Part I: Short answer (25 points)

1. a. Below is a tiny excerpt of a gene. What sequence of amino acids corresponds to the gene? (2 pts)
   
   A T G C A G A G G T C G C C T

   b. What would happen if the first three letters of the gene above were A T T instead of A T G? (2 pts)

   c. Mutations in a gene called \textit{BRCA1} are associated with breast cancer. What is cancer? (2 pts)

   d. Explain the relationship between gene function and cancer (4 pts).

2. a. The Ebola virus has been in the news a lot lately. List the steps that are common to all viral infections (not just Ebola), from initial contact to the release of new viruses (5 pts).

   b. Like HIV, the Ebola virus is surrounded by an envelope, which is very similar in structure (but not function) to a cell membrane. How does HIV acquire its envelope, and what does this have to do with the death of the host cell? (2 pts)

3. Rank these in order from smallest (1) to largest (4), then explain the relationships among them (5 pts).
   
   ____ chromosome   ____ gamete   ____ nucleotide   ____ gene

4. Hemophilia is a blood clotting disorder that is caused by a recessive allele on the X chromosome. If a woman has hemophilia, does that mean that both of her parents must have hemophilia as well? Explain your answer in words; include one or more Punnett squares if necessary. (3 pts)
Part II: 75 points (38 questions; each question is worth 2 points, except the last one)

True-false (mark A for true, B for false):
1. The cells that undergo meiosis are diploid.
2. After the chromosomes shown at right replicate, each will consist of four homologous chromatids.
3. In humans, every gamete that carries an X chromosome is an egg.
4. Sexual reproduction, which requires two parents, generates genetic variability that is most adaptive in an environment that changes frequently.

Multiple choice / matching:
5. Consider the Punnett square at right, in which the genotypes of the two parents are hidden. What should go in the blanks?
   a. One parent $I^A I^B$, one parent $ii$
   b. One parent $I^A$, one parent $I^B$
   c. This Punnett square is not possible; no combination of two parents can produce those offspring.

6. Reptilobirds (from lab) have 6 chromosomes in every diploid cell. Without considering crossing over, how many genetically different gametes can one bird make?
   a. $2^6 = 64$
   b. $2^3 = 8$
   c. $6^2 = 36$
   d. $3^3 = 9$

7. How many sperm and egg cells are required to make identical twins, conjoined twins, and fraternal triplets?
   a. Identical twins: 1 sperm, 1 egg; conjoined twins: 1 sperm, 1 egg; fraternal triplets: 3 sperm, 3 eggs
   b. Identical twins: 2 sperm, 1 egg; conjoined twins: 1 sperm, 1 egg; fraternal triplets: 3 sperm, 1 egg
   c. Identical twins: 1 sperm, 2 eggs; conjoined twins: 1 sperm, 1 egg; fraternal triplets: 1 sperm, 3 eggs
   d. Identical twins: 2 sperm, 2 eggs; conjoined twins: 2 sperm, 2 eggs; fraternal triplets: 3 sperm, 3 eggs

8. The DNA technology in which a plant receives genes that originally came from bacteria is called:
   a. stem cell therapy
   b. stem cell regeneration
   c. transgenic technology
   d. gene therapy
   e. somatic cell nuclear transfer

9. Which of the following statements about DNA technology is false?
   a. Once we understand how to control stem cell development, we may be able to grow a new human heart from a person’s own cells.
   b. Cloning occurs naturally in many plants and animals, but it does not occur naturally in mammals.
   c. The main problem with gene therapy today is that it’s hard to safely deliver new genes into cells that need them.
   d. If I wanted to make an adult clone of myself, I’d have to do somatic cell nuclear transfer and then wait for the child to grow up.
   e. Genetically modified plants are common in the food supply because they are free of ethical problems and of harmful effects on the environment.

10. How many different three-codon sequences could encode the amino acid sequence Phe-Val-Ala? (Hint: Use the genetic code)
    a. 32
    b. 10
    c. 64
    d. 3
    e. 8
11. People who have AIDS get opportunistic infections because
   a. When HIV enters the body, it mutates into the bacteria that cause infections such as tuberculosis.
   b. The drugs used to treat HIV cause the deadly infections.
   c. Being susceptible to HIV means your immune cells are already weak.
   d. HIV weakens the immune system and makes it difficult to fight diseases.
   e. All of the above are true.

