

Review the Concepts

Work through the following exercises to review the concepts in this chapter. For additional review, check out the activities at www.mybiology.com. The website offers a pre-test that will help you plan your studies.

Exercise 1 (Modules 9.1–9.4)

These modules discuss the basic principles of heredity and introduce the vocabulary of genetics. Read the modules carefully, and then practice using the vocabulary by matching each phrase on the left with a word or phrase on the right. (This is just a start; you will remember these terms better as you use them.)

- | | |
|---|---------------------------|
| _____ 1. A unit that determines heritable characteristics | A. Allele |
| _____ 2. Varieties that always produce offspring identical to parents | B. Homozygous |
| _____ 3. The offspring of two different varieties | C. Hybrid |
| _____ 4. When two alleles of a pair differ, the one that is hidden | D. Genotype |
| _____ 5. A feature that varies among individuals, such as flower color | E. Segregation |
| _____ 6. Parent organisms that are mated | F. F_2 generation |
| _____ 7. A diagram that shows possible combinations of gametes | G. True-breeding |
| _____ 8. A breeding experiment that uses parents different in one character | H. Heterozygous |
| _____ 9. One of the alternative versions of a gene for a character | I. Self-fertilization |
| _____ 10. Relative numbers of organisms with various traits | J. Dominant |
| _____ 11. An organism that has two different alleles for a gene | K. P generation |
| _____ 12. Each variant of a character, such as purple and white flower color | L. Monohybrid cross |
| _____ 13. An organism's genetic makeup | M. Locus |
| _____ 14. Separation of allele pairs that occurs during gamete formation | N. Phenotype |
| _____ 15. Fertilization of a plant by pollen from a different plant | O. Cross |
| _____ 16. An organism that has two identical alleles for a gene | P. F_1 generation |
| _____ 17. The science of heredity | Q. Recessive |
| _____ 18. The location of a gene on a chromosome | R. Homologous chromosomes |
| _____ 19. What an organism looks like; its expressed traits | S. Gene |
| _____ 20. Offspring of the F_1 generation | T. Phenotypic ratio |
| _____ 21. When pollen fertilizes eggs from the same flower | U. Trait |
| _____ 22. Separation of allele pairs during gamete production | V. Cross-fertilization |
| _____ 23. When two alleles of a pair differ, the one that determines appearance | W. Punnett square |
| _____ 24. Where the two alleles for a certain character are located | X. Character |
| _____ 25. Offspring of the P generation | Y. Genetics |
| _____ 26. A hybridization | Z. Segregation |

Exercise 2 (Modules 9.3–9.4)

Test your knowledge of Mendel's principles by answering the following questions. You may want to test your ideas on scratch paper.

1. A pea plant with green pods is crossed with a plant with yellow pods. (Note: We're talking about the *Pods* here, not the peas inside!) All their offspring have green pods.
 - a. Which allele is dominant? Which allele is recessive?
 - b. Using letters, what is the genotype of the green parent? The yellow parent?
 - c. What are the genotypes of the offspring?
2. F_1 pea plants from the above cross are crossed. Use a Punnett square to figure out the genotypic and phenotypic ratios in the F_2 generation.
 - a. Genotypic ratios:
 - b. Phenotypic ratios:
3. Two black mice mate. Six of their offspring are black and two are white.
 - a. What are the genotypes of the parents?
 - b. For which offspring are you sure of the genotypes?

Exercise 3 (Module 9.5)

Gregor Mendel studied the inheritance of two characteristics at once and found that each pair of alleles segregates independently during the formation of gametes. In other words, if a tall pea plant with purple flowers is crossed with a short plant with white flowers, some of their descendants can be tall with white flowers. The tall and purple alleles do not have to stick together—they are independent.

