between RNA and DNA.* *(6 pts- 2 pt per difference)*

RNA is single-stranded, DNA is double-stranded.
The sugar-phosphate backbone of DNA is deoxyribose while the sugar in RNA is ribose.
The complementary base to adenine in DNA is thymine, whereas in RNA, it is uracil, which is an unmethylated form of thymine.

5. What is genetic mosaicism? *(2 pt)*

The presence of two or more populations of cells with different genotypes in one individual who has developed from a single fertilized egg.

6. How does it differ from chimerism? *(2 pt)*

Chimerism is the fusion of more than one fertilized zygote in the early stages of embryonic development, rather than from a mutation or chromosome loss.

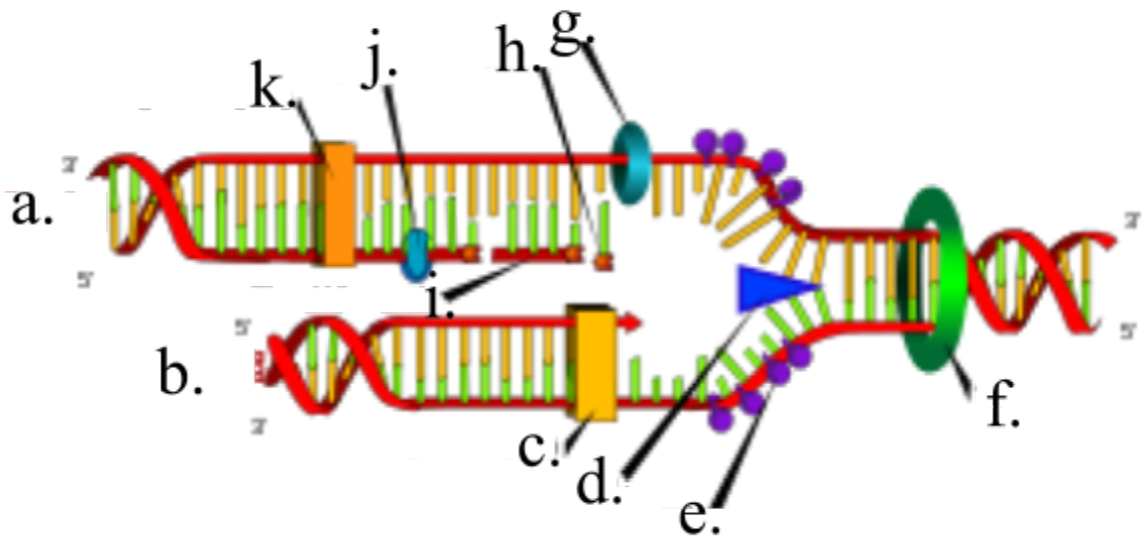
7. Why is mitochondrial DNA (mtDNA) usually exclusively inherited from the mother? *(2 pts)*

The mitochondria in mammalian sperm are usually destroyed by the egg cell after fertilization. Also, most mitochondria are present at the base of the sperm's tail, which is used for propelling the sperm cells; sometimes the tail is lost during fertilization. (either reason is accepted)

8. Label the different strands/enzymes/parts of DNA replication in the figure below. *(11 pts)*

a) Lagging strand
b) Leading strand
c) DNA Polymerase
d) Helicase
e) Single Strand Binding Proteins
h) RNA Primer
i) Okazaki fragment
j) DNA ligase
k) DNA polymerase

f) Topoisomerase
g) DNA primase



9. What kind of DNA mutation would usually have the greatest negative effect? *(1 pt)*
   a. Missense
   b. Silent
   c. Nonsense
   d. Insertion

20. What is the role of a spliceosome? *(2 pts)*
Removing introns from a transcribed pre-mRNA.

21. What amino acid would be found in large proportion in a histone? *(1 pt)*
   a. Lysine
   b. Aspartate
   c. Cysteine
   d. Glycine

