Unit 10 Meiosis & Inheritance Learner Packet

Why did Mendel use pea plants for his experiments?

- Easy _____ and _____
- Plants have many _____ that are heritable traits
- Able to control _____ of peas: self vs. cross pollination *(see 11.2 research method box – plant sex!)*
- Choose characters (traits) that exist in _____ distinct forms
- Start experiments with true (pure) breeding [_____] lines of plants for a character/trait
- Documented _____ cross & results of ALL _____
- Able to perform lots of _____ in short time; obtain _____ of offspring

Mendel's results: Figure 11. 1

Pearson. (2020). In *Biology In Focus* (Third Edition, pp. 220–220).

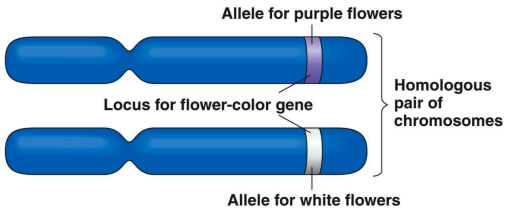
Table 14.1 The Results of Mendel's F_1 Crosses for Seven Characters in Pea Plants

Character	Dominant Trait	x	Recessive Trait	F_2 Generation Dominant:Recessive	Ratio
Flower color	Purple	×	White	705:224	3.15:1
Flower position	Axial	×	Terminal	651:207	3.14:1
Seed color	Yellow	×	Green	6,022:2,001	3.01:1
Seed shape	Round	×	Wrinkled	5,474:1,850	2.96:1
Pod shape	Inflated	×	Constricted	882:299	2.95:1
Pod color	Green	×	Yellow	428:152	2.82:1
Stem length	Tall	×	Dwarf	787:277	2.84:1

What do you notice about the ratios for dominant: recessive forms for ALL 7 traits.

Mendel's conclusions:

- There are _____ versions of a trait (gene) = allele
- Alleles are at the same locus on _____ chromosomes



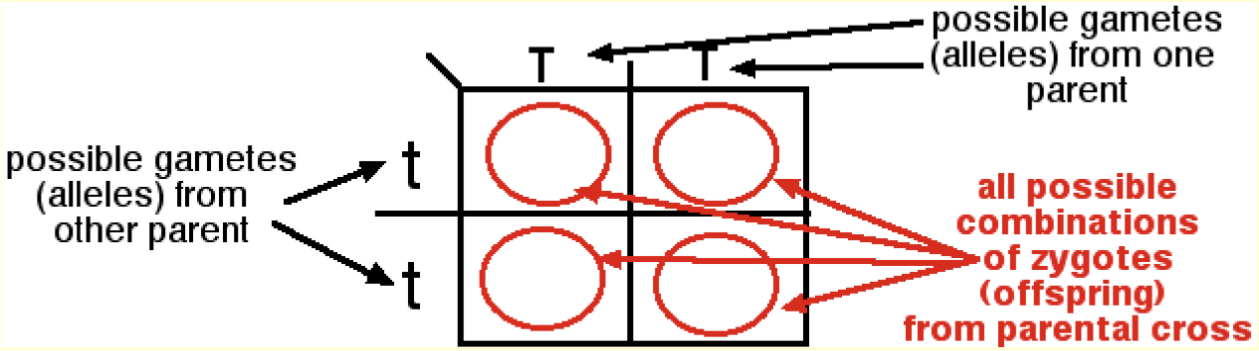
- Offspring receive _____ alleles of each trait: _____ from each parent
- Homologous chromosomes 're-pair' when gametes combine to form _____.
- Each allele (on homologous Xome) _____ during gamete formation: *Law of Segregation* (Law of meiosis)
- If alleles for a trait are different (Rr) then there is a _____% chance that a gamete receives one allele (R) and 50% chance the gamete receives the other allele (r)
- If alleles are different: Rr, then one allele 'R' is fully expressed as phenotype & other allele 'r' has no phenotypic effect = *Law of Dominance*

Genetics & Inheritance Vocabulary:

- Generations: P_1, F_1, P_2, F_2
- Trait, Gene, Allele
- Dominant allele, recessive allele
- Homozygous, Heterozygous
- Genotype
- Phenotype
- Genotypic Ratio
- Phenotypic Ratio
- Test Cross *(see figure 11. 7 in eText)*
- Hybrids: Monohybrid, Dihybrid, Trihybrid

STRATEGY FOR HOW TO SOLVE GENETICS PROBLEMS:

1. Read the problem *(more than once)*
2. Define symbols: A = dominant allele phenotype, a = recessive allele phenotype
3. Write any information given in the problem: parent's genotypes, offspring ratios, etc
4. Determine gametes produced by each parent
5. Construct a Punnett Square to help determine probabilities of genotypes & phenotypes



6. Answer the question of the problem and circle your final answer!

PATTERNS OF INHERITANCE:

For all Mendelian monohybrid crosses, there are three different genotypes: AA, Aa, aa and TWO different phenotypes: dominant, recessive

Mendelian Monohybrid cross	Genotypic Ratio	Phenotypic Ratio
AA x AA		
AA x Aa	**2AA : 2Aa : 0aa**	
AA x aa		
Aa x Aa		
Aa x aa		**2 dom : 2 rec**
aa x aa		

Pedigrees (D)

- TRACK the inheritance of one (or more) trait(s) through many generations of related individuals
- DETERMINE how a trait is inherited & passed from parents to offspring: *mode of inheritance*
- SHADE people who show recessive form of a trait OR a specific trait that you're keeping track of
- PRACTICE interpreting pedigrees & determining genotypes for families – **The Geller Family…**
- There are RULES for creating pedigrees
    - **Square** ▢ = MALE; **circles** ◯ = FEMALE
    - **Shaded shape** = homozygous recessive **OR** trait being studied
    - **Half shaded shape** = carrier (heterozygous)*[for sex-linked traits only]*
    - **Father** written on left, **mother** on the right
    - **Horizontal line** = marriage (& sex)
    - **Vertical line** = offspring produced; might be a bracket to show more than one offspring was produced
    - Offspring organized by age: **LEFT** = *oldest* → **RIGHT** = youngest
    - Each generation is in one horizontal row; label generations with Roman numerals: I, II, III, IV
    - Make a symbol key for all traits: shaded/unshaded, phenotype, genotype
    - **TITLE** the pedigree: "INSELBERGER / JAMES FAMILY"

Modes of Inheritance (Targets B & C)

- **Mendelian Inheritance:** Simple dominance, recessive
  Three genotypes and two phenotypes

- **Non Mendelian Inheritance:**
  Three (or more) genotypes and three (or more) phenotypes

    - Incomplete dominance

    - Codominance

    - Multiple alleles

    - Sex-linked traits

Incomplete Dominance: (section 11.3)

The dominant and recessive alleles of a heterozygote create a NEW phenotype which is a BLEND of the dominant and recessive alleles.

