

**BOT/MBIO/ZOO 1005 – Concepts in Biology**

Midterm 2 (100 points) -- Form 1 (Blue)

October 18, 2007

**Part I: Multiple choice, true-false, and matching (50 points)**

**True-false (mark T for true, F for false):**

1. A codon and an anticodon consist of the same number of nucleotides.
2. A good definition of a dominant allele is “the one that is most common in the population.”
3. Genetic mutations are the ultimate source of all new alleles.
4. From a medical standpoint, the most useful stem cells are likely to be the ones that already have some DNA that is permanently turned “off.”

**Multiple choice / matching (unless otherwise noted, choose the single best answer)**

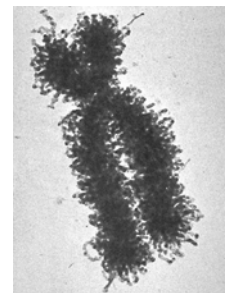
5. A cell on your head produces hair, which is largely made of a protein called keratin. How does the cell do it?
  - a. First the DNA replicates, then the keratin gene is translated, then it is transcribed.
  - b. First the DNA replicates, then it mutates, then the keratin gene is transcribed, then it is translated.
  - c. First the keratin gene is transcribed, then it is translated.
  - d. First the keratin gene is translated, then the DNA replicates, then the mRNA is transcribed.
  - e. First all of the cell’s DNA is transcribed, then the RNA is translated.
6. Which base(s) is/are complementary to the base adenine (A)? **(Enter ALL that apply; there may be one or more correct answers).**
  - a. adenine
  - b. cytosine
  - c. guanine
  - d. thymine
  - e. uracil
7. A mutation that results in the deletion of a single nucleotide from a gene might:
  - a. produce a different sequence of amino acids from the point of the mutation onward.
  - b. produce a "garbage gene," as the entire amino acid sequence after the mutation may be devastated.
  - c. result in a protein shorter than that produced without the mutation.
  - d. result in a protein longer than that produced without the mutation.
  - e. all of the above
8. HIV, the virus that causes AIDS, infects only cells with the CD4 receptor protein in their outer cell membranes. Why do some cells in the human body have the CD4 protein while others do not?
  - a. All cells have recipes for all proteins, but the CD4 gene is active only in certain cells.
  - b. Cells with CD4 protein have mutated.
  - c. The CD4 gene is missing from most cells.
  - d. Some cells are haploid and some are diploid.
  - e. Cells with CD4 proteins are gametes.
9. I recently read in a magazine article that “you replace about 1% of your cells every day.” What type of cell division is involved in most (if not all) of this constant renewal of your body?
  - a. binary fission
  - b. meiosis
  - c. mitosis
  - d. nondisjunction
  - e. sexual
10. A fish called an Amazon molly reproduces asexually. What can you say about this fish?
  - a. it probably has no cells that undergo meiosis
  - b. it probably has no cells that undergo mitosis
  - c. populations of these fish probably have more genetic variability than sexually reproducing fish
11. Arrange the following items in order of size, from smallest to largest:  
**(1) chromosome; (2) cell; (3) gene; (4) nucleotide; (5) nucleus; (6) codon.**  
That is, if you think the order is 123456 then enter “123456” into your clicker and hit enter.

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The Nobel Prize in medicine was recently awarded to a group of scientists (Mario Capecchi, Oliver Smithies, and Martin Evans) who discovered how to “knock out,” or inactivate, specific genes in mice.

12. Which of the following would knock out the expression of just one gene in a cell without affecting all of the other genes in the cell?
- Use a nucleic-acid-degrading enzyme to destroy all of the DNA in the cell.
  - Use a protein-degrading enzyme to destroy all of the protein in the cell.
  - Insert into the cell a piece of RNA that is complementary to the mRNA corresponding to the gene you want to knock out.
  - Inactivate the RNA polymerase enzyme so that it is unable to do its job.
  - Inactivate the DNA polymerase enzyme so that it is unable to do its job.
13. The scientists used the gene knockout technique to inactivate a gene encoding a particular membrane transport protein – in effect, they gave the mice cystic fibrosis. Cystic fibrosis is a disease caused by a recessive allele. You can conclude that:
- If a male with cystic fibrosis has children with a healthy woman, all of their children will inherit at least one copy of the disease-causing allele.
  - If a heterozygous male has children with a heterozygous woman, each child has a 25% chance of inheriting two copies of the healthy allele.
  - If one member of an *identical* twin pair has cystic fibrosis, the other twin will definitely have the same genotype and phenotype.
  - If one member of a *fraternal* twin pair has cystic fibrosis, the other twin will definitely have the same genotype and phenotype.
  - a, b, and c are all true.