22. Choose the correct statement for RACE. *(1 pt)*
   a. It stands for Random Amplification of cDNA ends
   b. It is for cloning particular cDNA ends
   c. It is only of one type, which is 5' RACE
   d. Sequence data is not available in any case

23. The genetic relatedness between organisms can be identified by studying the band patterns when different PCR products are analysed electrophoretically. This method is called: *(1 pt)*

a. restriction fragment length polymorphism (RFLP)
b. amplified fragment length polymorphism (AFLP)
c. random amplification of polymorphic DNA (RAPD)
d. polymorphism

25. The ability to control the expression of Cre allows controlling what? *(1 pt)*
a. Recombination
b. Replication
c. Excision
d. Packaging

26. Self-cleavage reaction can take place in? *(1 pt)*
a. DNA
b. RNA
c. Both DNA and RNA
d. Can take place in both but is preferred in DNA

27. The F plasmid is often used in conjugation. Which of the following is true? *(1 pt)*
a. The F plasmid encodes the factor which is transferred from one cell to another
b. The factor encoded by the F plasmid is called as Filamentous (F) factor
c. It is transferred from one cell to another by filament
d. The bacteria must belong to same species to carry out the conjugation

28. What is the difference between the two ends of DNA? *(3 pts)*
The 5' and 3' mean "five prime" and "three prime", which indicate the carbon numbers in the DNA's sugar backbone. The 5' carbon has a phosphate group attached to it and the 3' carbon a hydroxyl (-OH) group

29. a. What is an oncogene? *(2 pt)*
A gene that has the potential to cause cancer.

b. What is the difference between an oncogene and a proto-oncogene? *(2 pt)*
Proto-oncogenes are normal genes involved in cell growth and proliferation or inhibition of apoptosis. If they become mutated and are up-regulated, (gain of function mutation) they will predispose the cell to cancer and are thus termed oncogenes.

30. Western blotting is used for detecting *(1 pt)*
a. Specific RNA in a sample
b. Specific DNA in a sample
c. Specific protein in a sample
d. Specific glycolipid in a sample

31. Polyacrylamide gel is usually used for *(1 pt)*
    a. Protein
    b. DNA
    c. both A and B
    d. Vitamins

32. What is a probe? *(1 pt)*
    a. Chemically synthesized DNA
    b. Purified DNA
    c. Fragmented DNA duplex
    d. Either purified or synthesized single stranded DNA

33. What are the five general principles of bioethics? *(5 pt)*
Autonomy, Non-maleficence, Beneficence, Justice, Strict Monetary, Utilitarianism

34. Loosely define the purpose for the following methods: *(12 pt)*
    a. Karyotyping - creating a map of an individual's chromosomes
    b. Gene therapy - Changing someone's genes to alleviate effects of or cure a disease
    c. Cloning - making a copy of an organism with the same exact genetic makeup
    d. DNA fingerprinting - defining a person by unique pieces of their DNA
    e. PCR - Polymerase Chain Reaction → method to create many copies of a small piece of DNA
    f. 2D gel electrophoresis - method of organizing proteins by both size and pH

35. What are two types of DNA binding motifs? *(4 pt)*
Helix-turn-helix, Zinc finger, Leucine zipper, Winged helix, Winged helix-turn-helix, Helix-loop-helix, HMG-box, Wor3 domain, OB-fold domain

36. What is a gene family? How are gene families produced over time? With regard to gene function, what is the biological significance of a gene family? *(6 pts)*
A gene family is a group of genes that are derived from the process of gene duplication. They have similar sequences, but the sequences have some differences due to the accumulation of mutations over many generations. The members of a gene family usually encode proteins with similar but specialized functions. The specialization may occur in different cells or at different stages of development.

37. The cytoplasm of an animal cell is divided by means of: *(1 pt)*
    a. A cleavage furrow.
    b. A cell plate.
    c. A cell membrane formed within the cytoplasm.

d. Mitosis.