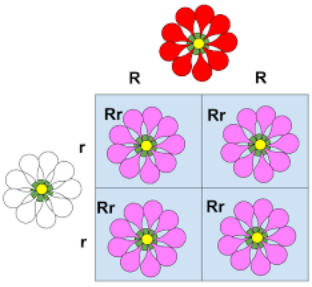
EXAMPLE PROBLEM: What is the phenotypic and genotypic ratio of a cross between a homozygous dominant red flower and a homozygous recessive white flower if flower color is incompletely dominant?

DO NOT DEFINE ALLELE SYMBOLS:

~~R = red flowers~~
~~r = white flowers~~

Relate Genotypes to specific Phenotypes:

RR = Red flowers ONLY
Rr = pink flowers ONLY
rr = white flowers ONLY



Co-dominance: **(section 11.3)**

The dominant and recessive allele are BOTH expressed in the phenotype of the heterozygote.

One allele is not more dominant compared to the other allele…each allele is equally expressed - proteins are made for BOTH genes! (ex. Co-president, Co-operate)

EXAMPLE PROBLEM: In cattle, coat color is codominant. A roan bull is crossed with a roan cow. Determine the probability for the resulting offspring to have red fur, white fur, or roan fur (both red and white).

Cannot define allele symbols

~~R = red fur~~
~~r = white fur~~

Relate genotypes to phenotypes

RR = Red fur ONLY
Rr = Roan fur ONLY
rr = white fur ONLY

Multiple Alleles (Section 11.3)

The human blood type trait exists as three alleles: I^A, I^B, *i*

"The *I* designation stands for isoagglutinogen, another term for antigen.[31] The gene encodes a glycosyltransferase—that is, an enzyme that modifies the carbohydrate content of the red blood cell antigens. The gene is located on the long arm of the ninth chromosome (9q34)."[32]

CITATION: Wikimedia Foundation. (2025, February 13). *Abo Blood Group System*. Wikipedia.

https://en.wikipedia.org/wiki/ABO_blood_group_system#:~:text=The%20I%20designation%20stands%20for,the%20red%20blood%20cell%20antigens

These three alleles create *6 different genotypes* and 4 different phenotypes (blood types)!

Genotype	Phenotype
I^AI^A	type A blood
I^Ai	type A blood
I^BI^B	type B blood
I^Bi	type B blood
I^AI^B	type AB blood
ii	type O blood

Based on genotype & phenotype info:

- I^A is dominant to *i*
- I^B is dominant to *i*
- I^A I^B are Co-dominant *(both phenotypes are present & expressed in the heterozygote)*
- *i* is recessive to both I^A and I^B

	Group A	Group B	Group AB	Group O
Red blood cell type	A	B	AB	O
Antibodies in plasma	Anti-B	Anti-A	None	Anti-A and Anti-B
Antigens in red blood cell	A antigen	B antigen	A and B antigens	None

EXAMPLE PROBLEM #1: A man with type B blood whose father had type O blood marries a woman with type AB blood. What is the phenotypic ratio for their possible offspring?

EXAMPLE PROBLEM #2: A man with type B blood whose father had type O marries a woman with type AB blood. What is the probability that any of their possible children will have a different blood type from their mother and father?

NOTE: *Rh factor (+ or -) is a completely independent trait from blood type. Both blood type and Rh factor are relevant data when infusing blood into a patient. Check out THIS LINK to learn more about the Rh factor trait.*

Sex-linked Traits (section 12.2)

A. You have 23 pairs of chromosomes

B. 22 chromosomes are called "autosomes"

Autosomes are "body" chromosomes and contain genes necessary for your body cells to perform daily functions EX: *digest lactose, make specific transmembrane proteins, etc.*

C. ONE pair is the sex chromosomes

This pair determines your biological sex (male or female)

XX means female

XY means male

D. The Sex Chromosomes

- The X chromosome is big & has lots of genes
- The Y chromosome is small & contains *few* genes
- Therefore, any sex-linked trait is present *only* on the X - sex chromosome
- Sex-linked recessive diseases* include:

•Hemophilia - *inability of blood to clot after a cut or bruise*

•Color Blindness - *can't see one or more colors such as blue, green, red*

•Duchenne Muscular Dystrophy - *Progressive weakening of muscles & loss of coordination. Usually results in death by age 20*

** Yes! There are also sex-linked DOMINANT disorders!*

E. In order for a girl to have a sex-linked recessive disease, she must have TWO copies of the recessive allele because she has two X chromosomes

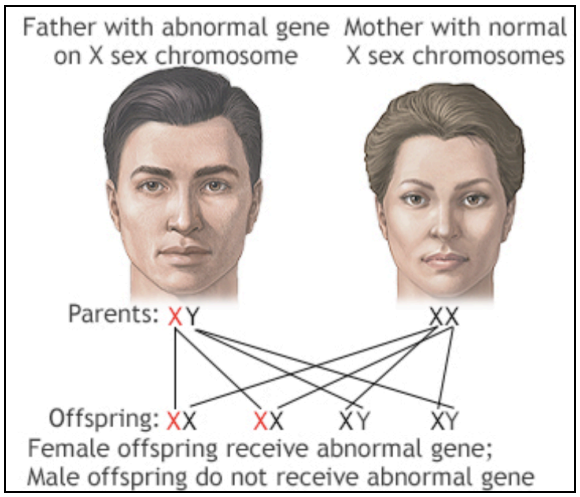
→ She receives one recessive allele on the X chromosome from her mother and the other recessive allele on the X chromosome from her father.

→ A boy only needs ONE recessive allele because he only has ONE X chromosome.

