Part I: Short answer (25 points)

1. a. Propose a DNA sequence that would encode the following amino acid sequence. Note that there may be more than one way to answer this problem correctly. *Show your work for full credit* (4 pts).
   Met -- Glu -- Trp -- Tyr -- Phe

   b. How might you mutate your DNA sequence so that the chain consists of only two amino acids instead of five? Explain your answer. (3 points)

2. Describe two similarities and two differences between HIV and a human cell (8 points).

3. a. Suppose that “excess body hair” is controlled by a single gene on the X chromosome. A woman who is heterozygous for this condition has children with a man who is unaffected. What are the possible genotypes of their male and female children? *Show your work for full credit* (4 points).

   b. Using what you know about X chromosome inactivation, explain why women who are heterozygous for this condition might vary in the amount of body hair they produce (2 points).

4. Cells called neuroglia outnumber cells called neurons in the nervous system by about 10 to 1. In addition, neuroglia retain the ability to divide, unlike most neurons. How do these two observations relate to the fact that most brain cancers begin in glial cells? Use the words *DNA replication*, *mutation*, *protein*, and *mitosis* in your answer (4 points).
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. A human diploid cell contains 23 pairs of chromosomes, with one member of each pair coming from each parent.
2. It is possible for a mutation to increase an organism’s reproductive success (relative to organisms that lack the mutation).
3. An active person who lives a healthy life can reduce his or her chance of getting cancer to zero.
4. Two parents who are symptomless carriers for cystic fibrosis have a 50% chance of having a child with cystic fibrosis.

Multiple choice / matching:
5. Are the genes in the cell nucleus shown at right turned “on”?
   a. Yes, all genes in a cell are turned on at all times.
   b. Yes, but only if the cell is from an early embryo.
   c. No, the cell nucleus shown at right doesn’t include any genes.
   d. No, the genes are not accessible at this moment.
6. In what way are the skin cells on your scalp different from the skin cells on the palm of your hand?
   a. Scalp cells have different chromosomes from hand cells.
   b. Scalp cells have the same chromosomes as hand cells, but the genes are different.
   c. Scalp cells have the same genes as hand cells, but the nucleotides are different.
   d. Scalp cells have the same nucleotides as hand cells, but the two cell types produce different proteins.
   e. Scalp cells make the same proteins as hand cells, but the two cell types use different amino acids.
7. What might cause a protein to not function correctly?
   a. Acid or heat might denature it, ruining its shape.
   b. A tRNA molecule might bring the wrong ribosome to the amino acid, ruining the protein’s shape.
   c. A mutation might cause a gene to encode the wrong amino acid, ruining the protein’s shape.
   d. All of the above are correct.
   e. Only a and c are correct.
8. What is the best description of DNA’s role in the life of a cell?
   a. It picks up the mess after the work is finished.
   b. It acts as an enzyme, physically assembling the raw materials that the cell requires to live.
   c. It is a specialized protein that knows how to read the cell’s genes.
   d. It is the “library” that contains all of the information needed to keep the cell alive.
   e. It is the place where the ATP is both produced and consumed.
9. Anti-HIV drugs typically target:
   a. proteins in HIV’s cell membrane.
   b. ribosomes inside the host cell.
   c. mitochondria inside the HIV particle.
   d. any HIV protein that host cells lack.
   e. any host cell protein that HIV lacks.
10. Cells produce enzymes that repair DNA that has been damaged by ultraviolet radiation and other mutagens. Some people’s cells produce defective versions of these enzymes. Such people have _______ risk for cancer when compared to the general public.
    a. a higher
    b. the same
    c. a lower
11. When in the cell cycle is transcription most likely to happen?
   a. telophase    b. cytokinesis    c. interphase    d. prophase    e. metaphase

For the next three 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

12. Number of chromosomes in an egg cell … number of genes in an egg cell
13. Number of ribosomes bound to the average DNA molecule … number of ribosomes bound to the average mRNA molecule
14. Number of cells produced in meiosis … number of cells produced in binary fission

15. What happens in transcription?
   a. The cell sorts its chromosomes in order of size.
   b. The cell copies all of its DNA, just before it divides.
   c. The cell copies all of its proteins, just before it divides.
   d. The cell creates an RNA copy of one gene.
   e. The cell uses dehydration synthesis to connect amino acids together to form a protein.