38. The step of mitosis in which chromosomes line up along the equatorial plane of the cell is called: *(1 pt)*

a. Prophase.
b. Metaphase.
c. Anaphase.
d. Telophase

39. The Ames test determines whether a compound is mutagenic by measuring __reversion_____ frequencies of two different types of auxotrophic histidine mutations. *(2 pts)*

40. A crossover within the inverted region of __paracentric____ inversion will give rise to an acentric fragment and a dicentric fragment. (*2 pts)*

41. What principle did the fluctuation test of Luria and Delbruck establish? *(2 pts)*
That mutations pre-exist within a population rather than being somehow induced by the Selecting agent.

42 What is the difference between mutation rate and mutation frequency? *(3 pt)*
Mutation rate is the number of mutations per unit of biological time (i.e. generation)
Mutation frequency is the number of mutations per unit of population.

43. Assuming that the level of glucose is low, a mutation in the repressor of the lac operon in E. coli, preventing binding of the repressor to the operator, should result in: *(1 pt)*

a. constitutive expression of the lac operon genes
b. lack of expression or reduced expression of the lac operon genes under all circumstances
c. expression of the genes only when lactose is present
d. expression of the genes only when lactose is absent

44. Assuming that the level of glucose is low, a mutation in the repressor associated with the lac operon of E. coli which prevents binding of the repressor to lactose should result in: *(1 pt)*

a. constitutive expression of the lac operon genes
b. lack of expression or reduced expression of the lac operon genes under all circumstances
c. expression of the genes only when lactose is present
d. expression of the genes only when lactose is absent

45. Positional cloning refers to *(1 pt)*

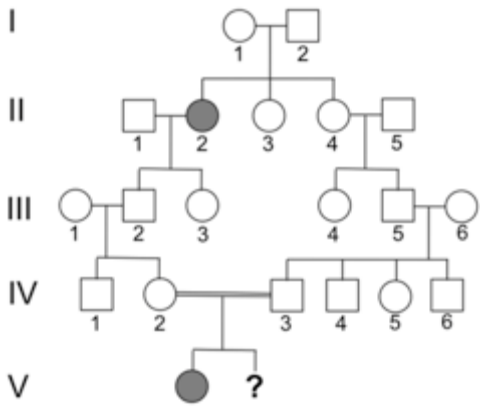
a. using a selection procedure to clone a cDNA
b. cloning a portion of a gene using PCR
c. isolating a gene by PCR using primers from another species

d. isolating a gene from a specific tissue in which it is being expressed
e. mapping a gene to a chromosomal region and then identifying and cloning a genomic copy of the gene from the region

46. Large quantities of useful products can be produced through genetic engineering involving (select all that apply) *(2 pts- all or nothing)*
a. bacteria containing recombinant plasmids
b. yeast carrying foreign genes
c. transgenic plants
d. mammals producing substances in their milk

47. QTL analysis is used to *(1 pt)*
a. identify RNA polymerase binding sites
b. map genes in bacterial viruses
c. determine which genes are expressed at a developmental stage
d. identify chromosome regions associated with a complex trait in a genetic cross
e. determine the most rapidly-evolving parts of genes

48. Alkaptonuria (aka black urine disease) is a rare inherited genetic disorder that causes the urine of affected individuals to turn brown or black after prolonged exposure to air. It results from a defect in tyrosine metabolism. Affected individuals show the trait from birth. The pedigree to the right shows an extended family including two individuals affected by the trait. Assume those who marry in don't have the mutation.



a. What mode of inheritance does alkaptonuria show? *(2 pts)*
autosomal recessive
b. Obligate carriers are individuals who must carry the mutation that produces the trait. Please list the obligate carriers in the pedigree at right. *(3 pts- all or nothing)*
I-1, I-2, II-4, III-2, III-3, III-5, IV-2, IV-3
c. What is the probability that II-3 carries the mutation (i.e. is heterozygous)? *(2 pts)*
⅔
d. What is the probability that IV-2 and IV-3's next child will be a boy who is affected by the disease? *(2 pts)*
½ X ½ X ½ = 1/8