*The son receives the sex-linked recessive allele from his _____ because…

F. Mothers pass ___ sex chromosome to their sons and ___ sex chromosome to their daughters.

G. Fathers pass ___ sex chromosome to their sons and ___ sex chromosome to their daughters.

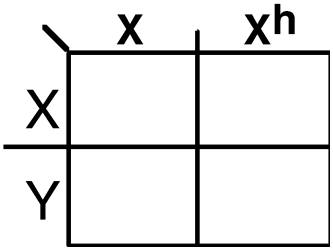


EXAMPLE PROBLEM: Hemophilia is a sex-linked, recessive disease that prevents blood from clotting. If mom is a *carrier* (heterozygote) for hemophilia and dad does not have hemophilia, what is the probability that their male child will have hemophilia?

X or X^H = normal

X^h = has hemophilia

Y = boy



Meiosis Vocabulary:

- HAPLOID = ___
- _____ the total # of chromosomes
- # of chromosomes in one _____
- # of chromosomes from one _____
- _____ (sex cells):
  - _____
  - _____

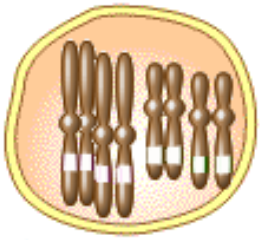
- DIPLOID = ___
- _____ # of chromosomes
- _____ in ___sets (2n)
- _____ of homologous chromosomes
- _____ (body cells)

*Draw a nucleus 2n = 4 in G1 of interphase. Label a **homologous pair***	*Draw a nucleus 2n = 4 in G2 of interphase. Label ONE example of **nonsister chromatids, sister chromatids, homologous pair.***

Comparing Mitosis & Meiosis (Target V)

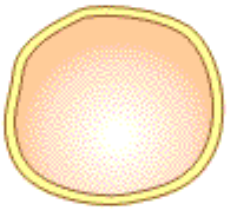
Review the process of Mitosis by creating a color key to indicate the colored bands on each chromosome & draw your results in each empty circle based on the initial model.

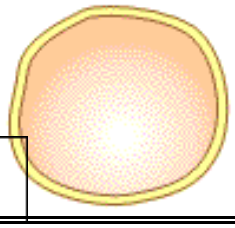
2n = ____



P-M-A-T

Number of chromosomes per daughter cell after mitosis = _____





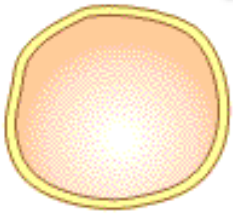
Mitosis separates sister _____

2n = ____

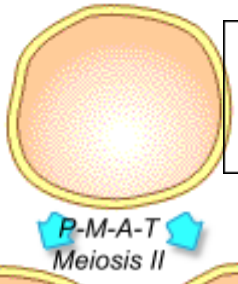
Meiosis

2n = ____

P-M-A-T
Meiosis I

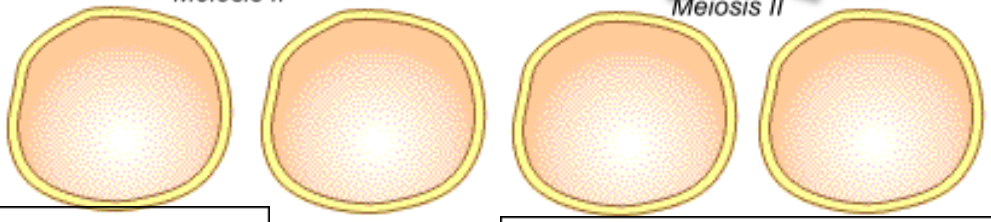


P-M-A-T
Meiosis II



P-M-A-T
Meiosis II

Meiosis I separates homologous _____



Number of chromosomes per daughter cell after meiosis = __

n = _____

Meiosis II separates sister _____

Compare your final results for Mitosis and Meiosis with 2 other groups @ another table. Were the results the ***same or different*** for Mitosis? (circle one) And for Meiosis? ***same or different*** ?

Meiosis ("Know" I)

Chromosome Number

For Questions 1–7, write True on the line if the statement is true. If the statement is false, change the underlined word to make the statement true and write the corrected term on the line.

_____ **1.** A gamete must contain one complete set of genes.

_____ **2.** Genes are located at specific positions on loci.

_____ **3.** A pair of corresponding chromosomes is homozygous.

_____ **4.** One member of each homologous chromosome pair comes from each gene.

_____ **5.** A cell that contains both sets of homologous chromosomes is diploid.

_____ **6.** The gametes of sexually reproducing organisms are haploid.

_____ **7.** If an organism's haploid number is 6, its diploid number is 3.

Phases of Meiosis

On the lines provided, identify the event as occurring in either meiosis I or meiosis II.

_____ **8.** Each replicated chromosome pairs with its corresponding homologous chromosome.

_____ **9.** Crossing-over occurs between tetrads.

_____ **10.** Paired homologous chromosomes line up across the center of the cell.

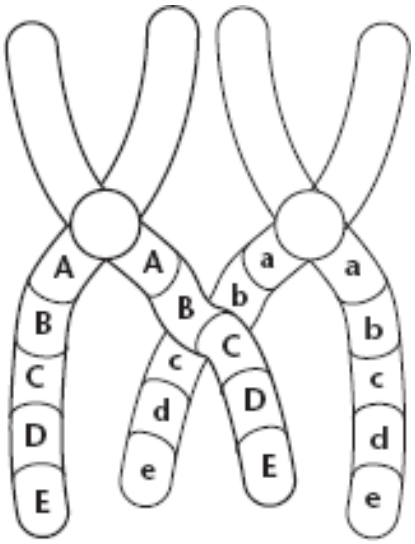
_____ **11.** Spindle fibers pull each homologous chromosome pair toward an opposite end of the cell.

_____ **12.** A nuclear membrane forms around each cluster of chromosomes and cytokinesis follows, forming two new cells.

_____ **13.** Chromosomes consist of two chromatids, but they do not pair to form tetrads.

_____ **14.** A nuclear membrane forms around each cluster of chromosomes and cytokinesis follows, forming four new cells.

Use this diagram to answer Questions 15–17.



15. What does the diagram show?

_____

_____

16. During what phase of meiosis does this process occur?

_____

_____

17. What is the result of this process?

_____

_____

For Questions 18–23, complete each statement by writing the correct word or words.

WORD BANK:

10 (ten)	2 (two)	4 (four)
23 (twenty three)	16 (sixteen)	half
even	8 (eight)	2 (two)

18. A diploid cell that enters mitosis with 16 chromosomes will divide to produce _____daughter cells. Each of these daughter cells will have _____chromosomes.

19. If the diploid number of chromosomes for a human is 46, then each daughter cell after mitosis will contain _____chromosomes.

