Name:_____ Class:_____ Date:_____

Chapter 01: Introduction to Genetics

Multiple Choice

1. Which one of the following pairings between the subdiscipline of genetics and the phenomenon is INCORRECT?
   a. evolution—population genetics
   b. gene regulation—molecular genetics
   c. allelic frequency alteration—population genetics
   d. arrangement of genes on chromosome—transmission genetics
   e. chemical nature of the gene—transmission genetics

ANSWER: e

2. Which one of the following topics of research belongs to the discipline of transmission genetics?
   a. inheritance pattern of gene alleles
   b. mechanism of DNA replication
   c. gene expression patterns
   d. evolution
   e. chemical modification of nucleic acids

ANSWER: a

3. The complete genetic makeup of an organism is referred to as its
   a. chromosome.
   b. alleles.
   c. locus.
   d. genome.
   e. phenotype.

ANSWER: d

4. Identify a TRUE statement from the following descriptions concerning genetics.
   a. The theory of pangenesis states that all living organisms are composed of cells.
   b. Bacteria and viruses are not useful in studying genes and inheritance because they are structurally and metabolically different from eukaryotic cells.
   c. Charles Darwin accurately described the laws of inheritance in his landmark book, *On the Origin of Species.*
   d. Many human traits, such as skin and hair color, are determined by more than a single gene.
   e. Evolution can occur without genetic changes in the population.

ANSWER: d

5. Identify a FALSE statement from the following descriptions of genetics.
   a. Humans first applied genetics to the domestication of plants and animals between approximately 10,000 and 12,000 years ago.
   b. Some viruses use RNA to carry their genetic information.
   c. Albinism results from a mutation in the genes that control the synthesis and storage of melanin.

Chapter 01: Introduction to Genetics

d. All human traits that display blending inheritance are affected by a single gene.
e. The process by which genetic information is copied and decoded is similar for all forms of life.

ANSWER: d

6. Which of the following species is considered a model genetic organism?
a. the plant *Linaria vulgaris*
b. the deer mouse *Peromyscus maniculatus*
c. the worm *Caenorhabditis elegans*
d. the frog *Hyla chrysoscelis*
e. the chimpanzee *Pan troglodytes*

ANSWER: c

7. Which of the following would serve the LEAST well as a model for understanding basic mechanisms of inheritance?
a. fruit flies
b. humans
c. yeast
d. mice
e. zebrafish

ANSWER: b

8. Which of the following statements is TRUE?
a. Each subdiscipline of genetics is very specific as to what is explored and does not overlap with the other subdisciplines.
b. All phenotypes or traits are always determined by multiple genes.
c. Albinism arises from the overexpression of the gene that controls the synthesis and storage of melanin.
d. Humans make excellent model organisms because they have a variety of well-defined traits.
e. None of the statements provided are true.

ANSWER: e

9. Which of the following statements is CORRECT?
a. All genomes are encoded in DNA only.
b. All genomes are encoded in nucleic acids.
c. All genomes are encoded in proteins only.
d. The genetic instructions are decoded completely differently in each organism.
e. Molecular studies suggest life evolved from multiple primordial ancestors.

ANSWER: b

10. Which one of the following topics belongs to a different subdiscipline of genetics when compared with the rest?

Chapter 01: Introduction to Genetics

a. mechanism of gene regulation
b. allele frequencies of a certain gene in different environments
c. transcription
d. chemical alternation of chromosomes
e. mechanism of DNA replication

ANSWER: b

11. The complete genetic makeup of any organism is referred to as a
a. phylogeny.
b. phenotype.
c. genome.
d. genotype.
e. single-nucleotide polymorphism.

ANSWER: c

12. A change in allele frequency within a population over time leads to
a. a genome.
b. a phenotype.
c. a genotype.
d. mutations.
e. evolution.