So far, the textbook has discussed inheritance in peas and dogs. Just to be different, let's look at a genetic cross involving rabbits. In rabbits, the allele for brown coat is dominant, the allele for white coat recessive. The allele for short fur is dominant, the allele for long fur recessive. Imagine mating a true-breeding brown, short-haired rabbit with a white, long-haired rabbit. Using Module 9.5 as a model, write the genotypes of rabbits and gametes in the P, F₁, and F₂ generations in the blanks in the Punnett square. You may want to modify the drawings (add some hair and color) to show the phenotypes of the rabbits in the F₂ generation. Then use the Punnett square to figure out the phenotypic ratios in the F₂ generation—the proportion of rabbits that you can expect to be brown and short-haired, brown and long-haired, white and short-haired, and white and long-haired. Write their phenotype and their proportions in the blanks at the bottom.

P Generation:

Brown, short-haired 1. _____  White, long-haired 2. _____ 

Eggs 3. _____  Sperm 4. _____ 

F₁ Generation:

 Brown, short-haired 5. _____

F₂ Generation:

Genotypes:

10. _____  11. _____  12. _____  13. _____ 

Sperm

6. _____  14. _____  15. _____  16. _____  17. _____ 

7. _____  18. _____  19. _____  20. _____  21. _____ 

8. _____  22. _____  23. _____  24. _____  25. _____ 

9. _____  26. _____  27. _____  28. _____  29. _____ 

Eggs

Phenotypes:

30. _____  31. _____ 

32. _____  33. _____ 

34. _____  35. _____ 

36. _____  37. _____ 

Exercise 4 (Module 9.6)

After reading this module on testcrosses, test your understanding by answering the following questions.

1. Recall that brown coat color in rabbits is dominant and white color is recessive. Suppose you have a group of rabbits—some brown and some white.
 - a. For which phenotype(s) do you know the genotype(s)?
 - b. For which phenotype(s) are you unsure of the genotype(s)?
2. Using *B* and *b* to symbolize the brown and white alleles:
 - a. What are the possible genotypes of a white rabbit in your group?
 - b. What are the possible genotypes of a brown rabbit?
3. Suppose you wanted to find out the genotype of a brown rabbit. What color rabbit would you mate it with?
4. A brown buck (male) is mated with a white doe (female). In their litter of 11 young, six are white and five are brown. Using a Punnett square to check your answer, what is the genotype of the buck?
5. Use a Punnett square to figure out the ratio of brown and white offspring that would have been produced by the above mating if the brown buck had been homozygous.
6. If half the offspring from a testcross are of the dominant phenotype and half are of the recessive phenotype, is the parent of the dominant phenotype (but unknown genotype) homozygous or heterozygous?
7. If all the offspring from a testcross are of the dominant phenotype, is the parent with the dominant phenotype (but unknown genotype) homozygous or heterozygous?

Exercise 5 (Module 9.7)

The rules of probability can be used to predict the flip of a coin, the drawing of a card from a deck, or the roll of a pair of dice. They also govern segregation and recombination of genes. Read Module 9.7 carefully, and then fill in the blanks below.

The probability scale ranges from ¹_____ (an event that is certain not to occur) to ²_____ (an event that is certain to occur). The probabilities of all possible outcomes for an event must add up to ³_____. Imagine rolling a pair of dice, one die at a time. Each of the six faces of a die has a different number of dots, from one to six. If you roll a die, the probability of rolling a one is ⁴_____. The probability of rolling any number other than one is ⁵_____. The outcome of a given roll is unaffected by what has happened on previous rolls. In other words, each roll is a(n) ⁶_____ event.

If you roll two dice simultaneously, what is the probability of “snake eyes” (both ones)? The roll of each die is an independent event. The probability of such a

Exercise 10 (Modules 9.9–9.16)

These modules discuss examples of inheritance that are a bit more complex—and common—than the simple patterns of heredity observed by Mendel. After reading the modules, see if you can match each description with a pattern of inheritance. Choose from:

- A. incomplete dominance
- B. multiple alleles
- C. codominance
- D. pleiotropy
- E. polygenic inheritance

_____ 1. There are three different alleles for a blood group— I^A , I^B , and i —but an individual has only two at a time.