16. The alleles associated with cystic fibrosis and sickle cell trait both:
   a. start as problems with RNA polymerase, which transcribes the genes incorrectly.
   b. involve proteins embedded in the cell membrane.
   c. encode proteins that do not do their job.
   d. are caused by a nondisjunction event that occurs during meiosis.
   e. illustrate the concept that dominant alleles are generally rare.

17. In the Fun with Genetics lab, you used the Mental app on the iPads to create concept maps linking various terms in genetics and reproduction. Which of the following is the MOST accurate connection between terms?
   a. DNA is copied in transcription, which happens after translation.
   b. Immediately after cytokinesis, each daughter cell has twice as much DNA as the original cell had immediately after interphase.
   c. Meiosis happens only in cells called gametes.
   d. After transcription, mRNA goes to a ribosome, where amino acids are strung together.
   e. Gametes are exact copies of the cell that undergoes meiosis.

18. Is it possible for a person with blood type A and a person with blood type B to have a child with blood type O?
   a. No, kids with blood type O only come from two parents with blood type O.
   b. No, kids only can get blood type O if they have a mutation in the “blood type” gene.
   c. Yes, but only if both parents are homozygous.
   d. Yes, but only if both parents are heterozygous.

19. Which of the following statements is false?
   a. All codons consist of the same number of nucleotides.
   b. The main function of RNA polymerase and DNA polymerase is to help the cell get rid of excess nucleic acids.
   c. Viruses play a role in gene therapy because they specialize in delivering genes directly into cells.
   d. Typically, the reason an allele is recessive is that it encodes a protein that cannot do its job.
20. Suppose a mutation happens in a skin cell’s DNA, inside a gene encoding the blood protein hemoglobin. Will the person’s phenotype be affected?
   a. Yes, because all mutations are harmful.
   b. Yes, because the mutations will be passed to the next generation.
   c. No, because skin cells don’t produce the hemoglobin protein.
   d. No, because the scenario is impossible; skin cells don’t contain the hemoglobin gene.

21. Suppose you invented a drug that would stop blood vessels from reaching tumor cells. What would be the most immediate consequence?
   a. The tumor cells would divide faster, because the blood vessels wouldn’t be stealing their food anymore.
   b. The tumor cells would divide faster, because they would all start undergoing apoptosis.
   c. The tumor cells would divide more slowly, because they wouldn’t have food or oxygen.
   d. The tumor cells would be less likely to spread to other parts of the body.

22. A typical tRNA molecule has all of the following except:
   a. uracil  b. nucleotides  c. anticodon  d. amino acid  e. thymine

23. Which of the following statements is false?
   a. One of the main advantages of asexual reproduction is that offspring will be as well suited for the environment as the parent is.
   b. One of the main disadvantages of asexual reproduction is that offspring will be as poorly suited for the environment as the parent is.
   c. One of the main disadvantages of sexual reproduction is that the offspring have twice as many chromosomes as the parents.
   d. One of the main advantages of sexual reproduction is that at least some of the offspring might survive if the environment changes.
   e. Asexual reproduction occurs in both prokaryotes and eukaryotes.

24. In the Bacteria and Disease lab, you saw a film clip about the spread and health dangers of antibiotic resistant bacteria. What ultimately accounts for the origin of resistance allele in bacteria?
   a. Errors occurring in meiosis.
   b. Meiosis scrambling parental alleles in bacteria.
   c. Errors occurring in mitosis.
   d. Humans creating transgenic bacteria.
   e. Mutations creating new alleles of bacterial genes.

25. If the image at right is showing binary fission, then:
   a. the DNA must have duplicated before the division occurred.
   b. it could be showing a bacterium or a virus.
   c. the top structure contains 46 chromosomes.
   d. the top cell is diploid, and the two daughter cells are haploid.
   e. the DNA is confined to an organelle called the nucleus.

26. Identify the best analogy to explain the relationship between genes and proteins:
   \[ A \text{ gene is to a protein as } \_\_\_\_\_ \text{ to } \_\_\_\_\_ \].
   a. Instructions for knitting a sweater … the sweater  d. a brick is … a wall
   b. Beads are … a necklace  e. a piece of bread is … a sandwich
   c. One twin is … its identical sibling
27. Ashton Kutcher (the actor) has a fraternal twin brother. That means that:
   a. They share 100% of the same DNA.
   b. They share much more DNA than regular siblings, but much less DNA than identical twins.
   c. They share the same amount of DNA as regular siblings.
   d. They have no DNA in common.