ANSWER: e

13. Assume that a geneticist is doing a study with a wild mouse species. She captures 100 of these mice, takes a DNA sample from each, and sequences the same specific gene from each mouse. This gene has two alleles within this population. She then calculates the frequency of each of the two alleles from the sequencing results. Which subdivisions of genetics would this study include?
a. transmission and population genetics
b. transmission and molecular genetics
c. molecular genetics only
d. molecular and population genetics
e. transmission genetics only

ANSWER: d

14. Albinism is rare in most human populations, occurring at a frequency of about 1 in 20,000 people. However, the trait occurs at a frequency of 1 in 200 in certain Hopi villages of Black Mesa in Arizona. In light of this example and others that you might be aware of, what can you conclude about particular alleles such as the allele for albinism?
a. An allele that leads to an abnormal phenotype will be rare in most populations but common in Native American populations.
b. An allele that leads to an abnormal phenotype will not be beneficial in any population.
c. An allele that leads to an abnormal phenotype may be beneficial in some environments but harmful

in others.

d. An allele that leads to an abnormal phenotype will rise in frequency after many generations.

e. An allele that leads to an abnormal phenotype will soon disappear from a population.

ANSWER: c

15. The experiments of Gregor Mendel can be placed into which subdivision of genetics?

a. molecular genetics

b. population genetics

c. transmission genetics

d. molecular genetics and transmission genetics

e. population genetics and transmission genetics

ANSWER: c

16. Among the model genetic organisms, *Escherichia coli*, a single-celled bacterium, is a prokaryote; *Saccharomyces cerevisiae*, one-celled yeast, is a eukaryote, as are *Caenorhabditis elegans*, a multicellular nematode worm, and *Arabidopisis thaliana*, a multicellular plant. Which of these organisms would NOT contain membrane-bound organelles?

a. *Escherichia coli*

b. *Saccharomyces cerevisiae*

c. *Escherichia coli* and *Saccharomyces cerevisiae*

d. *Caenorhabditis elegans*

e. *Caenorhabditis elegans* and *Arabidopisis thaliana*

ANSWER: a

17. In the late 1990s, what important discovery in genetics was made?

a. The three-dimensional structure of DNA was described, which showed how DNA might be replicated.

b. The first recombinant DNA experiments were performed that started the biotechnology field.

c. DNA sequencing methods were first discovered.

d. Genes were found to be located on chromosomes.

e. Tiny RNAs were discovered that play important roles in the regulation of gene expression.

ANSWER: e

18. CRISPR/Cas9 is a powerful new method that allows

a. DNA sequencing to be performed very quickly so that numerous individual genomes can be sequenced in a short period of time.

b. precise editing of specific DNA sequences in living cells.

c. the identification of genes involved in important medical conditions.

d. the introduction of genes from one species into another species.

e. the arrangement of genes on chromosomes.

ANSWER: b

Chapter 01: Introduction to Genetics

19. The golden mutation in the zebrafish was useful because of which of the following results?
    a. It led to the discovery of a similar gene in humans that is involved in skin pigmentation.
    b. It led to the development of new varieties of wheat.
    c. It led to the ability to identify many of the genes that result in an increase in heart attacks.
    d. It allowed the zebrafish to be grown in captivity and become commercially profitable.
    e. It became the first gene in a model organism to be sequenced.

ANSWER: a

20. What commonsense observation makes the theory of preformationism unlikely?
    a. An individual may inherit traits found in both of his or her parents.
    b. Anatomical changes such as loss of a limb are not seen in the offspring of an individual.
    c. Evolution requires genetic change in populations.
    d. Alleles that result in abnormal phenotypes may be less common in some populations than in others.
    e. Offspring often look more like their parents than unrelated individuals.

ANSWER: a

21. What commonsense observation makes the theory of acquired characteristics UNLIKELY?
    a. An individual may inherit traits found in both of his or her parents.
    b. Anatomical changes such as loss of a limb are not seen in the offspring of an individual.
    c. Evolution requires genetic change in populations.
    d. Alleles that result in abnormal phenotypes may be less common in some populations than in others.
    e. Offspring often look more like their parents than unrelated individuals.

ANSWER: b

22. Which of the following theories of inheritance is currently considered TRUE?
    a. germ-plasm theory
    b. pangenesis
    c. blending inheritance
    d. inheritance of acquired characteristics
    e. None of these theories is considered true based on new evidence.

ANSWER: a

23. Which of the following theories of inheritance is no longer accepted as TRUE?
    a. pangenesis
    b. blending inheritance
    c. inheritance of acquired characteristics
    d. preformationism
    e. None of the provided theories is currently considered true.

