Name: _____

**Extra Heredity Practice Packet**

**Pedigree**

This feature is designed to get you thinking about pedigree analysis. It highlights how pedigrees are used by disease researchers, as well as how they can inform patients and families.

Answer the questions throughout this feature. It should help you see that understanding and using pedigree information is not always clear-cut.

<u>It Runs in the Family</u>

When more than one individual in a family is afflicted with a disease, it suggests that the disease might be inherited.

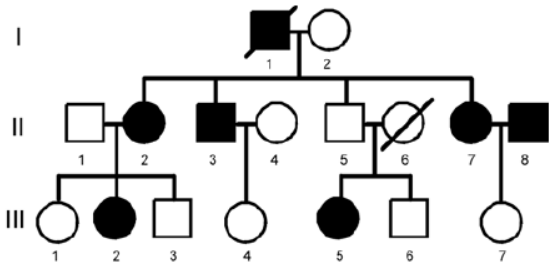
A basic method for determining the pattern of inheritance of any trait, including a disease, is to look at its occurrence in several individuals within a family, spanning as many generations as possible. Family history information is usually combined with information from medical tests, increasingly including genetic tests.

From family history and medical test results, a physician, genetic counselor, or researcher can draw a pedigree. A pedigree is simply a family tree that uses a particular set of standardized symbols.

<u>Introduction to Pedigree Symbols</u>

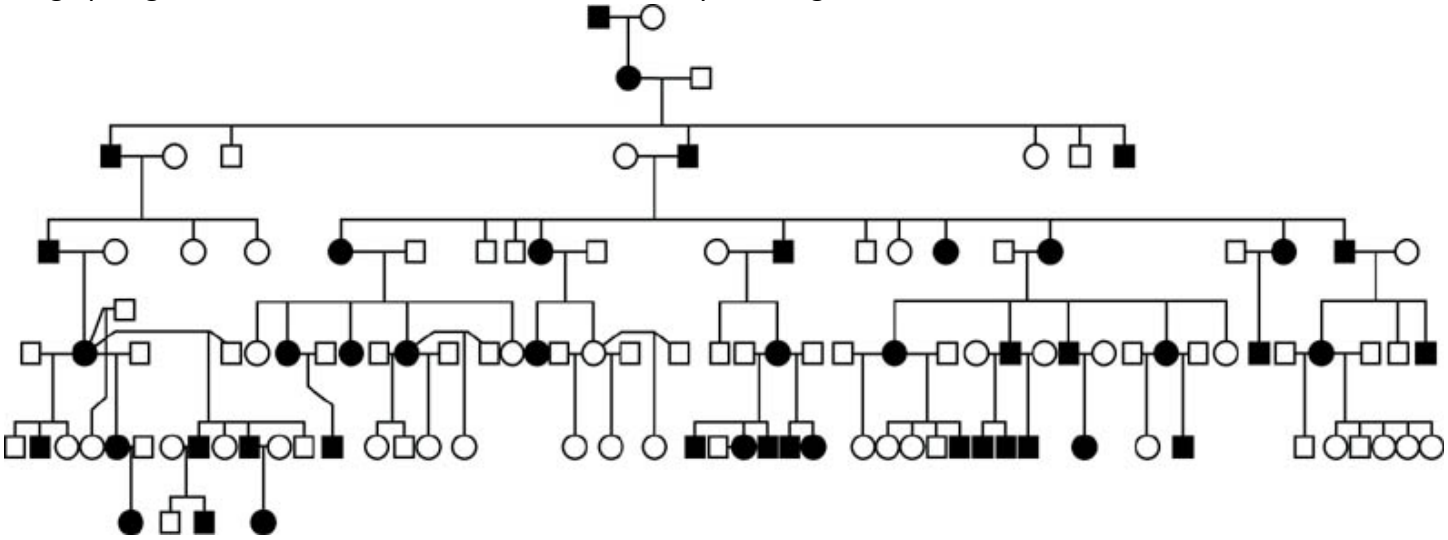
- Males are represented by squares.
- Females are represented by circles.
- Filled symbols show individuals who exhibit the trait in question.
- A horizontal line between two symbols represents a mating.
- A vertical line descends from parents to a horizontal line shared by all their offspring.A diagonal line through a symbol indicates that person is deceased.
- Roman numerals (I, II, III,…) represent generations.
- Arabic numerals (1, 2, 3,…) represent the birth order of siblings.
- Specific combinations of numerals (like II-3) uniquely identify each individual in the pedigree. Many pedigrees do not include numerals.