_____ 2. Crosses between two cremello (off-white) horses always produce cremello offspring. Crosses between chestnut (brown) horses always result in chestnut offspring. A cross between chestnut and cremello horses produces palomino (a golden-yellow color somewhat intermediate between chestnut and cremello) offspring. If two palominos are mated, their offspring are produced in the ratio of 1 chestnut:2 palominos:1 cremello.

_____ 3. The sickle-cell allele, s , is responsible for a variety of phenotypic effects, from pain and fever to damage to the heart, lungs, joints, brain, or kidneys.

_____ 4. In rabbits, an allele for full color (C) is dominant over an allele for chinchilla (c') color. Both full color and chinchilla are dominant over the white allele (c). A rabbit can be CC , Cc' , Cc , $c'c'$, $c'c$, or cc .

_____ 5. In addition to the A and B molecules found on the surface of red blood cells, humans also have M and N molecules. The genotype $L^M L^M$ produces the M phenotype. The genotype $L^N L^N$ gives the N phenotype. Individuals of genotype $L^M L^N$ have both kinds of molecules on their red blood cells, and their phenotype is MN.

_____ 6. If a red shorthorn cow is mated with a white bull, all their offspring are roan, a phenotype that has a mixture of red and white hairs.

_____ 7. Independent genes at four different loci are responsible for determining an individual's HLA tissue type, important in organ transplants and certain diseases.

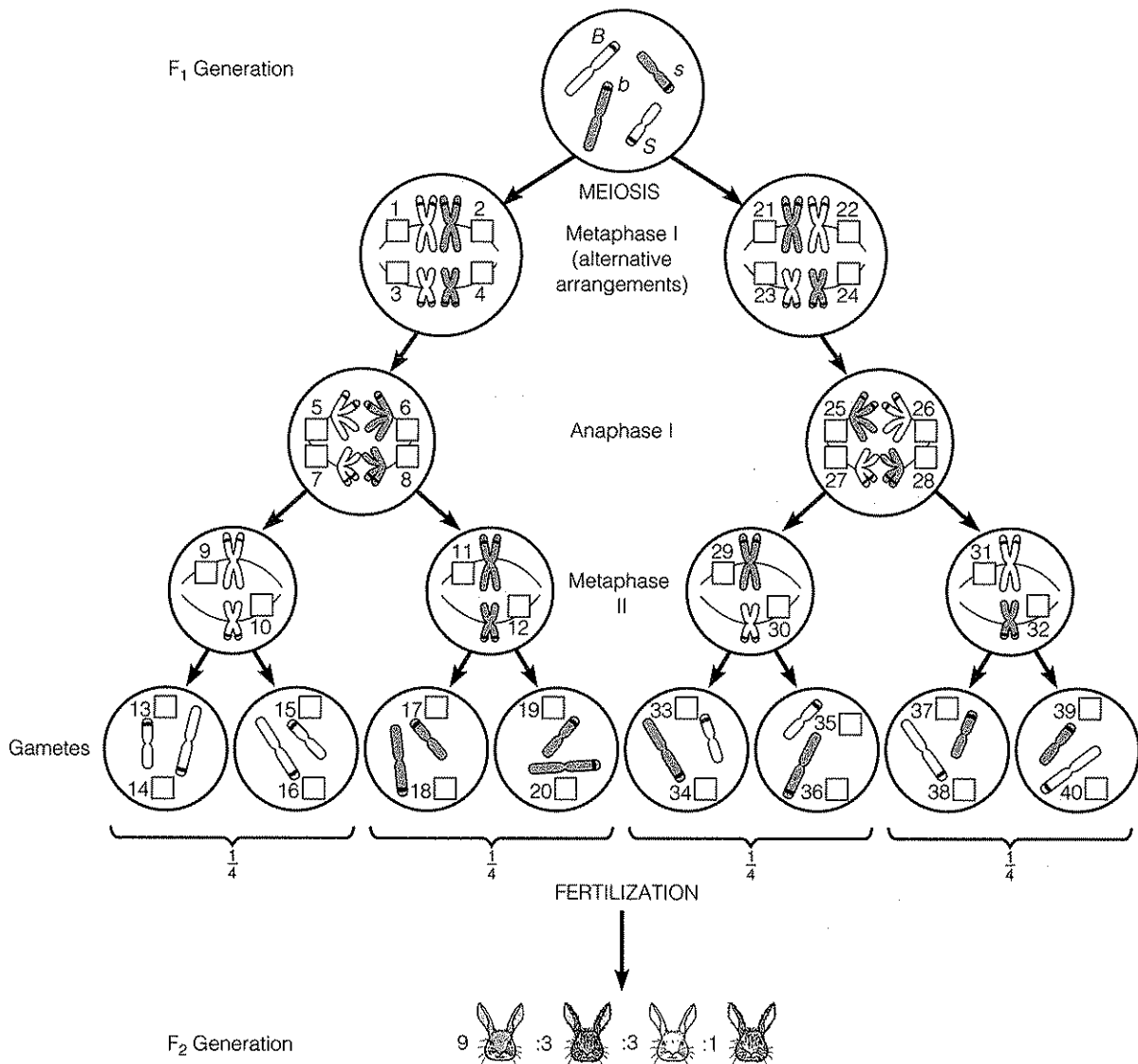
_____ 8. A recessive allele causes a human genetic disorder called phenylketonuria. Homozygous recessive individuals are unable to break down the amino acid phenylalanine. As a consequence, they have high levels of this substance in their blood and urine, reduced skin pigmentation, lighter hair than their normal brothers and sisters, and often some degree of mental impairment.