ANSWER: e

24. Which of the following CORRECTLY describes the cell theory?

Chapter 01: Introduction to Genetics

a. Genetic information from different parts of the body travels to the reproductive organs.
b. The cell is the compositional and functional unit of all life.
c. Inside the germ cells, there exists a fully formed miniature adult that enlarges in the course of development.
d. The genetic material itself blends, which cannot be separated out in future generations.
e. Traits acquired in a person's lifetime become incorporated into the person's hereditary information, which will be passed on to his or her offspring.

ANSWER: b

25. Which of the following examples of scientists and their contribution is matched INCORRECTLY?
a. Watson and Crick—three-dimensional structure of DNA
b. Mendel—principles of heredity using pea plants
c. Gilbert and Sanger—DNA sequencing methods
d. Morgan—polymerase chain reaction
e. Sutton—genes on chromosomes as units of inheritance

ANSWER: d

26. Choose the correct match between the scientists and the field of genetics to which they contributed.
a. Haldane and Wright—transmission genetics
b. Mendel—molecular genetics
c. Gilbert and Sanger—population genetics
d. Darwin—molecular genetics
e. Morgan—transmission genetics

ANSWER: e

27. The first complete DNA sequence of a nonviral, free-living organism was obtained for
a. a bacterium in 1900.
b. a bacterium in 1945.
c. a bacterium in 1995.
d. humans in 1990.
e. humans in 2000.

ANSWER: c

28. Which of the following scientists contributed significantly to the foundations of population genetics?
a. James Watson
b. Thomas Hunt Morgan
c. Ronald Fisher
d. Charles Darwin
e. Frederick Sanger

ANSWER: c

Chapter 01: Introduction to Genetics

29. Which of the following scientists contributed significantly to the foundations of molecular genetics?
    a. James Watson
    b. Thomas Hunt Morgan
    c. John B. S. Haldane
    d. Charles Darwin
    e. Sewall Wright

ANSWER: a

30. Which of the following scientists contributed significantly to the foundations of transmission genetics?
    a. James Watson
    b. Thomas Hunt Morgan
    c. John B. S. Haldane
    d. Charles Darwin
    e. Sewall Wright

ANSWER: b

31. The contribution Charles Darwin made to biology was to
    a. demonstrate the connection between Mendel's principles of inheritance and evolution.
    b. propose that evolution occurs by natural selection.
    c. develop the theory of evolution, based on earlier theories of population genetics.
    d. connect the fields of evolution and molecular genetics.
    e. determine the first DNA sequence for a free-living organism.

ANSWER: b

32. Which of the following combines molecular biology and computer science?
    a. single-nucleotide polymorphism
    b. microRNAs
    c. polymerase chain reaction
    d. bioinformatics
    e. eukaryotics

ANSWER: d

33. What commonsense observation makes the theory of blending inheritance unlikely?
    a. An individual may inherit traits found in only one of his or her parents.
    b. Anatomical changes such as loss of a limb are not seen in the offspring of an individual.
    c. Evolution requires genetic change in populations.
    d. Some traits disappear in one generation and then reappear in the next generation.
    e. Offspring often look more like their parents than unrelated individuals.

ANSWER: d

34. A measurable or observable trait or characteristic is called a

Chapter 01: Introduction to Genetics

a. phenotype.
b. genotype.
c. single-nucleotide polymorphism.
d. small interfering RNA.
e. gene bank.

ANSWER: a

35. Genetic information can be carried in which of the following biomolecules?
a. proteins
b. DNA but not RNA
c. RNA but not DNA
d. either DNA or RNA
e. proteins but not RNA

ANSWER: d

36. Which of the following sequences CORRECTLY shows the flow of genetic information during gene expression?
a. RNA → DNA → protein
b. protein → DNA → RNA
c. DNA → RNA → protein
d. DNA → protein → DNA
e. None of the answers is correct.

ANSWER: c

37. The contribution of Gilbert and Sanger to modern genetics was to
a. develop the PCR technique.
b. discover DNA in the nucleus of cells.
c. describe the structure of DNA.
d. show that genes were made of DNA.
e. develop a method for sequencing DNA.