1. Individual II-5 in the pedigree shown to the right is:
   A. male who does not exhibit the trait.
   B. A father.
   C. Has three affected siblings.
   D. All of the above.



Large Pedigree

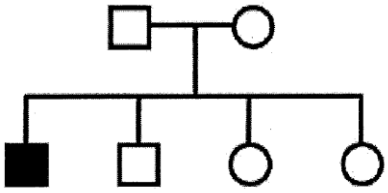
This large pedigree was collected from an extended family all living in a small town.



2. This disease is very severe and strikes early in childhood.
   A) True
   B) False

3. This large pedigree shows a dominant trait because:
   A) Mostly males are affected.
   B) The family is very large.
   C) The trait shows up every generation.
   D) Filled symbols always show dominance.

4. Directions: analyze the following pedigree to figure out which type of inheritance the disorder follows. Make sure to look at male/female ratios, who might be a carrier, who doesn't have the disease, etc.



Could this trait be inherited as a simple…

| | | | If yes, then suggest a genotype | | |
|---|---|---|---|---|---|
| | | | **Father** | X | **Mother** |
| a. Autosomal recessive | Yes | No | _____ | X | _____ |
| b. Autosomal dominant | Yes | No | _____ | X | _____ |
| c. X-linked recessive | Yes | No | _____ | X | _____ |
| d. X-linked dominant | Yes | No | _____ | X | _____ |
| e. Y-linked recessive | Yes | No | _____ | X | _____ |

5. If black and white true-breeding mice are mated and the result is all gray offspring, what inheritance pattern would this be indicative of?
   A. codominance
   B. dominance
   C. incomplete dominance
   D. multiple alleles

6. The ABO blood groups in humans are controlled by the $I^A$, $I^B$, and i alleles. The $I^A$ allele encodes the A blood group antigen, $I^B$ encodes B, and i encodes O. Both A and B are dominant to O. If a heterozygous blood type A parent ($I^Ai$) and a heterozygous blood type B parent ($I^Bi$) mate, one quarter of their offspring will have AB blood type ($I^AI^B$) in which both antigens are expressed equally. Therefore, the ABO blood groups are an example of _____.
   A. codominance and incomplete dominance
   B. incomplete dominance only
   C. multiple alleles and incomplete dominance
   D. multiple alleles and codominance

7. Petunias can be blue, red, or violet. When a blue flower is crossed with a red flower, all the resulting flowers are violet. Two violet petunias are crossed. Which is the most probable result of the cross?
   A. 75% of the flowers are blue and 25% of the flowers are red.
   B. 50% of the flowers are blue and 50% of the flowers are red.
   C. 75% of the flowers are red and 25% are blue.
   D. 25% of the flowers are blue, 50% of the flowers are violet, and 25% of the flowers are red.