20. A diploid cell that performs *meiosis* with 16 chromosomes will pass through _____cell divisions, producing _____daughter cells, each with _____ chromosomes.

21. Gametes are haploid because gametes have _____ the number of chromosomes as a diploid cell.

22. If an organism's haploid number is 5, then its diploid number is _____.

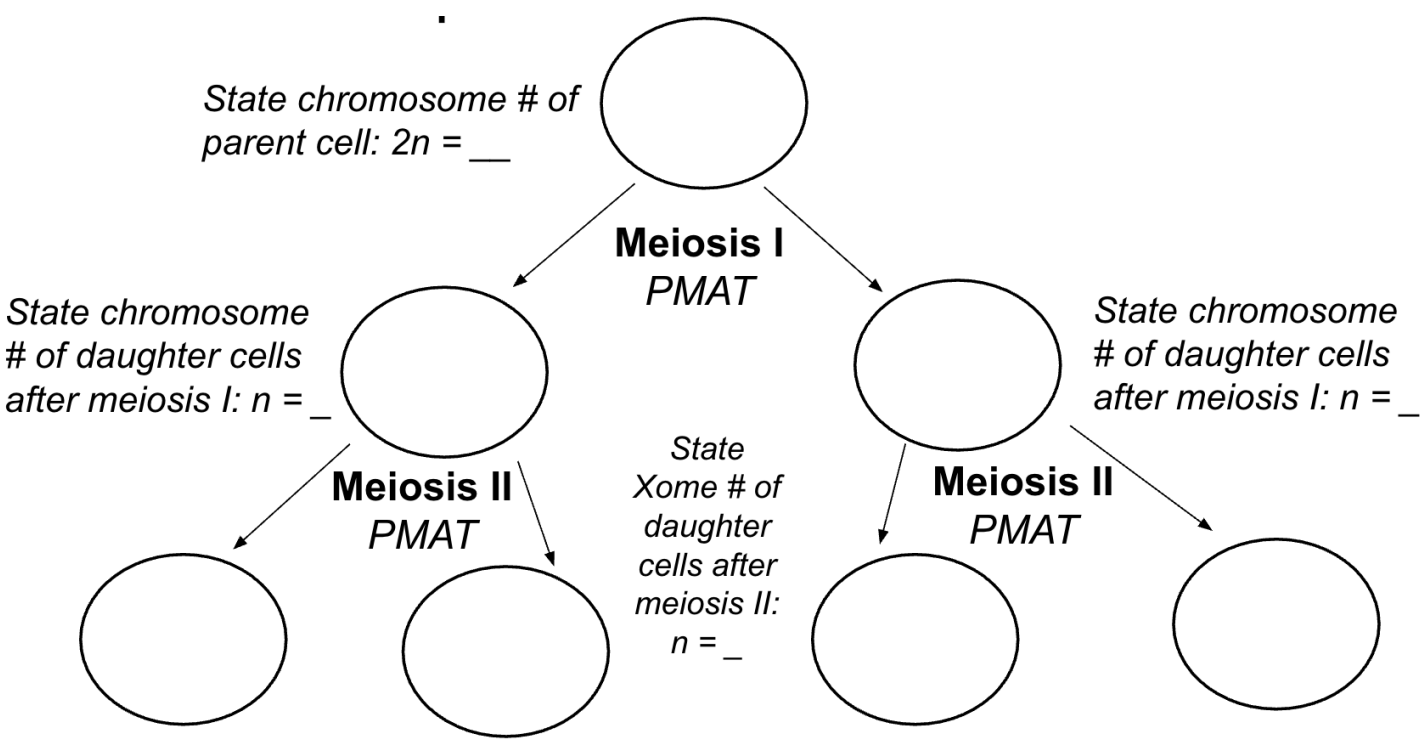
23. While a haploid number of chromosomes may be even or odd, a diploid number is always _____.

Two Types of Cell Division (Target I)

Use the website: http://www.pbs.org/wgbh/nova/miracle/divide.html to complete the chart below. Read introductory information, then click on "Go to Mitosis vs. Meiosis"

Characteristic	MITOSIS	MEIOSIS
Associated with sexual or asexual reproduction		
# of daughter cells produced		
Daughter cells identical to parent cell or different from parent cell		
A type of cell division *(yes or no)*		
Makes gametes: ova & sperm *(yes or no)*		
Makes body (somatic) cells *(yes or no)*		
Occurs in ovaries and testes after puberty		
Chromosomes (DNA) replicate before parent cell divides		
Number of times cell undergoes Prophase → Metaphase → Anaphase → Telophase		
Chromosome Number		

Simplified model of meiosis



THE FOLLOWING ARE SINGLE TRAIT GENETICS CROSSES THAT FOLLOW MENDELIAN INHERITANCE

Mendel observed seven traits in pea plants that exhibited complete dominance (the heterozygote expresses only the dominant allele, the recessive allele is masked) For instance, he found that purple flowers (R) were dominant over white flowers (r) by conducting the crosses described in problems #1-2.

1. Mendel crossed a homozygous purple-flowered plant with a homozygous white-flowered plant in the first parental generation (P_1). The progeny of this cross, called F_1 (or first filial generation), were all purple; therefore, the allele for purple completely masked the allele for white. Which of Mendel's laws relates to the last sentence? **(KNOW VI, B)**

2. Next, Mendel allowed the purple, heterozygous F_1 to self-pollinate and were the second parental generation (P_2). Determine genotypic and phenotypic ratios of the F_2 generation offspring for the P_2 cross: **(KNOW VI, B)**

3. A **test cross** will often reveal whether an organism exhibiting a dominant phenotype is homozygous or heterozygous. In sheep, white wool is dominant to black. At times black wool appears in a flock of sheep. Black wool is worthless because it cannot be dyed. When you mate two white sheep, ¼ of the offspring have black wool. **(KNOW VI, B)**
   a. What are the genotypes of the parents of this cross?
   b. If one parent (from part a) is test crossed with a black sheep (homozygous recessive), what is the probability of the offspring having black sheep?
   c. How can be black wool allele be eliminated from your sheep population?