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14. The analogy that best describes the relationship between a gene and a chromosome is:
- Genes are to chromosomes as a buckle is to a belt (because genes attach the two ends of a chromosome to each other)
  - A gene is to a chromosome as the wrist is to the arm (because the wrist is a part of the arm)
  - Genes are to chromosome as a cup is to coffee (because coffee is poured into a cup)
  - A gene is to a chromosome as a tablecloth is to a table (because genes sit on top of chromosomes)
  - A gene is to a chromosome as a staple is to a stack of papers (because genes attach chromosomes to each other)

15. The figure at right shows:
- |                                     |                      |
|-------------------------------------|----------------------|
| a. a pair of homologous chromosomes | d. two genes         |
| b. two identical DNA molecules      | e. a pair of gametes |
| c. two alleles                      |                      |



16. Which of the following statements is FALSE?
- Human height, skin color, and eye color are traits that are each determined by multiple genes.
  - Mendel used test crosses with homozygous recessive pea plants to determine the genotype of pea plants with a dominant phenotype.
  - A human zygote has twice as much genetic information as a human sperm cell.
  - It is possible for two people with blood type AB to have children with blood type O.
  - Plant cells, fungal cells, bacterial cells, and animal cells all can be infected by viruses.

17. DNA is a type of \_\_\_\_\_. (Enter ALL that apply into your clicker; there may be one or more correct answers)
- |                     |           |            |              |         |
|---------------------|-----------|------------|--------------|---------|
| a. organic molecule | b. enzyme | c. protein | d. organelle | e. cell |
|---------------------|-----------|------------|--------------|---------|

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Matching.

- a. transcription    b. translation    c. crossing over    d. nondisjunction    e. spindle formation

18. Event that occurs (or may occur) between prophase and cytokinesis in both mitosis and meiosis.  
19. Event that does the most to increase genetic variability in sexually reproducing organisms.

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20. In the figure at right, how many amino acids will be translated from the mRNA?

- a. 14    b. 24    c. 48    d. 7    e. 4

21. Which of the following statements is FALSE?

- a. DNA replication occurs during interphase of both mitosis and meiosis.  
b. Both DNA replication and transcription require complementary base-pairing between nucleotides.  
c. Both DNA replication and protein synthesis occur in both prokaryotic and eukaryotic cells.  
d. In humans, the zygote undergoes meiosis immediately after fertilization.  
e. Eukaryotic cells, but not prokaryotic cells, require a spindle to move chromosomes during cell division.

22. Which of the following statements is FALSE?

- a. Cancer is more likely to be a disorder of mitosis than a disorder of meiosis.  
b. Chemicals that mutate DNA can cause cancer if they damage genes encoding proteins that control the rate at which cells divide.  
c. In a benign tumor, cancerous cells spread from one type of tissue in the body to another.  
d. The term "cancer" includes many possible causes and many possible origins in the body.  
e. The most common cancer treatments are surgery, radiation, and chemotherapy.

23. Transfer RNA (tRNA) is important in translation because:

- a. it can bind to promoter DNA  
b. it can bind both amino acids and RNA  
c. ribosomes can attach to both tRNA and DNA at the same time  
d. it is the only molecule involved in DNA replication that occurs in the nucleus  
e. none of the above is true

24. A human cell is dividing, and the resulting cells each contain 23 chromosomes. This is a description of \_\_\_\_\_ cells formed by the process of \_\_\_\_\_.

- a. body DNA ... replication                      d. sperm ... meiosis  
b. egg ... mitosis                                      e. homologous ... crossing over  
c. zygote ... meiosis

25. Which of the following is NOT a correctly matched pair?

- a. Prophase I of meiosis – crossing over occurs                      d. Anaphase of mitosis – centromeres split  
b. Interphase – RNA polymerase is active in the cell                      e. Cytokinesis – fertilization occurs  
c. Interphase – DNA polymerase is active in the cell

26. Important! What color is your test form? (0 points).    a. blue                      b. green



*NOTE: If you noticed anything at all unusual happening to your clicker during the exam, please describe what happened:*

MC _____ / 50
SA _____ / 50
Total = _____ / 100

**BOT/MBIO/ZOO 1005 – Concepts in Biology**  
 Midterm 2 (100 points) -- Form 1 (Blue)  
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*On my honor, I affirm that I have neither given nor received inappropriate aid in the completion of this exam.*