8. Scientists are trying to figure out the dominance hierarchy for a newly discovered plant. They have found that when a true-breeding yellow plant is crossed to a true-breeding green plant, the resulting offspring have distinct spots of yellow and green. What is the most likely explanation for this result?
   A. Codominance
   B. Incomplete dominance
   C. Green is the dominant allele
   D. Yellow is the dominant allele

9. In a specific type of flower the genes coding for color display codominance. What would you expect the phenotype to be for a cross between a flower homozygous for white coloration and a flower homozygous for red coloration?
   A. White
   B. Distinct red and white spots
   C. Red
   D. Pink

10. Dr. Salk, a hospital director, calls you in a state of shock. When he has finally calmed down enough to talk coherently, you learn that one of his orderlies came on duty the previous night, as a joke proceeded to exchange wrist bands on the four babies in the nursery, all of whom are the same age. As a first step in unravelling this mess, you blood type the parents and babies with the exception of Mr. and Mrs. Dorsett who refuse to do anything until they have talked with a lawyer. The results of the parents' blood tests are:

| | |
|---|---|
| Mr. Narduzzi – Type AB | Mrs. Narduzzi – Type O |
| Mr. Heme – Type B | Mrs. Heme – Type B |
| Mr. Youngblood – Type O | Mrs. Youngblood – Type O |
| Mr. Dorsett – Not typed | Mrs. Dorsett – Not typed |

Assume that the individuals listed are the true parents, <u>each set of parents having had one of the four babies</u>. Indicate the one family to which each of the following children belons on the basis of blood type. Explain your reasoning.

| | |
|---|---|
| Baby 1 (Type B) | |
| Reason: | |
| Baby 2 (Type A) | |
| Reason: | |
| Baby 3 (Type AB) | |
| Reason: | |
| Baby 4 (Type O) | |
| Reason: | |

**Non-Mendelian Genetics: Sex-linked Genetics**

In humans, hemophilia is a sex-linked trait. Females can be normal, carriers, or have the disease. Males will either have the disease or not (but they won't ever be carriers since they only have one copy of the X-chromosome).

| | |
|---|---|
| $X^HX^H$ – female, normal | $X^HY$ – male, normal |
| $X^HX^h$ – female, carrier | $X^hY$ – female, hemophiliac |
| $X^hX^h$ – female, hemophiliac | |

11. A woman who is a carrier marries a man who has hemophilia. Show the cross.
    a. What is the probability that their children will have the disease? _____
    b. What is the probability that their son will have the disease? _____
    c. What is the probability that their daughter will have the disease? _____

12. A woman who is a carrier marries a normal man. Show the cross.
    a. What is the probability that their children will have the disease? _____
    b. What is the probability that their son will have the disease? _____
    c. What is the probability that their daughter will have the disease? _____

13. A woman who has hemophilia marries a normal man. Show the cross.
    a. What is the probability that their children will have the disease? _____
    b. What is the probability that their son will have the disease? _____
    c. What is the probability that their daughter will have the disease? _____

In cats, the gene for calico (multicolored) is codominant. Females that receive a B and an R gene have black and orange splotches on white coats. Males can only be either black or orange, but never calico since they only have one copy of the X-chromosome. A calico female cat will have the genotype of $X^BX^R$.

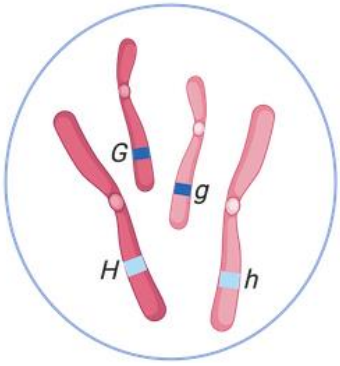
14. Show the cross of a female calico cat with a black male.
    a. What percentage of the kittens will be black and male? _____
    b. What percentage of the kittens will be calico and male? _____
    c. What percentage of the kittens will be calico and female? _____

15. Show the cross of a female black cat with a male orange cat.
    a. What percentage of the kittens will be calico and female? _____
    b. What color will all the male cats be? _____

16. The diagram below shows two pairs of homologous chromosomes in a diploid cell. The larger chromosomes have different alleles of Gene H, and the smaller chromosomes have different alleles of Gene G.