ANSWER: e

38. Which of the following pairs is a part of a single nucleotide?
a. nitrogenous base and sugar
b. sugar and amino acid
c. guanine and cytosine, two nitrogenous bases
d. amino acid and nitrogenous base

ANSWER: a

39. A form of a gene that has a slightly different sequence than other forms of the same gene but encodes the same type of an RNA or protein is called a(n)

Chapter 01: Introduction to Genetics

a. locus.
b. allele.
c. homologous chromosome.
d. heterozygote.
e. homozygote.

ANSWER: b

40. _____ is a change in allele frequency of a population over time.
a. Blending inheritance
b. Preformation
c. Genome
d. Evolution
e. Phenotype

ANSWER: d

41. Permanent, heritable changes in genetic information (DNA) are called
a. evolution.
b. defects.
c. SNP.
d. alleles.
e. mutations.

ANSWER: e

42. Within cells, genes are located on structures called
a. genomes.
b. chromosomes.
c. phenotypes.
d. genotypes.
e. alleles.

ANSWER: b

43. Which of the following statements is FALSE concerning prokaryotic cells?
a. They lack a nuclear membrane.
b. They lack organelles such as chloroplasts.
c. They are less complex than eukaryotic cells.
d. They lack genetic information.
e. They lack a true nucleus.

ANSWER: d

44. Which of the following statements is the CORRECT definition of meiosis?
a. It is the method by which prokaryotic cells divide and produce daughter cells.

b. It is the process by which the genetic information in DNA is transferred to RNA.
c. It is the separation of chromosomes in the division of sex cells to produce gametes.
d. It is the separation of chromosomes in the division of somatic cells in plants and animals.
e. It is the process that produces multiple alleles of genes.

ANSWER: c

45. Assume that a mutation occurs within a gene within an individual fruit fly. What will be the most likely series of consequences of this mutation?

a. It will initially change the RNA sequence; then this change in genetic information will be transferred to the DNA sequence and finally result in a change in the protein made by the gene.
b. It will initially change the DNA sequence; then this change in genetic information will be transferred to the RNA sequence and finally result in a change in the protein made by the gene.
c. It will initially change the RNA sequence; then this change in genetic information will be transferred to the protein made by the gene and finally result in a change in the DNA.
d. It will initially change the DNA sequence; then this change in genetic information will be transferred to the protein made by the gene and finally result in a change in the RNA.
e. It will initially change the protein sequence made by the gene; then this change in genetic information will be transferred to DNA and finally result in a change in the RNA.

ANSWER: b

46. How do DNA and RNA differ?

a. DNA contains the nitrogenous base thymine while RNA contains the base uracil instead of thymine.
b. DNA contains the nitrogenous base guanine while RNA contains the base cytosine instead of guanine.
c. DNA is composed of repeating units called nucleotides while RNA is composed of repeating units called amino acids.
d. DNA is composed of repeating units called amino acids while RNA is composed of repeating units called nucleotides.
e. In DNA the nucleotides contain a sugar, a base, and a phosphate while in RNA the nucleotides contain no sugar.

ANSWER: a

47. Identify a TRUE statement.

a. Genetic influences are solely responsible for the traits of an organism.
b. Environmental influences can only responsible for the physical traits of an organism, such as height, weight, or color.
c. Environmental influences can only be responsible for the behavioral traits of an organism .
d. Environmental influences can affect gene activity.
e. Separating genetic and environmental influences on organismal traits is easy.

ANSWER: d

48. What powerful piece of evidence suggests a genetic modification led to snakes developing without limbs?

Chapter 01: Introduction to Genetics

a. A few species of snakes, such as pythons, have vestigial leg bones.
b. A few rare species of snakes actually develop with small limbs.
c. Genes controlling leg development in mice can be introduced into snakes and cause them to develop limb-like structures.
d. A genetic element called an enhancer believed to be responsible for suppression of limb development in snakes was isolated from a snake and introduced into mice. The resulting mice developed with truncated limbs.
e. Sequencing of an enhancer element proved it was responsible for the suppression of limb development in snakes.