_____ 9. When graphed, the number of individuals of various heights forms a bell-shaped curve.

_____ 10. Chickens homozygous for the black allele are black, and chickens homozygous for the white allele are white. Heterozygous chickens are gray.

Exercise 11 (Module 9.16)

Genes are located on chromosomes. Genes undergo segregation and independent assortment because the chromosomes that carry them undergo segregation and independent assortment during meiosis. The illustration below is similar to that in Module 9.16. It shows how alleles and chromosomes are arranged in an F_1 rabbit and how meiosis sorts the alleles into their gametes. The diagram below shows only the chromosomes. Put a letter (B , b , S , or s) in each of the numbered boxes to show how segregation and independent assortment of chromosomes cause segregation and independent assortment of alleles.



Exercise 12 (Modules 9.17–9.19)

These three modules discuss the inheritance of linked genes—genes that are on the same chromosome and therefore tend to be inherited together. Their pattern of inheritance is inconsistent with Mendel’s “rules,” but they illustrate important principles of chromosome structure and behavior. (In fact, linked genes were one of the original clues that genes are on chromosomes!) After reading the modules, match each of the observations below with the statement that explains the observation. Take your time and be careful; this exercise is not easy.

Observations

- _____ 1. When two heterozygous round yellow peas are crossed, their offspring are produced in a 9:3:3:1 ratio (9 round yellow:3 round green:3 wrinkled yellow:1 wrinkled green).
- _____ 2. When two peas heterozygous for purple flowers and long pollen are crossed, the expected 9:3:3:1 ratio is not seen. The ratio is close to 3 purple long:1 red round. Similarly, when a fruit fly with red eyes and long wings (*SsCc*) is crossed with a fly with scarlet eyes and curled wings (*sscc*), offspring are not produced in the expected 1:1:1:1 ratio. Most offspring are red long and scarlet curled.
- _____ 3. When two heterozygous purple long peas are crossed, most of their offspring are purple and long or red and round. But a very small number of offspring are purple and round or red and long. Similarly, when the *SsCc* and *sscc* fruit flies are mated, nearly all their offspring are *SsCc* and *sscc*. However, a small number of offspring (about 6% of the total) are *Sscc* and *ssCc*.
- _____ 4. When a fruit fly with red eyes and long wings (*SsCc*) is crossed with a fly with scarlet eyes and curled wings (*sscc*), 94% of their offspring are *SsCc* and *sscc*, and 6% are *Sscc* and *ssCc*. In other words, the recombination frequency between the *s* and *c* alleles is 6%. When a fly with red eyes and pale body (*SsEe*) is crossed with a fly with scarlet eyes and ebony body, 27% of their offspring are *Ssee* and *ssEe*. The recombination frequency between alleles *s* and *e* is 27%.
- _____ 5. When a fly with long wings and pale body (*CcEe*) is crossed with a fly with curled wings and ebony body (*ccee*), 21% of their offspring are *Ccee* and *ccEe*. The recombination frequency between alleles *c* and *e* is 21%.