= maternally inherited

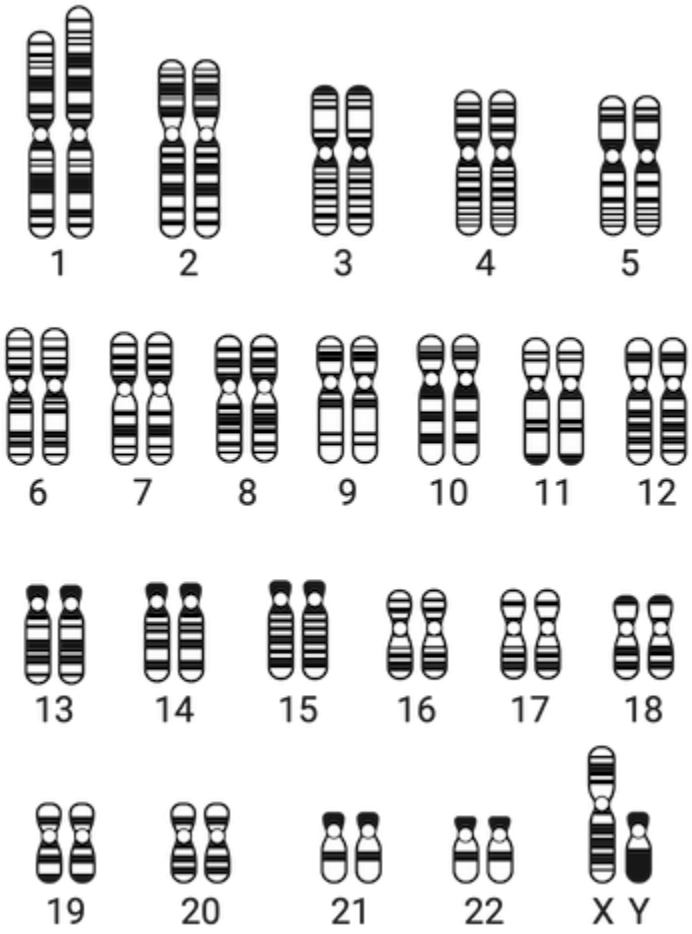
= paternally inherited




Which of the following statements is true regarding the gametes formed when cells like this one undergo meiosis?

A. Gametes with alleles G and H occur at a lower frequency than gametes with alleles g and h.
B. Gametes with alleles G and g occur at the same frequency as gametes with alleles G and H.
C. Gametes with alleles G and H occur at the same frequency as gametes with alleles g and H.
D. Gametes with alleles H and h occur at a higher frequency than gametes with alleles G and h.

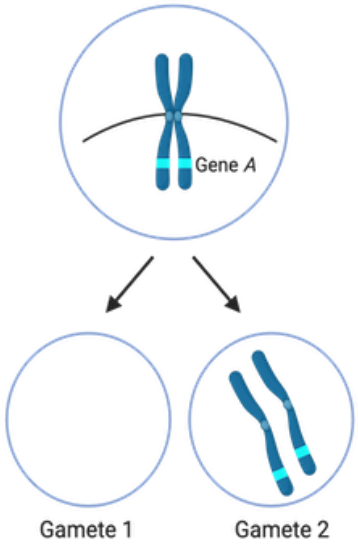
17. The following diagram shows a karyotype of a certain human.



Based on the karyotype, which of the following statements is most likely true?

A. The individual has a genetic condition caused by the X and Y chromosomes being different sizes.
B. The individual has a genetic condition caused by a nondisjunction event.
C. The individual has a genetic condition caused by a chromosomal duplication.
D. The individual has a genetic condition caused by a single nucleotide substitution on chromosome 16.

