

Your name: _____

1. (15 points) Cytosine deamination produces what base? What causes cytosine deamination (X-rays? uv light? alkylating agents? something else)? How are deaminated cytosines in DNA repaired? What enzymes are involved? Would a similar mechanism work if the genome were RNA? Why or why not?

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2. (10 points) Define microsatellite markers. Explain how they are normally scored, for what purpose(s) they are normally used and their advantages and disadvantages (relative to SNPs) as genetic markers.

3. (10 points) Define LTR. What sort of genetic element has LTRs? What function(s) do they serve?

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(3 points each for questions 4-18). In each of the following there are two or more statements. One is true (generally, it is taken directly from your textbook or another reliable source) and the others have been modified so as to be untrue, misleading, false, wrong, unlikely or bogus. Circle, check or otherwise designate the correct statement. Ambiguous marks (checking both, placing a mark between the two statements, etc.) will be considered wrong.

4.
 - a) A typical bacterial genome is a single **linear** molecule.
 - b) A typical bacterial genome is a single **circular** molecule.
5.
 - a) In *E. coli*, *hisA* and *hisB* are two **genes**.
 - b) In *E. coli*, *hisA* and *hisB* are two **alleles** of the same gene.
6.
 - a) The bacterial origin of DNA replication "fires" only **after** the prior round of DNA replication is complete.
 - b) The bacterial origin of DNA replication can "fire" **before** the prior round of DNA replication is complete.
7.
 - a) A single base mismatch in an allele-specific primer used in **PCR amplification** will provide maximal discrimination when located **at the center** of the primer.
 - b) A single base mismatch in an allele-specific primer used in **PCR amplification** will provide maximal discrimination when located **at the 3' end** of the primer.
8.
 - a) A single base mismatch in an allele-specific oligonucleotide used in **hybridization** will provide maximal discrimination when located **in the center** of the oligonucleotide.
 - b) A single base mismatch in an allele-specific oligonucleotide used in **hybridization** will provide maximal discrimination (the greatest possible difference in T_m) when located **at the 3' end** of the oligonucleotide.
9.
 - a) A comparison of two haploid human genomes would reveal about **3,000** allelic differences.
 - b) A comparison of two haploid human genomes would reveal about **100,000** allelic differences.
 - c) A comparison of two haploid human genomes would reveal about **3 million** allelic differences.
10.
 - a) New methods for the rapid and inexpensive sequencing of entire genomes are **unlikely to emerge** because of natural limits on DNA sequencing technology based on physical laws.
 - b) New methods for the rapid and inexpensive sequencing of entire genomes are under active development and **dramatic improvements in technology have taken place in the past year and continue to take place**.
11.
 - a) The **shotgun sequencing** protocol is a reasonable and commonly used approach to sequence whole genomes.
 - b) The **primer-walking** protocol is a reasonable and commonly used approach to sequence whole genomes.

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12. a) **Most** of the human genome (about **80%**) is conserved with non-primate mammalian genomes (such as the dog).
 b) Only a **small** fraction of the human genome (about **5%**) is conserved with non-primate mammalian genomes (such as the dog).
13. a) Of that fraction of the human genome that is conserved with non-primate mammalian genomes (such as the dog), most (about 4/5) is **noncoding**.
 b) Of that fraction of the human genome that is conserved with non-primate mammalian genomes (such as the dog), most (about 4/5) **codes for protein**.
14. a) A target site duplication is a duplication of sequence **present at the target site prior to the insertion** of a transposable element. This duplication is caused by insertion of the element and the two duplicates flank the inserted element.
 b) A "target site duplication" occurs whenever a transposable element inserts into a new site without being lost from the original site. **The duplication refers to the element itself**.
15. a) The human alpha globin gene and the mouse beta globin gene are **orthologs**.
 b) The human alpha globin gene and the mouse beta globin gene are **paralogs**.
16. a) The human alpha globin gene and the mouse beta globin gene are **homologs**.
 b) The human alpha globin gene and the mouse beta globin gene are **not homologs**.
17. a) The basic motif DNA-binding domain in the Myc-Max system functions only in **dimeric** proteins.
 b) The basic motif DNA-binding domain in the Myc-Max system allows either proteins to bind as a **monomer**.
18. a) RNA polymerase **I** transcribes protein-coding genes and miRNAs.
 b) RNA polymerase **II** transcribes protein-coding genes and miRNAs.
 c) RNA polymerase **III** transcribes protein-coding genes and miRNAs.

19. (6 points) You have a piece of DNA that includes the sequence:

5' GATGAGGATGAGGAGAAGTACCGCCGCCGCTGCGCATCACAATATGTTTCAGT 3'

To amplify this DNA by PCR you would use a pair of primers containing which **two** of the following eight primers (you must get both primers right to get any credit -- circle **two** letters):

- a) 5' - C T A C T C C T A C T C C T C T T C - 3'
 b) 5' - G A T G A G G A T G A G G A G A A G - 3'
 c) 5' - C T T C T C C T C A T C C T C A T C - 3'
 d) 5' - G A A G A G G A G T A G G A G T A G - 3'
 e) 5' - A C T G A A C A T A T T G T G A T G - 3'
 f) 5' - T G A C T T G T A T A A C A C T A C - 3'
 g) 5' - G T A G T G T T A T A C A A G T C A - 3'
 h) 5' - C A T C A C A A T A T G T T C A G T - 3'

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Each of the following statements applies to just one of the following three distinct types of cell: **a)** F⁺, **b)** F' or **c)** Hfr. Indicate which one by writing **a**, **b** or **c**. One cell type might be the answer for multiple questions. (2 points each)

20. These cells are used in interrupted mating experiments that can be used to map bacterial genes, generating a genetic map measured in minutes. _____

21. These cells contain the F plasmid, an extrachromosomal circle of double-stranded DNA that is approximately 100 kb. in length. _____

22. These cells contain the F plasmid integrated into a single site on the bacterial chromosome. _____

23. These cells transfer a few bacterial genes very efficiently, generating stable partial diploids. _____

24. (6 points) You isolate DNA from a plant and purify organellar DNA (DNA from the chloroplast and mitochondria, free of nuclear DNA). The mixture has equal amounts by mass of chloroplast DNA and mitochondrial DNA (two milligrams of each). You take a sample of the DNA, shear it by sonication and heat the mixture to denature it. You measure hybridization rate as the time required for half of the DNA to become double-stranded (not the initial reaction rate). You observe that the mitochondrial DNA hybridizes much faster; it takes only 1/4 as long to hybridize.

Which is likely to be the case?

- ___ **a)** The mitochondrial genome is 4 times the size of the chloroplast genome.
- ___ **b)** The mitochondrial genome is 2 times the size of the chloroplast genome.
- ___ **c)** The mitochondrial genome is 1/2 the size of the chloroplast genome.
- ___ **d)** The mitochondrial genome is 1/4 the size of the chloroplast genome.
- ___ **e)** You cannot conclude anything about the size of the genomes from this experiment.