Explanations

- A. The greater the distance between two genes, the greater the opportunity for crossing over to occur between them. If crossing over is more likely, more recombinant offspring will result. If two genes are farther apart, the recombination frequency will be greater between them.
- B. Pairs of alleles on different chromosomes segregate independently during gamete formation. They follow Mendel’s principle of independent assortment. In other words, genes for different traits on different chromosomes do not tend to “stick together” when passed on to offspring.
- C. If two genes are on the same chromosome, or linked, they tend to be inherited together. Alleles on the same chromosome do not segregate independently. They tend to “stick together,” violating Mendel’s principle of independent assortment.
- D. Recombination frequencies can tell you how far apart genes are on a chromosome. If you know the distance from *a* to *b*, the distance from *a* to *c*, and the distance from *b* to *c*, you can map the sequence of genes on the chromosome.
- E. Homologous chromosomes cross over during meiosis and exchange segments. This recombines linked genes into assortments not seen in the parents.

Exercise 13 (Module 9.20)

What determines an individual's sex? Sex is generally determined by genes and chromosomes, but the process of sex determination works differently in different species. Match each group of organisms below with their system of sex determination.

- | | |
|--|---|
| _____ 1. Most plants, including peas, and corn
(earthworms and land snails too) | A. Females are ZW, males ZZ. |
| _____ 2. Humans and fruit flies | B. Females are diploid, males haploid. |
| _____ 3. Date palms and marijuana | C. Females are XX, males XO (one X). |
| _____ 4. Some butterflies, birds, and fishes | D. Females are XX, males XY. |
| _____ 5. Grasshoppers and roaches | E. Sexes not separate; all individuals produce both eggs and sperm. |
| _____ 6. Ants, bees | |
| _____ 7. Wild strawberries | |

Exercise 12 (Modules 9.20–9.23)

Genes located on the sex chromosomes—called sex-linked genes—determine many traits unrelated to maleness or femaleness. Due to the X-Y sex-determination system of humans, sex-linked traits show a peculiar pattern of inheritance. Red-green color blindness is a recessive sex-linked trait in humans. After reading these modules, see if you can describe the inheritance of color blindness by filling in the blanks below.

The genes for normal color vision and red-green color blindness, like most human sex-linked traits, are carried on the ¹ _____ chromosome. A capital letter C represents the ² _____ allele for normal vision; a small c represents the color-blindness allele. A male with normal color vision has the genotype ³ _____. (Because these genes are carried on the X chromosome, their symbols are shown as superscripts on the letter X.) A color-blind male has the genotype ⁴ _____.

A color-blind male will transmit the allele for color blindness to all his ⁵ _____ but none of his ⁶ _____. This is because only his daughters inherit his ⁷ _____ chromosome, and only his ⁸ _____ chromosome is passed to all his sons. All the children of a color-blind male and a homozygous dominant female will have normal color vision. Their sons will inherit only the normal vision allele, but their daughters will be ⁹ _____ of the color-blindness allele, thus possessing the genotype ¹⁰ _____.

A heterozygous female carrier transmits the color-blindness allele to ¹¹ _____ of her offspring. If she and a male with normal vision have children, ¹² _____ of their sons will be normal and ¹³ _____ will be color blind. ¹⁴ _____ of their daughters will be normal, because they inherit at least one dominant allele from their ¹⁵ _____. But half these daughters will be ¹⁶ _____ of the color-blindness trait, because they inherit the color-blindness allele from their mother.