ANSWER: d

Multiple Response

49. Which of the following traits would make a species useful as a model genetic organism? (Select all that apply.)
a. large number of progeny
b. long generation time
c. small size
d. ability to be studied in a laboratory
e. ability to be propagated inexpensively

ANSWER: a, c, d, e

50. The fruit fly *Drosophila melanogaster* is an important model system for studying inheritance in animals and genetic control of animal development, including humans. If researchers ultimately want to understand a biological process in humans, why might they want to study the process in fruit flies first? (Select all that apply.)
a. Fruit flies are relatively easy to genetically manipulate and to isolate mutations.
b. Fruit flies have short generation times and produce relatively large numbers of progeny.
c. Fruit flies have simpler genomes than do humans.
d. Fruit flies share all important physiological and developmental processes with humans.
e. Fruit flies are small and easy to raise.

ANSWER: a, b, c, e

51. The three-dimensional structure of DNA was first deciphered based on the work of which of the following individuals? (Select all that apply.)
a. James Watson
b. Francis Crick
c. Maurice Wilkins
d. Thomas Hunt Morgan
e. Rosalind Franklin

ANSWER: a, b, c, e

Chapter 01: Introduction to Genetics

Essay

52. Albinism is rare in most human populations, occurring at a frequency of about 1 in 20,000 people. However, the trait occurs at a frequency of 1 in 200 in certain Hopi villages of Black Mesa in Arizona. Explain in terms of natural selection why albinism is so rare in most human populations.

ANSWER: In most populations, there is fairly strong selection against albinism because albinos don't produce melanin, causing their skin cells not to be protected from the damaging effects of sunlight. Also, the lack of melanin in their eyes causes them to have poor eyesight. Finally, in most cultures albinos are seen as abnormal, and they are not normally sought out for marriage and mating. Therefore, in most populations the alleles that cause albinism are selected against, and they decrease in frequency or are kept at a low level, causing the recessive trait to be rare.

53. Albinism is rare in most human populations, occurring at a frequency of about 1 in 20,000 people. However, the trait occurs at a frequency of 1 in 200 in certain Hopi villages of Black Mesa in Arizona. Explain in terms of natural selection why the trait is so much more common among the Hopis of Black Mesa.

ANSWER: Albinos occupy a privileged position among the Hopis of Black Mesa. In this culture, albinos are viewed as especially pretty, clean, and intelligent, and they often occupy positions of leadership. Albinos are celebrated in the villages as a sign of purity of Hopi blood in the community. Furthermore, albinos are often excused from normal male field labor because of their sensitivity to sunlight, causing them to be left behind in the village with the women during the daytime. This allows them extra mating opportunities compared to the other men of the village. Therefore, the alleles that cause albinism are either selected for in this culture or at least not selected against as strongly as in other cultures, allowing the trait to occur at a much higher frequency.

54. The fruit fly *Drosophila melanogaster* is an important model system for studying inheritance in animals and genetic control of animal development, including humans. Evaluate fruit flies as a model system for human biology. What are their strengths and weaknesses as a model system?

ANSWER: Strengths—Fruit flies have proven to be an excellent model system for studying aspects of biology that they share with humans. Fruit flies are simpler in structure and physiology than humans and have a much simpler genome. They are small and easy to raise, they have a short generation time, and they produce a large number of offspring. Their chromosomes have been mapped and their genomes analyzed extensively. It is relatively easy to isolate and study mutants that are defective in specific processes of interest. These characteristics make them ideal for genetic studies of biological processes.

Weaknesses—Some aspects of fruit fly genetics and development are not shared with humans. Therefore, some features discovered in fruit flies will not apply directly to humans. Also, humans have many features that fruit flies lack. Fruit flies will not serve well as a model system for studying these features of human biology.

55. What common features of heredity suggest that all life on Earth evolved from a common ancestor?

ANSWER: Despite the remarkable diversity of life on Earth, all genomes are encoded in nucleic acids. With few exceptions, the genetic code is common to all forms of life. Finally, the process by which genetic information is copied and decoded is remarkably similar for all forms of life.

56. Why might bacteria and viruses be good model organisms for studying the basics of inheritance? Describe two advantages over studying genetics in mice, dogs, or humans.