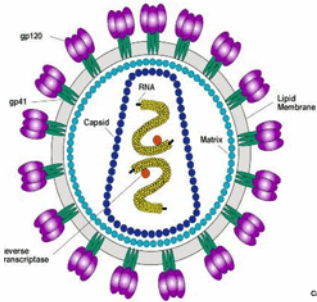
(signed) \_\_\_\_\_

**Part II: Short answer (50 points)**

Score (this page) \_\_\_\_\_ / 16 points

1. I found an article in the newspaper about a woman who runs a sperm bank. The reporter stated that “sperm that have two X chromosomes are destined to create a girl baby” and that “XY sperm create a boy.” What is wrong with how the article describes the inheritance of sex? (3 points)

2. a. The virus pictured at right contains an enzyme called reverse transcriptase. What is the specific name of the virus? (1 point)



b. What specific type of human cell does the virus infect? (1 point)

c. Name one way a person can acquire this virus (1 point).

d. What does the reverse transcriptase do once the virus enters the cell? (2 points)

e. Why don't antibiotics cure a cold, influenza, or any other disease caused by viruses? (2 points)

3. a. In class, Ashley mentioned a tabloid article with the headline, “Girl gives birth to her own mother.” While this exact scenario is not possible, it is theoretically possible for a female to give birth to a CLONE of her mother. What steps would this involve? (4 points)

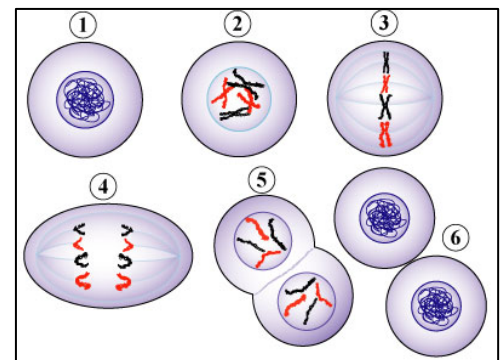
b. Would it be possible for the female to give birth to a clone of her FATHER? Why or why not? (2 points)

4. [Use the dictionary of the genetic code on the back of the page to help answer this question]. A portion of a gene has the sequence:

**A G G C T T C G C T A A A G T**

- a. What is the function of a gene in a cell? (2 points) \_\_\_\_\_
- b. What type of molecule is produced in the *transcription* of the above DNA? (1 point) \_\_\_\_\_
- c. What is the *sequence* of the molecule produced in (b)? (2 points)
- d. What is the amino acid sequence that corresponds to your answer to (c)? (2 points)
- e. Propose a mutation that would cause the first amino acid in the sequence to be replaced by a different amino acid. Describe the mutation, and name the new amino acid (3 points).
- f. A mutation such as the one you proposed in (e) is usually harmful to an organism, but it is also possible for a mutation to benefit an organism. Explain how this is possible (2 points).
- g. Cynthia Kenyon is the scientist who was mutating the DNA of nematode worms in the film clip we saw in class. She was causing the genetic mutations in hopes of learning about aging. How can creating a nonfunctioning allele of a gene help us learn how a gene normally works? (2 points)

5. a. Look at the diagram at the right. What type of cell division is being depicted? (2 points)
- b. How many chromosomes are in every DIPLOID cell of this species? (2 points)
- c. How many chromosomes are in a sperm cell of this species? (1 point)
- d. Give an example of a place in your body where this type of cell division would occur (1 point).



6. A strawberry plant can clone itself, but it can also reproduce sexually. Why would it make sense to reproduce asexually while conditions are favorable but sexually when conditions get tough? (4 pts)
7. Marfan syndrome is a serious genetic disorder caused by a dominant allele on chromosome 15. If one parent does not carry the allele and the other is heterozygous for it, what is the chance that any child will inherit the disease? Use a Punnett square to support your answer (3 points).
8. Snapdragon plants with red flowers are homozygous for allele  $R^1$ . White-flowering snapdragons are homozygous for allele  $R^2$ . Heterozygous plants have pink flowers. What phenotypes should appear among the offspring of a cross between a pink-flowered and a white-flowered snapdragon plant? Use a Punnett square to support your answer (3 points).
9. Hemophilia A is a blood clotting disorder; the faulty gene is located on the X chromosome. A woman has a brother with hemophilia A, but their parents are healthy. (a) What is the chance that she has inherited the hemophilia allele? (b) If she did inherit the allele, what is the chance that she will conceive a son with hemophilia? Use Punnett squares to support your answers (4 points).
11. **EXTRA CREDIT**: A family has an X-linked dominant form of a disorder in which the body is excessively hairy. Males are more severely affected than females. Moreover, the women in the family often have asymmetrical, hairy patches on their bodies. How does X chromosome inactivation explain this observation? (2 points)

## Dictionary of the Genetic Code

		Second letter					
		U	C	A	G		
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G	
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G	
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G	
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G	

Third letter