Color blindness is much more common in men than in women. If a man inherits a single color-blindness allele from his ¹⁷ _____, the gene will be expressed

and he will be color blind. Because a man has only one ¹⁸ _____ chromosome, whatever genes it carries are seen in the man's phenotype. If a woman inherits just one color-blindness allele, she has relatively normal vision, because the dominant normal allele on her other X chromosome masks most of the effects of the color-blindness allele. For a woman to be color blind, she would have to inherit ¹⁹ _____ alleles from both her mother and her father, which is much less likely.

Because the Y chromosome is so much smaller than the X, it carries many fewer genes. One important gene on the Y chromosome is called the ²⁰ _____ gene. It seems to code for proteins that control other genes on the Y related to "maleness." The Y chromosome is special—it is the only chromosome unique to one sex. (Both men and women, after all, possess ²¹ _____ chromosomes.) Because the Y is passed essentially unchanged from father to son, it is useful for tracing human ²² _____. But lest men become smug about this unique genetic endowment, it is perhaps relevant to note that the Y chromosome is the only chromosome that an individual can live without. (Think about it!)

Test Your Knowledge

Multiple Choice

- How did Mendel's studies in genetics differ from earlier studies of breeding and inheritance?
 - Mendel worked with plants; earlier studies used animals.
 - Mendel was able to explain the "blending" hypothesis.
 - Mendel's work was more quantitative.
 - Mendel worked with wild species, not domesticated ones.
 - Mendel found that offspring inherit characteristics from both parents.
- A true-breeding fruit fly would be _____ for a certain characteristic.
 - homozygous dominant
 - homozygous recessive
 - heterozygous
 - Any of the above can be true-breeding.
 - a or b
- When looking at the inheritance of a single characteristic, Mendel found that a cross between two true-breeding peas (between purple and white, for example) always yielded a _____ in the F₂ generation.
 - 1:1 phenotypic ratio
 - 3:1 genotypic ratio
 - 1:2:1 phenotypic ratio
 - 3:1 phenotypic ratio
 - 1:1 genotypic ratio
- Alternative forms of genes for a particular character are called
 - traits.
 - alleles.
 - linked genes.
 - genotypes.
 - phenotypes.
- A fruit fly has two genes for eye color, but each of its sperm cells has only one. This illustrates
 - independent assortment.
 - linked genes.
 - pleiotropy.
 - polygenic inheritance.
 - segregation.
- Mendel made some crosses where he looked at two characteristics at once—round yellow peas crossed with wrinkled green peas, for example. He did this because he wanted to find out
 - how new characteristics originated.
 - whether different characteristics were inherited together or separately.
 - how plants and animals adapt to their environments.
 - whether the characteristics influence each other—whether color affects degree of roundness, for example.
 - Actually, Mendel never had a clear purpose in mind.