4. In *Drosophilia,* gray body color is dominant over black body color. By crossing a heterozygous gray- bodied fly with a black-bodied fly, 100 offspring resulted. How many would be *expected* to have black bodies? **(TKNOW VI, B)**

5. Albinism, the lack of pigment, occurs commonly in animals and is always recessive to normal pigmentation. Ten brown and eight albino mice were born to parents that were likewise brown and albino. What are the genotypes of both parents? **(KNOW VI, B)**

6. The ability to roll one's tongue into a "U" is determined by a dominant allele (R). Two tongue rollers have a child who cannot roll his tongue. (a) What are the genotypes of the parents and their son? (b) What is the probability that their next child will be a non-tongue roller? **(KNOW VI, B)**

7. In dogs, wire hair is due to a dominant factor, smooth hair to its recessive allele. Two wire-haired dogs produce a male pup which is wire- haired. To find out most quickly whether he carried the factor for smooth hair, he should be mated to what kind of female? What term is applied to a cross used to determine of an unknown genotype?
   (TARGET VI, B)

8. In humans, normal pigmentation is due to a dominant factor (A), albinism to its recessive allele (a). A normal man marries an albino woman. Their first child is an albino. What are the genotypes of these three persons? If they have a second child, what is the probability that it will also be an albino? **(KNOW VI, B)**

9. An albino man marries a normally pigmented woman. They had nine children, and all had normal pigmentation. What must be the genotypes of the parents and all the children? If the couple had only two children, could we absolutely determine the genotype of the mother? Explain.

THE FOLLOWING PROBLEMS TRACK THE INHERITANCE OF TWO TRAITS (DIHYBRID CROSS)
When doing these crosses, **be sure that each haploid gamete contains one allele for *<u>each</u>* trait.**

10. Brown hair (B) is dominant to blond (b) and curly hair (H) is dominant to straight hair (h). Determine the **genotypic and phenotypic** ratios for the following crosses. MEMORIZE THEM! **(KNOW VI, B)**
    a. BBHH x bbhh (Parental cross)
    b. BBhh x bbHH
    c. BbHh x BbHh (F_1 dihybrid cross)
    d. BbHh x bbhh (Test Cross)

11. In peas, tall (T) is dominant to short, and yellow seeds (Y) is dominant to green seeds. **(KNOW VI, B)**
    a. What will be the genotypes that result from the crossing of a homozygous tall, yellow-seeded plant with a short, green-seeded plant?
    b. When these F1's are crossed with each other, many plants result, ninety of which are tall and yellow-seeded. Assuming the ideal ratio, how many would be expected to be short and green-seeded?

12. In rabbits, black fur is dominant to white fur, and black eyes are dominant to pink eyes. A white, pink-eyed female had a litter consisting of one rabbit with black fur and pink eyes, one with black fur and black eyes, one with white fur and pink eyes, and one with white fur and black eyes. What is the genotype of the father of this litter? **(KNOW VI, B)**

13. In horses, black coat color is dominant (B) and chestnut is recessive (b). Trotting gait is dominant (T), and pacing gait is recessive (t). If a homozygous black pacer is mated to a homozygous chestnut trotter, what will be the phenotype(s) of the F_1 generation? **(KNOW VI, B)**

14. a) If two F_1 individuals from problem #13 were mated, what kinds of offspring would they have, and in what proportions? **(KNOW VI, B)**
    b) If an F_1 male were mated to a homozygous female black pacer, what phenotypes will offspring show and in what proportions? **(KNOW VI, B)**

15. In rabbits, black fur is caused by dominant allele (B), & brown is recessive (b). Short hair is caused by a dominant allele (H), and long hair is recessive (h). In a cross between a homozygous black short-haired male and a homozygous brown long-haired female, determine the genetic constitution (genotypes) and the appearance (phenotypes) of the F_1 generation? The F_2 generation? **(KNOW VI, B)**

16. Suppose that you should back cross the F_1 female rabbits in problem 15 to their black short-haired male father, what would be the appearance of the offspring? If instead, you back cross the F1 males to their brown-long-haired mother, what would be the appearance of the offspring? Which one of these backcrosses is considered to be a test cross? **(KNOW VI, B)**

17. Suppose that you have a homozygous black short-haired male rabbit and a brown long-haired female rabbit, and wish to develop a homozygous strain of black long-haired rabbits from them. Outline the breeding procedure necessary to establish such a strain. **(KNOW VI, B)**

18. For the following cross, what fraction of the offspring would be expected to exhibit all five dominant traits ABCDE? Hint: Separately determine the phenotypic ratio for each gene cross. Express it as a fraction, then multiply these fractions to answer the question. **(KNOW I, VI, B)**

AaBbCcddEe x AabbCCDdEE

THE FOLLOWING PROBLEMS INVOLVE TRAITS
THAT FOLLOW <u>NON</u>-MENDELIAN INHERITANCE PATTERNS

19. When a long-tailed cat was mated to a tailless cat, all of their kittens had short tails. When two short-tailed cats were mated, their litter contained three kittens without tails, two with long tails and six with short tails. Explain this pattern of inheritance and determine the genotypes for tailless, long-tailed and short-tailed cats? **(KNOW C)**

20. Shorthorn cattle may be red, white or roan in color. The roan is an intermediate coloration due to a mixture of red and white hairs, and is the result of **codominance**. A breeder of shorthorn cattle has cows that are white, and a bull that is roan. What proportion of the calves produced in this herd will be white, roan, and red? **(KNOW C)**
    a. Which of the calves would be homozygous? Which would be heterozygous?
    b. Starting with a roan bull and white cows, how can true-breeding red herds be established?

21. In cattle, long tails (T) are dominant over short tails (t). A cross between cattle with a red coat (RR) and those with a white coat (rr) result in offspring with roan (Rr) coats (roan = *<u>both</u>* red and white hairs are present). A long-tailed roan bull is mated to three cows. With cow A, which is short-tailed and white, a short-tailed roan calf is produced. With cow B, which is short-tailed and roan, a long-tailed red calf is produced. With cow C, which is long-tailed and red, a short-tailed red calf is produced, what are the genotypes of all these individuals? **(KNOW C)**

Problems 22 and 23 involve **<u>multiple alleles</u>**. In this case, more than two alleles exist for **<u>one</u>** trait. Each individual has only two of the possible of these alleles because they only have 1 pair of homologous chromosomes! ABO blood types are an example of multiple alleles. Within the population there are three alleles, A (I^A), B (I^B), and *i*. A and B are co-dominant. The *i* allele is recessive to both the A and B alleles. The following is the relationship between genotype and phenotype for blood types:

<u>Genotype</u>		**<u>Phenotype</u>**
AA	($I^A I^A$)	blood type A
A*i*	($I^A i$)	blood type A
BB	($I^B I^B$)	blood type B
B*i*	($I^B i$)	blood type B
AB	($I^A I^B$)	blood type AB
ii		blood type O

22. a. Cross a heterozygous type A with a heterozygous type B and determine the possible blood types of their children. **(KNOW C)**
    b. In the court of law, a type A mother claims that a type B man is the father of her type O child. Is this possible? What if this man's parents were both type AB? **(KNOW C)**

23. Another example of multiple allele exists in Labrador retrievers. Three alleles exist in the population: one allele codes for black labs: C^B, one for chocolate: C^C, and one for golden: C^g. Black is dominant to chocolate, and both black and chocolate are dominant to golden. Therefore, a golden retriever must have the genotype: C^gC^g. **(KNOW C)**
    a. State the phenotypes of the parents of the following cross: $\mathbf{C^BC^g \times C^CC^g}$
    b. Determine the genotypic and phenotypic ratios for the offspring

THE FOLLOWING PROBLEMS INVOLVE TRAITS THAT ARE SEX-LINKED

A sex-linked gene is one that is physically located on the X chromosome and is **recessive to the** normal condition. Because a female has two X's and males only one, the patterns of inheritance are different compared to genes for traits carried on autosomes. **ALWAYS USE X'S AND Y'S when dealing with sex-linked traits. No genes are carried on the Y chromosome!** In humans, colored blindness, Duchenne Muscular Dystrophy, and hemophilia are sex-linked recessive disorders. In *Drosophila* (fruit flies), the genes for eye color are sex-linked (located on the X chromosome). Red eyes (X^R) are dominant to white eyes (X^r). In setting up crosses for this sex-linked trait, use the following notation:

Genotype	Phenotype
X^RX^R	Female with red eyes
X^RX^r	Carrier female (has red eyes, but carries allele for white eyes)
X^rX^r	Female with white eyes
X^RY	Red-eyed male
X^rY	White-eyed male

24. How could one determine whether a sex-linked trait was dominant or recessive? Which of the above genotypes would reveal this? **(KNOW C)**

25. Red-green color blindness is a sex-linked recessive. A male with normal vision marries a color-blind woman. What would be the chance that their sons would be color blind? What would be the chance that their daughters are colorblind? **(KNOW C)**

26. In humans, hemophilia (inability for blood to clot) is inherited in the same way as white eyes in *Drosophila*. Hemophilia is caused by a sex-linked recessive gene. Until very recently, no authenticated cases of hemophilia in females were recognized. **(KNOW C)**
    a. If a female had hemophilia, what prediction could we make with respect to the presence or absence of the hemophilia allele in the mother and father?
    b. What is the probability that her brother could have hemophilia?
    c. Is it possible for a son to inherit hemophilia from his father? Why or why not?
    d. From which parent does a hemophiliac son inherit the recessive, sex-linked allele?

THE FOLLOWING PROBLEMS CAN EXHIBIT ANY MODE OF INHERITANCE.
USE APPROPRIATE ALLELE NOTATION SYMBOLS, SHOW WORK (Punnett Square OR probability calculations), AND BE ABLE TO EXPLAIN HOW YOU DETERMINED THE ANSWER.

27. A male gamete of corn contains 10 chromosomes. **(KNOW I, VI)**
    a. How many of each type of chromosome would be found in a cell of a leaf of a corn plant?
    b. How many total chromosomes would be found in the leaf cell mentioned above?

28. Anirdia is a type of blindness that is due to a dominant allele (A). Hemophilia is a disease in which the blood does not clot properly and it results from a sex linked recessive allele. A non-hemophiliac man who is blind from aniridia but whose mother was not blind marries a non-hemophiliac woman who is not blind but whose father was afflicted with hemophilia. If four sons are born to this couple, what different combinations of traits might they exhibit in regard to aniridia and hemophilia? **(KNOW B, C, E)**

29. Curly hair is dominant over straight hair and color blindness is sex-linked recessive. A curly-haired man whose mother was color-blind and whose father had straight hair is engaged to a woman whose color blind mother had straight hair, and whose normal visioned father had straight hair. If they marry and have a family what are their chances of having: (a) a curly-haired, normal vision child? (b) a straight-haired color blind child? (c) a curly-haired, color blind daughter? **(KNOW B, C, E)**

30. How essentially does the process of meiosis differ from the process of mitosis? You should consider both the important difference in the behavior of the chromosomes during the prophase and metaphase of mitosis and the first prophase and metaphase of meiosis, and the results of these difference as reflected in the chromosome numbers of the daughter cells resulting from mitosis and meiosis. How may the behavior of the homologous chromosomes during the first anaphase of meiosis be correlated with Mendel's Law of Segregation as it applies to genes? How may the behavior of different pairs of homologous chromosomes during the first meiotic anaphase be correlated with Mendel's Law of Independent Assortment as it applies to genes? **(KNOW I, III, VI)**

31. In tomatoes, red fruit color is dependent upon a dominant factor (R), yellow is dependent upon its recessive allele (r); tallness is due to a dominant factor (T), dwarfness to its recessive allele (t). The Golden Beauty variety has yellow fruit and is tall. The Dwarf Giant is dwarf and with red fruit. **(KNOW C)**
    a. Using these two varieties to start with, could you eventually obtain a homozygous variety which was tall with red fruit?
    b. Could you obtain a homozygous variety with red fruit and is tall?
    c. Could you obtain a homozygous variety that was dwarf with yellow fruit?
    d. Which would be more readily obtained? Outline the procedure in each case.

32. White fruit of summer squashes is due to a dominant factor (F), and colored fruit is due to its recessive allele (f). Disc-shaped fruit is due to a dominant factor (D), sphere-shaped fruit to its recessive allele (d). **(TARGET C)**
    a. How many different genotypes may squash plants have in regard to color and shape of fruit?
    b. How many phenotypes result from these genotypes?
    c. How many different homozygous genotypes are possible?