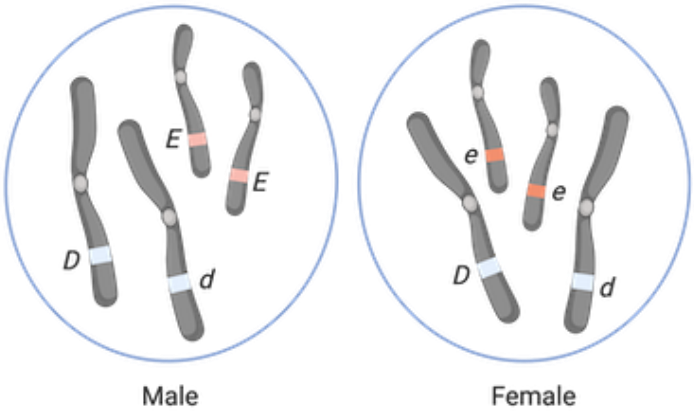
18. The diagram below shows a nondisjunction event for a single human chromosome during gamete formation. The chromosome depicted in the diagram contains Gene A.




If Gamete 2 is fertilized, how will the nondisjunction event affect the resulting embryo?

A. The embryo will not be able to produce the Gene A protein product.
B. The embryo will have four copies of Gene A in each cell.
C. The embryo will not be viable because monosomy is not typically tolerated in humans.
D. The embryo will have higher-than-normal levels of the Gene A protein product in its tissues.

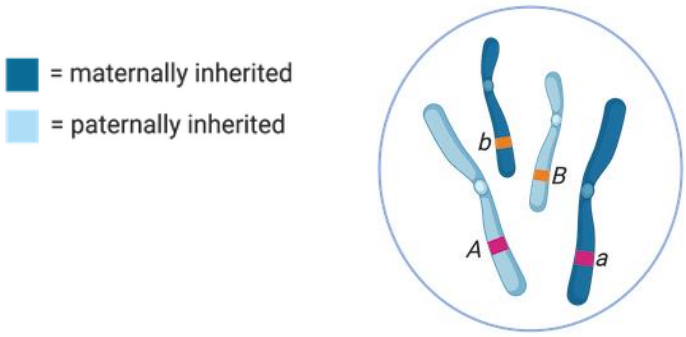
19. The following diagram depicts two diploid cells, one from a male and one from a female of the same species. In each cell, two pairs of homologous chromosomes are shown. The larger chromosomes have different alleles of Gene D, and the smaller chromosomes have different alleles of Gene E.




If the male and female mate, which of the following will be true about their offspring?

A. All of the offspring will have a parental genotype.
B. None of the offspring will have a parental genotype.
C. Roughly half of the offspring will have the genotype of the female parent.
D. Roughly a quarter of the offspring will have the genotype of the male parent.

20. The diagram below shows two pairs of homologous chromosomes in a diploid cell. The larger chromosomes have different alleles of Gene A, and the smaller chromosomes have different alleles of Gene B.