12. Which type of mutation can cause a stop codon to appear in the middle of a gene?
   a. Insertion of 1 nucleotide
   b. Deletion of 1 nucleotide
   c. Substitution of 1 nucleotide
   d. Deletion of 3 nucleotides
   e. Any of the above

For the next two questions, mark your scantron as follows (answers may be used more than once or not at all):

- Mark “a” if the first item is larger than the second
- Mark “b” if the first item is smaller than the second
- Mark “c” if the two items are the same size

13. Amount of RNA polymerase in the nucleus … amount of RNA polymerase in the cytoplasm
14. Number of genes in the zygote that became you … number of genes in the specialized cells that make up your eyeball

15. Which stage of cell division is incorrectly matched with an event that occurs during that stage?
   a. anaphase I of meiosis – sister chromatids move away from each other
   b. prophase I of meiosis – crossing over occurs
   c. interphase of mitosis – proteins copy the DNA inside a cell
   d. prophase of mitosis – chromosomes condense and become visible
   e. metaphase of mitosis – chromosomes align at the cell’s “equator”

16. The left half of the chromosome pictured at right was inherited from one parent, and the right half of the chromosome was inherited from the other parent.
   a. That’s true.
   b. That’s true, but only for males.
   c. That’s true, but only for the X chromosome.
   d. That’s true, unless nondisjunction happened.
   e. That’s false.

17. Rett syndrome affects one in every 10,000 to 15,000 female births, and its symptoms vary from mild to severe. It is caused by a mutation in a gene carried on the X chromosome. Boys with the mutated gene die shortly after birth, but girls with the mutated gene typically survive. Why?
   a. Because female infants generally have a stronger will to survive than do male infants.
   b. Because only boys inherit the X chromosome.
   c. Because in boys, the Y chromosome cancels out the genes that are on the X chromosome.
   d. Because girls have two different X chromosomes, one of which is turned “off” in every cell.
   e. Because eggs that will be girls have other genes that make up for the faulty one.

18. Chris is infected with HIV. To keep from acquiring the HIV infection, Chris’s roommates should avoid contact with Chris’s:
   a. fork and spoon.  b. blood.  c. bathroom.  d. sweat.  e. All of the above.
19. The graph at right is typical of a trait that involves:
   a. one phenotype as the product of multiple genes.
   b. inheritance of one gene on the Y chromosome.
   c. inheritance of one gene through the female parent only.
   d. a typical Mendelian pattern of inheritance.

20. Normal Regional Hospital has announced that it can test for alleles of genes BRCA1 (chromosome 17) and BRCA2 (chromosome 13), both of which are strongly associated with breast and ovarian cancers. If man inherits one faulty allele for each gene, what is the chance that a sperm cell contains faulty alleles for both genes?
   a. 100%, since all sperm contain all of a man’s chromosomes.
   b. 50%, since he has one faulty allele for each gene.
   c. 25%, since each sperm has a 50% chance of having the faulty allele for BRCA1 and a separate 50% chance of having the faulty allele for BRCA2.
   d. 0%, since sperm cannot pass on alleles related to breast or ovarian cancer.

21. The image at right shows a cell being infected with HIV. Which of the following statements about the image at right is false?
   a. HIV includes RNA, a protein coat, and an envelope, among other molecules.
   b. The host cell being infected is important for the functioning of the immune system.
   c. “RT” stands for “reverse transcriptase,” and it makes a DNA copy of the RNA entering the cell.
   d. The virus supplies the ATP, nucleotides, and amino acids required to produce new viruses.
   e. In real life, more than one new virus would be assembled.

22. The cell at right is:
   a. haploid because each chromosome consists of two chromatids.
   b. diploid because each chromosome consists of two chromatids.
   c. haploid because it contains two sets of chromosomes.
   d. diploid because it contains two sets of chromosomes.

23. In humans, sickle cell anemia is caused by a mutation of a gene that encodes an important blood protein. The allele for the normal protein (S) is dominant to the one associated with the disorder (s). The gametes produced by an individual who suffers from sickle cell anemia would carry:
   a. All SS        b. All ss        c. 50% S, 50% s        d. All S        e. All s
24. Why can’t we cure HIV yet, even though it’s been around for decades?
   a. Because HIV is not made of the same types of organic molecules as we are.
   b. Because HIV keeps mutating.
   c. Because HIV won’t infect the cells of lab animals used to test drugs.
   d. Because HIV has ribosomes that aren’t affected by most antibiotics.
   e. Both b and c are contributing factors.