33. In poultry, black color is due to a dominant factor (B), red to its recessive allele (b). Crested head is due to a dominant factor (H), plain head to its recessive allele (h). A red crested bird is mated to a black plain female. They produce offspring, half of which are black crested, and the half of the offspring are red crested. *What are the genotypes of the parents?* **(KNOW C)**

34. In garden phlox, white flowers are due to a dominant allele (A), cream to its recessive allele (a). Salver-shaped flowers are due to a dominant allele (F), funnel-shaped flowers to its recessive allele (f). A plant producing cream, salver-shaped flower is crossed with one producing white, funnel-shaped flowers. Of the offspring, one quarter produced white, salver-shaped flowers, one-quarter produced cream, salver-shaped flowers, one-quarter produced white, funnel shaped flowers and one quarter produced cream, funnel-shaped flowers. *What are genotypes of parents?* **(KNOW C)**

35. A plant producing white salver-shaped flowers is crossed with one producing cream, funnel-shaped flowers. What were the genotypes of the parents if, out of 76 offspring: 37 produce white, salver-shaped flowers and 39 cream, salver-shaped flowers?

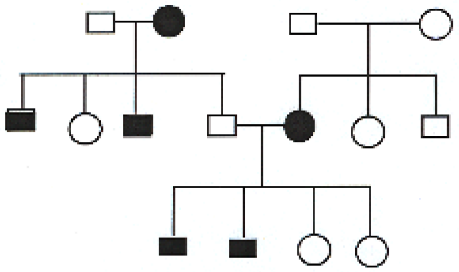
36. A rough, long-haired, black male guinea pig is mated to a rough, short-haired, white female. Rough hair (R) is dominant to smooth hair (r), short hair (H) is dominant to long (h), and black hair (B) is dominant to white hair (b). After they have produced several litters, their offspring have been found to be as follows: 15 rough, short-haired black; 13 rough, long-haired, black; 4 smooth, short-haired black; and 5 smooth, long-haired black. *What were the genotypes of the parents?*

37. In *Drosophila* (the fruit fly), the wild type is red. A few flies, however, are found which possess white eyes. White eyes have been demonstrated to be due to a sex-linked recessive gene. If after crossing two flies one finds that there are 48 red-eyed females, 21 red-eye males, and 20 white-eyed males in the progeny. *What must have been the genotypes of the parents?*

38. Patented hybrid roses when received by the gardener often include a notice that prohibits self-pollination and distribution of the resultant seed by the home gardener or retailer. The hybrid, which arose from crossing two other parent varieties, is likely to be highly heterozygous.
    a. Can you explain, on a genetic basis, why distribution of seeds obtained from self-pollination is prohibited?
    b. How are such hybrid varieties propagated in the first place from a single plant in such a manner such that the new individuals will be duplicates of the original?

39. In cats, short hair is dominant to long hair; the gene is autosomal. An allele BI, of another gene is sex linked and produces a yellow coat color; the allele B2 produces black coat; and the heterozygous mate B1/B2 produces a tortoise shell (calico) color. If a long-haired black male is mated with a tortoise-shelled female homozygous for short hair:
    a. What type of kittens would they produce in the F_1?
    b. If the F_1 cats were allowed to mate freely, what are the chances of obtaining a yellow-haired male?

40. The following shows three generations of a pedigree of deafness in a family. Black circles indicate female deafness and black squares indicate male deafness. State whether the conditions of deafness in this family are inherited as:
    a. autosomal dominant
    b. autosomal recessive
    c. sex-linked dominant
    d. sex-linked recessive
    e. codominant



TRAITS CONTROLLED BY MULTIPLE GENES (POLYGENIC INHERITANCE)

41. <u>Hair Color</u>: Dark hair is dominant to light hair. To determine the color of your offspring's hair, assume there are two pairs of genes involved. There are probably more.

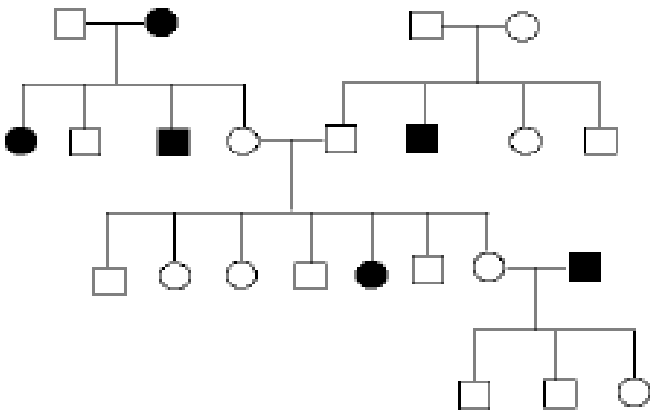
AABB - Black	AaBb - Brown
AABb - Black	aaBB - Dark blond (mixed with brown)
AAbb - Red	aaBb - Regular blond
AaBB - Brown	Aabb - Regular blond
	aabb - Pale blond

Determine inheritance pattern for **pedigrees** below. Write genotypes for as many individuals of each pedigree as possible. (**KNOW D**)

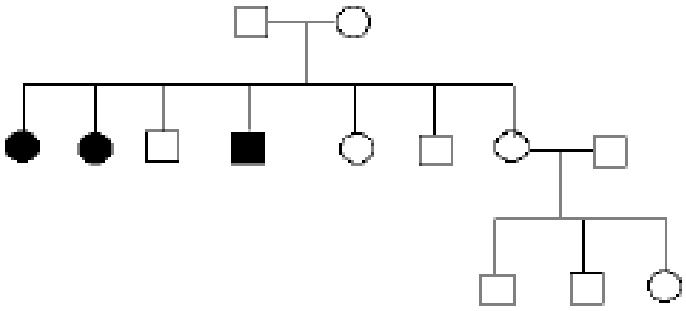
HINTS:

- ***Autosomal dominant*** *traits never skip generations and two affected individuals can have normal children.*
- ***Autosomal recessive*** *traits may skip generations and two normal individuals can have affected children.*
- ***Sex-linked recessive*** *traits are more common in males than females.*

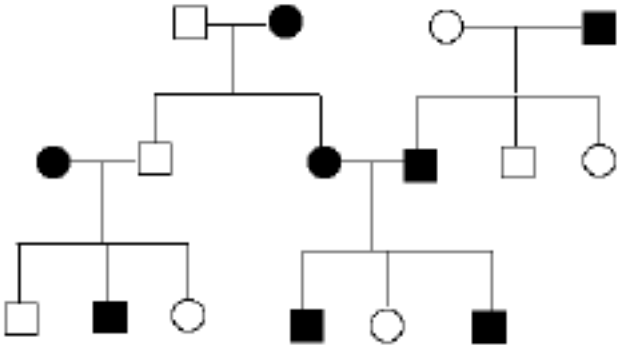
A.



B.



C.