Chapter 01: Introduction to Genetics

ANSWER: Bacteria and viruses have their genetic material (DNA) organized into genes, just like other organisms, so the basics of inheritance are the same in bacteria and viruses as in other organisms.

The genetic systems of bacteria and viruses are simpler when compared to higher eukaryotic organisms such as mice, dogs, or humans: they have fewer genes, fewer chromosomes, and less DNA.

Bacteria and viruses reproduce more quickly than higher eukaryotic organisms: the generation time is shorter than for mice, dogs, or humans.

Bacteria and viruses are easy and less expensive to grow (take up less space, have less complicated nutritional needs) than vertebrates.

57. Many good ideas in science ultimately turn out to be incorrect, and this has happened several times in the history of genetics. In your own words, state one idea in the history of genetics that turned out to be incorrect.

ANSWER: Answers will vary but might include pangenesis, inheritance of acquired characteristics, preformationism, or blending inheritance, which are all described in Section 1.1. Pangenesis—The idea that information needed to encode each body structure is stored in that structure and transported to the reproductive organs and passed to the embryo at conception. Inheritance of acquired characteristics—The idea that traits acquired through use during one's lifetime can be passed to one's offspring. Preformationism—The idea that the sperm or egg carries a tiny preformed person whose development simply involves enlargement. Blending inheritance—The idea that the genetic material is a fluid that gets blended during sexual reproduction between a male and female, resulting in the production of traits in the offspring that are blended intermediates of those of the parents.

58. Many good ideas in science ultimately turn out to be incorrect, and this has happened several times in the history of genetics. Why do you think a particular idea was widely accepted by scholars of that time? Include in your answer some evidence in favor of the idea, observations that seemed to support the idea, or other rationale for accepting the idea.

ANSWER: Answers will vary but should include specific evidence or observations that support the idea.
Examples:
Pangenesis—It is reasonable to assume that the information needed to build a structure must reside in that structure. It is less obvious that the information might also reside in other structures. Therefore, it is reasonable to envision the information being stored in each structure and transported to the reproductive structures before being passed to the next generation.
Inheritance of acquired characteristics—Observations to support this view would have been commonplace. For example, a man with a muscular physique would often have sons with muscular physiques. A talented musician often produced children with musical talent.
Preformationism—It would have been hard for people before the late 1800s to imagine how a complex organism could build itself from a single undifferentiated cell. Indeed, the problem has occupied developmental biologists for over 100 years. Preformationism is easier to understand. Add to that the poor optics of microscopes at that time, and it is easy understand how early biologists might have thought they could see a preformed person in a sperm or an egg, such as in Figure 1.11.
Blending inheritance—For example, a mating between a tall person and a short person producing a person of medium stature might have suggested blending inheritance.

59. Many good ideas in science ultimately turn out to be incorrect, and this has happened several times in the

history of genetics. Summarize the evidence that ultimately caused an idea to be rejected by modern geneticists.

ANSWER: Answers will vary but should include specific evidence or observations that do not support the idea. Pangenesis—Observations of animals with body parts lost to injury producing normal offspring would not support pangenesis. Inheritance of acquired characteristics— Experiments were conducted in which body parts were removed and normal offspring were produced, showing that the acquired characteristic was not inherited. Also, experiments in which offspring are raised in an environment different from that of their parents and do not develop their parents' traits would suggest that the environment influences development of these traits. Preformationism—Eventually better microscopes were produced that proved that gametes do not contain preformed people. Also, we eventually came to understand that both sperm and egg contribute genetic information during sexual reproduction. Blending inheritance—Mendel showed that genes behave as particles that are not blended or changed during inheritance.

60. Describe one way in which discoveries in genetics currently impact your daily life apart from this course.

ANSWER: Answers will vary, but the best answers will include one or more specific discoveries in genetics and describe how they affect the student personally. Examples could come from those listed in Section 1.1 or from the student's background. This question and Questions 52 and 53 will work best if students are asked to consider ahead of time how these discoveries might impact their lives. For example, students might discuss the role of genetics and genetic technology in the Green Revolution of the 1950s and 1960s, which greatly expanded food production throughout the world, making food more efficient, more affordable, and more available to world populations. A much smaller part of the world's population works in agriculture, freeing up more people for work in other industries. They might also discuss the use of genetically modified crops in agriculture, including a significant proportion of corn and soybeans in the United States and other countries.