25. In the image at right, which cells are haploid, and which are diploid?
   a. Haploid: 1, 4, 5; Diploid: 2, 3
   b. Haploid: 1, 2, 3; Diploid: 4, 5
   c. Diploid: 1, 2, 3; Haploid: 4, 5
   d. Haploid: 2, 3, 4; Diploid: 1, 5
   e. Diploid: 1, 4, 5; Haploid: 2, 3

26. OU’s Homecoming opponent this weekend is Kansas State. Their mascot is a wildcat. Suppose wildcats come in three colors and that the trait is controlled by a single gene with incomplete dominance. The genotypes and phenotypes are as follows: BB = blue; Bb = purple; bb = red. What are the phenotypes of the offspring if a blue wildcat mates with a red one?
   a. 100% blue
   b. 100% red
   c. 100% purple
   d. 25% blue, 50% purple, 25% red
   e. 50% blue, 50% red

27. In the chicken wing microbiology lab, you did something like what’s shown at right. Why did you have to do that?
   a. To activate the bacteria.
   b. To feed the bacteria.
   c. To help the bacteria get rid of harmful viruses, so they’d grow on agar.
   d. To make sure you’d get a “countable” number of bacteria on at least some of your plates.
   e. As a control for the wings you treated.

28. A human red blood cell is unusual because as the cell matures, it actually discards its nucleus (including its DNA) and most other organelles, presumably to make more room for oxygen-toting hemoglobin. Without DNA and a nucleus, it is reasonable to conclude that many items in the following list are also absent. How many of the items found in other cells are unnecessary in a mature red blood cell?
   tRNA  Water  Nitrogen atoms
   DNA polymerase  Cell membrane  Proteins required for meiosis
   RNA polymerase  Carbon atoms  Proteins required for mitosis
   a. Six  b. Five  c. Four  d. Three  e. Two
29. Ultimately, cancer is caused by:
   a. eating too much sugar.
   b. getting too little exercise.
   c. damage to genes.
   d. living near other people with cancer.
   e. having parents that had cancer.

30. Binary fission and mitosis are:
   a. similar in that both occur in eukaryotic cells.
   b. similar in that both are forms of sexual reproduction.
   c. different in that mitosis is preceded by DNA replication, but binary fission is not.
   d. different in that binary fission occurs in cells with many chromosomes, whereas mitosis occurs in cells with just one chromosome.
   e. None of the above is true.

31. What was the effect of crossing over in the “reptilobird” portion of the Fun with Genetics lab?
   a. It helped each zygote grow into a hatchling.
   b. It eliminated harmful alleles that the birds had acquired by mutations.
   c. It determined which sperm cells fertilized which egg cells.
   d. It increased the variation among the offspring of the four parent birds.

32. What is going on in the image at right?
   a. The cell is transcribing two genes at once.
   b. The cell is switching from homozygous to heterozygous.
   c. The cell is copying its DNA.
   d. The cell is making proteins.
   e. The cell is carrying amino acids to the ribosomes.

33. In the Bacteria and Disease lab, you saw “zones of inhibition” that revealed which bacteria were killed by which antibiotics. Tetracycline is an antibiotic that blocks a bacterial cell’s ribosomes. This action kills the bacterial cell because ribosomes participate directly in:
   a. DNA replication.
   b. transcribing DNA to mRNA.
   c. the assembly of amino acids into proteins.
   d. binary fission.
   e. ATP production.

34. Which of the following binds to tRNA by complementary base pairing?
   a. DNA
   b. DNA polymerase enzyme
   c. The mitotic spindle
   d. RNA polymerase enzyme
   e. mRNA

35. One story that has recently been in the news is about a woman who was born without a uterus and therefore had a donated uterus transplanted into her own body. Doctors extracted an egg from her ovary, fertilized it with her husband’s sperm in the laboratory, then implanted the resulting embryo into the uterus. The baby (a boy) was born recently. The baby has:
   a. Equal numbers of chromosomes from the mother, the father, and the donor of the uterus.
   b. Most chromosomes from the mother or father, but a small number of chromosomes from the donor of the uterus.
   c. Half of its chromosomes from its mother and half from its father (none from the uterus donor).
   d. Since the baby is a boy, all of its chromosomes come from the father (none from the mother or the donor of the uterus).
   e. Since the baby is a boy, both of its sex chromosomes come from the father, but all the rest of the chromosomes come from the mother.
36. SB sent me an article about an unusual blue-skinned family from Kentucky. Suppose two parents have normal (not blue) skin. Given what you know about inheritance, what would have to be the genotypes of the parents for each of the children to have a 25% chance of having blue skin?
   a. Both heterozygous (assuming the disorder is dominant)
   b. Both heterozygous (assuming the disorder is recessive)
   c. Both homozygous recessive
   d. Both homozygous dominant
   e. One heterozygous, one homozygous dominant

37. The cell at right is undergoing:
   a. metaphase of mitosis
   b. metaphase I of meiosis
   c. metaphase II of meiosis
   d. a, b, and c are all possible

38. What color is your test form?
   a. Blue
   b. Green