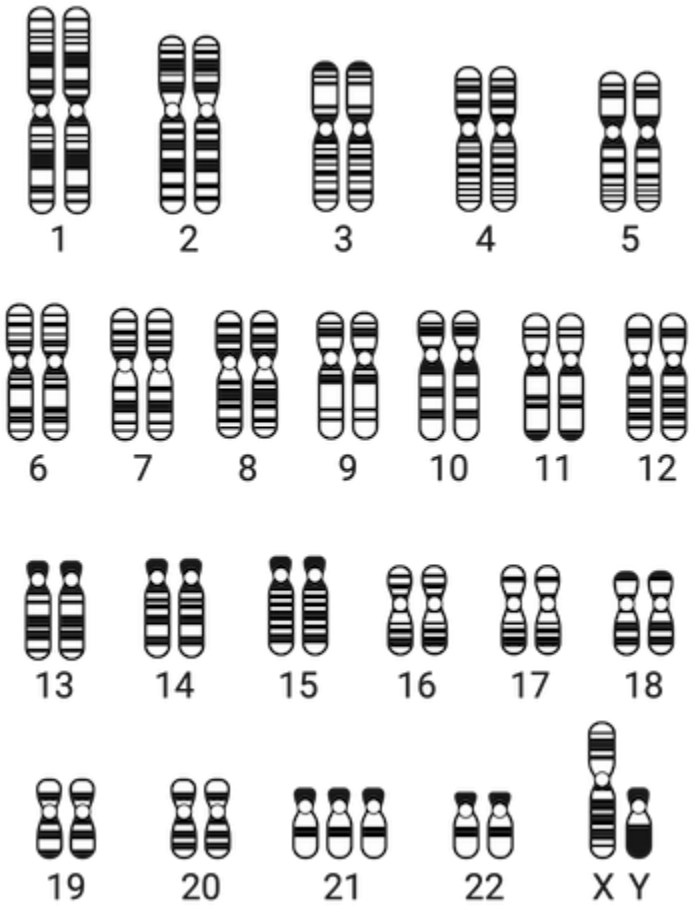



If the cell undergoes meiosis, which of the following is true regarding the allele combinations in the resulting gametes?

A. Allele combination Aa is just as likely to occur in a gamete as allele combination aB is.
B. Allele combination AB is just as likely to occur in a gamete as allele combination Ab is.
C. Allele combination ab is less likely to occur in a gamete than allele combination AB is.
D. Allele combination Bb is more likely to occur in a gamete than allele combination Ab is.

21. The following diagram shows a karyotype of a certain human.

Based on the karyotype, which of the following statements is most likely true?




A. The individual has a genetic condition caused by the nondisjunction of chromosomes during meiosis.
B. The individual has a genetic condition caused by an autosomal duplication that occurred during gamete formation.
C. The individual has a genetic condition caused by a single nucleotide substitution on chromosome 3.
D. The individual has a genetic condition caused by having X and Y chromosomes of different sizes.

## (OPTIONAL) Multiple Allele Challenging Question

You are a scientist performing the first analysis of the genetic basis for the inheritance of flower color in a certain species of wildflower. You begin your investigation by observing that there are four different flower colors in the local wild population: white, red, blue and purple. Your first assumption (hypothesis) is that you are looking at the effects of a single gene, so operate under that assumption. You collect a variety of samples of all colors, take them back to your greenhouse, and begin making crosses. Remember, you are crossing members of a wild population—you have no idea whether any of your plants are homozygous or heterozygous. Here are the various results you observe:

| | |
|---|---|
| White X White | All offspring always produce white flowers. |
| Red X Red | In some matings, all offspring produce red flowers.<br>In other matings, some of the offspring produce red flowers, some white, with red flowering offspring outnumbering white flowering offspring. |
| Blue X Blue | In some matings, all offspring produce blue flowers.<br>In other matings, some of the offspring produce blue flowers, some white with blue flowering offspring outnumbering white flowering offspring. |
| Purple X Purple | Always produces a mixture of red, blue and purple flowering offspring, with purple most frequent, followed by red and blue in roughly equal numbers. |
| White X Red | In some matings, all offspring produce red flowers.<br>In other matings, some of the offspring produce red flowers, some white.<br>Red and white occur in roughly equal numbers. |
| White X Blue | In some matings, all offspring produce blue flowers.<br>In other matings, some of the offspring produce blue flowers, some white.<br>Blue and white occur in roughly equal numbers. |
| White X Purple | Always produces roughly equal numbers of blue flowering offspring and red flowering offspring. |
| Red X Blue | Always produces purple offspring, but in some matings also produces red and/or blue offspring, and/or white offspring. |
| Red X Purple | Always produces red and purple offspring, sometimes mixed with blue. |
| Blue X Purple | Always produces blue and purple offspring, sometimes mixed with red. |

a. How many alleles are governing flower color in this plant? What color does each of these alleles produce (in other words, what colors are your homozygous plants)?

b. Explain the dominance relationships among your alleles, and explain the results of each of the crosses described above.