61. Describe one way in which discoveries in genetics will likely impact your life in the future.

ANSWER: An example would be the use of genetic tests in medical practice. Genetic tests are already fairly commonplace and will become more common in the near future. In the future, most people will be offered one or more genetic tests as part of their ordinary medical care. They will need to understand the basis of the tests and their limitations, as well as how to interpret results and how to use the information provided.

Genome editing of humans, as with the CRISPR-modified babies born in 2019, may influence humankind more generally. Rules and regulations and their enforcement vary greatly through the world.

62. Describe a discovery in genetics or an area of current research that you are concerned about that might have a negative impact on your life in the future. Explain why you think it might have a negative impact on you personally.

ANSWER: Again, answers will vary, but an example is the possible abuse of genetic information about individuals that is becoming more available. Many people worry that results from genetic tests, for example, could be used to discriminate against individuals in the workplace and in the insurance marketplace. The Genetic Information Nondiscrimination Act offers limited protection against genetic discrimination, but the possibility of negative consequences from such tests remains.

Human genome editing is very controversial and could have unforeseen negative consequences not

only to the edited individual's life but more broadly.

63. List and describe two significant events in the history of genetics that occurred during the twentieth century.

ANSWER: 1900: Mendel's previously published work on pea plants, which stated basic principles of inheritance, was rediscovered.
1902: Sutton proposed that genes are located on chromosomes.
1910: Thomas Hunt Morgan began studies of transmission genetics, using fruit fly mutants.
1930s: Fisher, Haldane, and Wright outlined the founding principles of population genetics.
1940s: Organization of chromosomes and genes was studied using bacteria and viruses.
1940s–1950s: Evidence was accumulated for DNA as the genetic material; Watson and Crick described the DNA structure.
1966: The relationship between the chemical structure of DNA and the amino acid sequence of proteins was determined.
1973: The first recombinant DNA experiments were conducted.
1977: The Gilbert and Sanger methods for DNA sequencing were published.
1983: Mullis developed PCR.
1990: The first use of gene therapy was used in humans.
1990s: The Human Genome Project was started.
1995: The first genome of a free-living organism was sequenced (*Haemophilus influenzae*).
1996: The first genome of a eukaryote was sequenced (yeast).
2000–present: The human genome sequence was released.

64. Write a paragraph explaining why genetics is considered a young science, even though people have been applying genetic principles for thousands of years.

ANSWER: Techniques for the observation of cells have been available only since the late 1500s, when the first microscopes were produced. The observation of chromosomes has been possible for only a century and a half. The widespread systematic study of genes and inheritance has been conducted only in the twentieth century, since the rediscovery of Mendel's work in 1900. The structure of DNA was determined only in the mid-twentieth century. Many molecular genetics techniques, like PCR, have been developed only in the last few decades. However, without understanding the nature of chromosomes and genes, plant and animal breeders have been applying the principles of inheritance for thousands of years to obtain desired characteristics in domesticated organisms.

65. Which features distinguish a prokaryotic cell from a eukaryotic cell?

ANSWER: Prokaryotic cells lack a nuclear membrane and possess no true membrane-bound cell organelles, whereas eukaryotic cells possess a nucleus and membrane-bound organelles such as chloroplasts and mitochondria.

66. Though humans are the subject of intense genetic investigation, *Homo sapiens* are not generally considered a model genetic organism. Why not? Does this make sense?

ANSWER: Answers may vary. In some senses, the wealth of genetic information and studies concerning humans, the fact that the human genome has been sequenced, and the existence of experimental techniques to study humans provide similarities to model organisms. However, humans don't conform to true model organisms in terms of other experimentation advantages—short generation time, small size, inexpensiveness to propagate. Also, while natural, environmental, and substance-induced variations are studied in humans, experiments and studies must be set up within strong

ethical guidelines and approvals not required for any other true model organism. The recognition of *Homo sapiens* as a distinct, separate form of life with an inherent dignity not common to other organisms prevents them from being classified as model organisms.