7. A pea plant with purple flowers is heterozygous for flower color. Its genotype is Pp . The P and p alleles in the pea plant's cells are located
 - a. next to each other on the same chromosome.
 - b. at corresponding locations on homologous chromosomes.
 - c. on the X and Y chromosomes.
 - d. at different locations on the same chromosome.
 - e. at different locations on homologous chromosomes.
8. When an individual has both I^A and I^B blood group alleles, both genes are expressed and the individual has group AB blood. This is an example of
 - a. codominance.
 - b. a dihybrid.
 - c. pleiotropy.
 - d. incomplete dominance.
 - e. linked genes.
9. How many genes are there on one chromosome?
 - a. one
 - b. two
 - c. hundreds
 - d. thousands
 - e. millions
10. Which of the following is *not* true of linked genes?
 - a. They tend to be inherited together.
 - b. They violate Mendel's principle of independent assortment.
 - c. They are on the same chromosome.
 - d. They can form new combinations via crossing over.
 - e. They are relatively rare; most genes are unlinked.
11. T. H. Morgan and his students were able to map the relative positions of genes on fruit fly chromosomes by
 - a. coloring chromosomes with dyes and observing them under a microscope.
 - b. scrambling the chromosomes and observing how the flies changed.
 - c. crossing various flies and looking at the proportions of offspring.
 - d. transplanting chromosomes from one fly to another.
 - e. looking at crosses that showed independent assortment.
12. The sex chromosomes of a human female are _____. The sex chromosomes of a human male are _____.
 - a. XX . . . XY
 - b. YY . . . XX
 - c. XX . . . YY
 - d. XY . . . XX
 - e. YY . . . XY
13. Most sex-linked traits in humans are carried on the _____ chromosome, and the recessive phenotypes are seen most often in _____.
 - a. X . . . women
 - b. X . . . men
 - c. Y . . . women
 - d. Y . . . men
14. The most common fatal genetic disease in the United States is
 - a. sickle-cell disease.
 - b. cystic fibrosis.
 - c. Huntington's disease.
 - d. hemophilia.
 - e. PKU.
15. The Y chromosome is useful for tracing ancestry because
 - a. every human has one.
 - b. it carries a large number of genes.
 - c. it carries a small number of genes.
 - d. it is the location of most sex-linked genes.
 - e. it is passed on virtually unchanged.
16. Which of the following human genetic disorders is sex linked?
 - a. hemophilia
 - b. PKU
 - c. cystic fibrosis
 - d. sickle-cell disease
 - e. all of the above
17. There are various procedures that can be used to detect genetic disorders before birth. Among the tests discussed in this chapter, _____ is the least invasive, while _____ carries the highest risk.
 - a. chorionic villus sampling . . . amniocentesis
 - b. ultrasound imaging . . . genetic screening
 - c. ultrasound imaging . . . chorionic villus sampling
 - d. chorionic villus sampling . . . ultrasound imaging
 - e. amniocentesis . . . ultrasound imaging

Essay

1. Explain why Gregor Mendel was able to figure out the principles of heredity, while many other investigators before (and some after) Mendel failed to do so.
2. If you flip two coins, the probability that you will get two heads is $1/4$, but the probability that you will get one head and one tail is $1/2$. Explain why.
3. Why are organisms such as peas and fruit flies better subjects for genetics studies than human beings?
4. What determines a human's sex? Describe two other systems of sex determination in different organisms.
5. What are some of the ethical questions posed by genetic testing?

Apply the Concepts

Multiple Choice

1. A brown mouse is mated with a white mouse. All of their offspring are brown. If two of these brown offspring are mated, what fraction of their offspring will be white?
 - a. all
 - b. none
 - c. $1/4$
 - d. $1/2$
 - e. $3/4$
2. Suppose you wanted to know the genotype of one of the brown F_2 mice in question 1. The easiest way to do it would be to
 - a. keep careful records of the parent mice.
 - b. mate it with a brown mouse.
 - c. mate it with a mouse of its own genotype.
 - d. mate it with a white mouse.
 - e. It can't be done.
3. Some dogs bark while trailing; others are silent. The barker gene is dominant, the silent gene recessive. The gene for normal tail is dominant over the gene for screw (curly) tail. A barker dog with a normal tail who is heterozygous for both characteristics is mated to another dog of the same genotype. What fraction of their offspring will be barkers with screw tails?
 - a. $3/4$
 - b. $9/16$
 - c. $3/16$
 - d. $1/4$
 - e. $1/16$
4. Two heterozygous tall pea plants with purple flowers are crossed. The probability that one of their offspring will have white flowers is $1/4$. The probability that one of their offspring will be short is $1/4$. What is the probability that one of their offspring will be short with white flowers?
 - a. 0
 - b. $1/16$
 - c. $1/8$
 - d. $1/4$
 - e. $1/2$
5. A young woman had a baby. Her blood group is AB. The baby's blood group is A. There are two possible fathers: Jim is group A, and Michael is group O. Which man could be the father?
 - a. either
 - b. Jim
 - c. Michael
 - d. neither
 - e. impossible to tell given this evidence
6. Which of the following illustrates pleiotropy?
 - a. In fruit flies, the genes for scarlet eyes and hairy body are located on the same chromosome.
 - b. Matings between earless sheep and long-eared sheep always result in short-eared offspring.
 - c. Wheat kernels can range from white to red in color, a trait controlled by several genes.
 - d. The human cystic fibrosis gene causes many symptoms, from respiratory distress to digestive problems.
 - e. An individual with both I^A and I^B alleles has blood group AB.
7. When two gray-bodied fruit flies are mated, their offspring total 86 gray-bodied males, 81 yellow-bodied males, and 165 gray-bodied females. The allele for yellow body is
 - a. sex-linked and dominant.
 - b. not sex-linked and dominant.
 - c. sex-linked and recessive.
 - d. not sex-linked and recessive.
 - e. impossible to say on the basis of this information.