28. How many items in the following list have FEWER chromosomes than a normal human skin cell?

   - Cell from a child with Down syndrome (trisomy 21)
   - Cell from a child with Turner syndrome (XO)
   - Cell from a child with Rett syndrome
   - Cell from a child with cystic fibrosis

   a. two  b. three  c. four  d. five  e. six

29. In the chicken wing microbiology lab, what was the purpose of the jelly-like stuff in the petri dishes?
   a. It provided water and nutrients for the bacteria to grow.
   b. It included mutagenic chemicals that added variation to the bacteria.
   c. It provided pigments that made the bacterial colonies easier to see.
   d. It ensured that the number of colonies on the plate was never too large to accurately count.
   e. It sped up mitosis in the bacterial cells.

30. In an alien species, eye colors can be black, white, or gray. A white-eyed alien and its black-eyed mate have all gray-eyed children.
   a. This inheritance pattern is most likely incomplete dominance.
   b. It is possible for a gray-eyed alien and a black-eyed mate to have a white-eyed baby.
   c. A gray-eyed couple can have offspring that are white-eyed, black-eyed, or gray-eyed.
   d. All of the above are correct.
   e. Only two of the above are correct.

31. Which step in the HIV replication cycle is unique to HIV (i.e. never occurs in uninfected host cells)?
   a. Genes are transcribed from RNA to DNA.
   b. Proteins are produced at ribosomes in the endoplasmic reticulum.
   c. Proteins are produced at ribosomes in the cytoplasm.
   d. DNA is transcribed in the nucleus.
   e. ATP, nucleotides, and amino acids are consumed.

32. What is happening in the image shown at right?
   a. DNA is getting mutated.
   b. DNA is getting transcribed.
   c. DNA is getting replicated, just before cell division.
   d. DNA is getting wound tightly into visible chromosomes, during prophase of mitosis.
   e. DNA is being produced as part of a viral infection.
33. The main difference between an organism that has received gene therapy and a genetically modified organism is:
   a. In an organism that has received gene therapy, only some cells receive modified DNA; in a genetically modified organism, every cell’s DNA is modified.
   b. Gene therapy targets only one faulty gene at a time; a genetically modified organism receives a full set of chromosomes from a donor organism.
   c. In an organism that has received gene therapy, the new DNA comes from the same species; in a genetically modified organism, the new DNA comes from a different species.
   d. All of the above are correct.
   e. Only a and c are correct.

34. Let’s say you take a nucleus from one of your cheek cells, put it into an egg cell (lacking a nucleus), and use it to grow a baby “identical twin” of yourself. Which DNA technology would you be using?
   a. Nondisjunction
   b. Cloning
   c. Stem cells
   d. Transgenic (genetically modified) technology
   e. Gene therapy

35. Which of the following is essential to the function of meiosis?
   a. The cell that undergoes meiosis must be haploid, and the daughter cells must be diploid.
   b. The daughter cells must contain half as many chromosomes as the cell that undergoes meiosis.
   c. In humans, the zygote must undergo meiosis if it is to start dividing to form the embryo.
   d. The daughter cells must be identical to each other and to the cell that undergoes meiosis.
   e. Each chromosome must consist of two chromatids (joined by a centromere), one of which is inherited from each parent.

36. Suppose you create a concept map using terms related to DNA and cell division. What is a correct connection between these two ideas?
   a. DNA encodes the proteins that control cell division.
   b. Proteins have to copy the DNA in a cell before it can divide.
   c. The interphase stage of cell division is when the DNA in a cell is unwound and available for use.
   d. All of the above are correct.
   e. Only two of the above are correct.

37. Which of the following statements about the cell at right is FALSE?
   a. You can tell it is a diploid cell because there are two versions of each chromosome.
   b. You can tell that the DNA has already replicated because the chromosomes consist of two chromatids.
   c. You can tell the cell is in meiosis I because the homologous pairs of chromosomes are paired up.
   d. You can tell that the gametes of this organism will have two chromosomes each because the cell contains four chromosomes total.
   e. You can tell that a mutation has happened in this cell because two chromosomes are smaller than the others.

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