8. In fruit flies, the allele for red eyes is dominant, and the allele for purple eyes is recessive. Normal gray body is dominant, and black body is recessive. A geneticist mated a heterozygous red-gray male with a purple-black female. She predicted that there would be four phenotypes of offspring in equal numbers, but she was wrong. Instead, 48% of the offspring were red-gray, 46% were purple-black, 3% were red-black, and 3% were purple-gray. She concluded that in the male, the red and gray genes were linked, and in the female the purple and black genes were linked. If this is the case, how would you account for the red-black and purple-gray offspring?
 - a. This is an example of pleiotropy.
 - b. Body color and eye color are quantitative characteristics.
 - c. Crossing over during meiosis recombined the genes.
 - d. This cross shows incomplete dominance at work.
 - e. Segregation of alleles occurred during meiosis.
9. Red-green color blindness is a human recessive sex-linked trait. A man and a woman with normal vision have a color-blind son. What is the probability that their next child will also be a color-blind son?
 - a. 0
 - b. $1/8$
 - c. $1/4$
 - d. $1/2$
 - e. $3/4$
10. On a pedigree tracing the inheritance of PKU, a horizontal line joins a black square and a half-black circle. What fraction of this couple's children would you expect to suffer from PKU?
 - a. none
 - b. $1/4$
 - c. $1/2$
 - d. $3/4$
 - e. all
11. Duchenne muscular dystrophy is caused by a sex-linked recessive allele. Its victims are almost invariably boys, who usually die before the age of 20. Why do you suppose this disorder is almost never seen in girls?
 - a. Sex-linked traits are never seen in girls.
 - b. The allele is carried on the Y chromosome.
 - c. Nondisjunction occurs in males but not in females.
 - d. Males carrying the allele don't live long enough to be fathers.
 - e. A sex-linked allele cannot be passed on from mother to daughter.
12. Which of the following would be most useful for preventing a particular genetic disorder?
 - a. knowing how the allele causes its phenotypic effects
 - b. being able to identify carriers
 - c. a test that can determine whether a fetus suffers from the disorder
 - d. knowing which chromosome bears the allele that causes the disorder
 - e. tracing the trait back through parents and grandparents

Essay

1. Two apparently normal parents have a daughter who suffers from agammaglobulinemia, an inherited defect of the immune system. Use a Punnett square to show how two normal parents could have a child afflicted with an inherited disease. What are the parents' genotypes? The daughter's genotype? What is the probability that their second child will also have agammaglobulinemia?
2. A pea plant with purple flowers and green pods is crossed with a plant that has white flowers and yellow pods. All the offspring have purple flowers and green pods. If two of these F_1 peas are crossed, what phenotypes will be seen in the F_2 generation, and in what proportions?
3. Freckles is dominant, no freckles recessive. A man with freckles and a woman with no freckles have three children with freckles and one with no freckles. What are the genotypes of the parents and children?
4. The inheritance of flower color in snapdragons illustrates incomplete dominance: When a red snapdragon is crossed with a white one, all their offspring are pink. What offspring would be produced, in what proportions, if two of these pink snapdragons were crossed? What offspring would be produced, in what proportions, if a pink snapdragon was crossed with a white one?