D.

none of the pedigrees relate to the disorder

First, determine the inheritance pattern associated with each of the pedigrees below. Then, match the genetic disorder below to the proper pedigree. (Know D)

_____ 1. Cystic Fibrosis

_____ 2. Tay Sach's Disease

_____ 3. Colorblindness

_____ 4. Down Syndrome

_____ 5. Polydactyly

_____ 6. Achondroplasia (dwarfism)

_____ 7. Sickle Cell Anemia

_____ 8. Huntington's Chorea

_____ 9. Duchenne Muscular Dystrophy

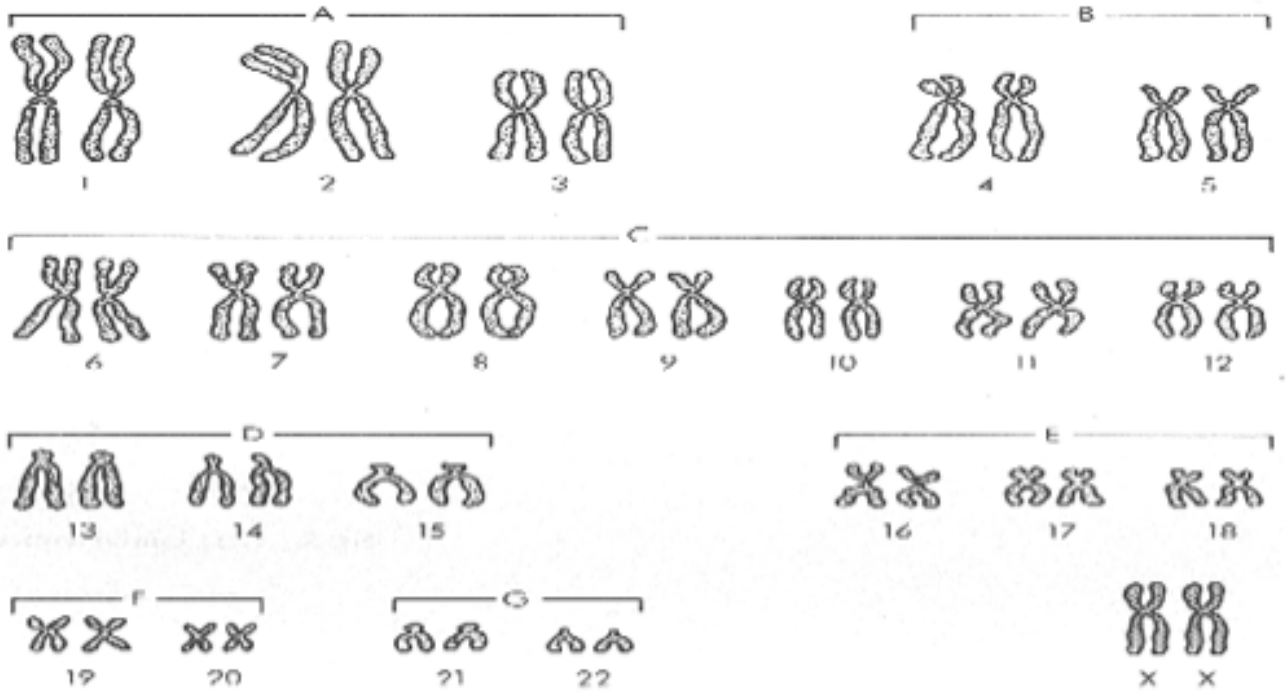
_____ 10. Klinefelter's Syndrome

_____ 11. Phenylketonuria (PKU)

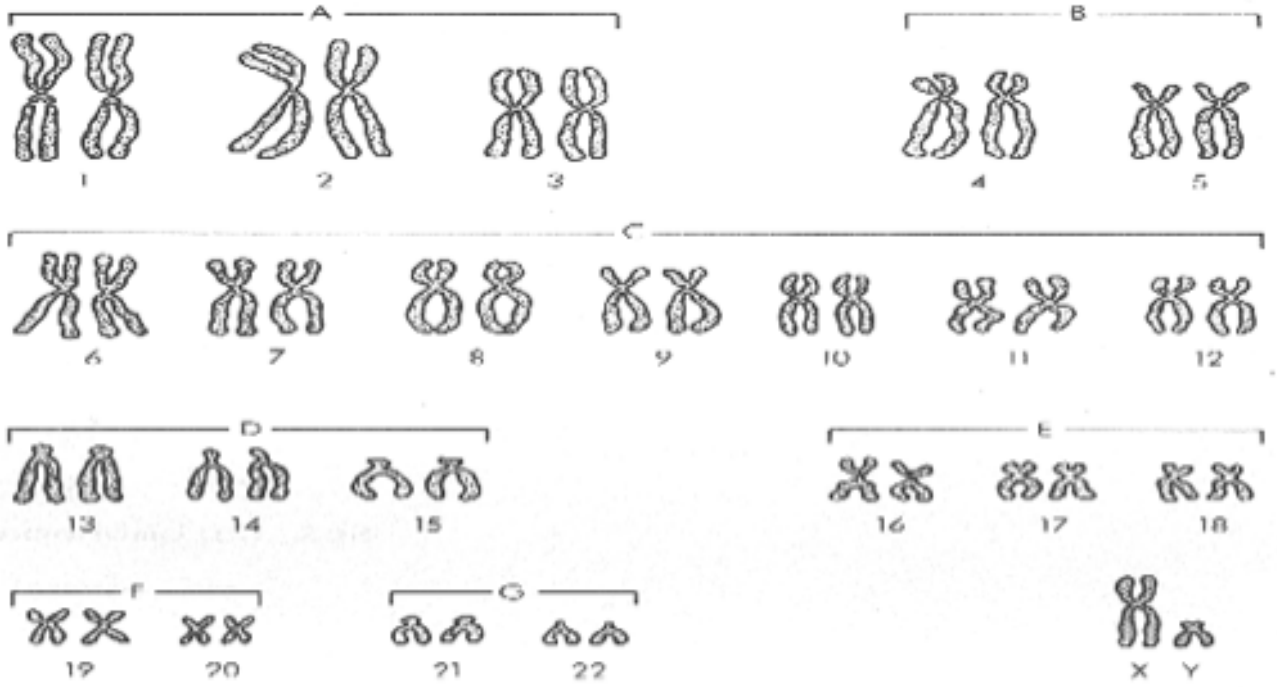
_____ 12. Turner's Syndrome

_____ 13. Hemophilia

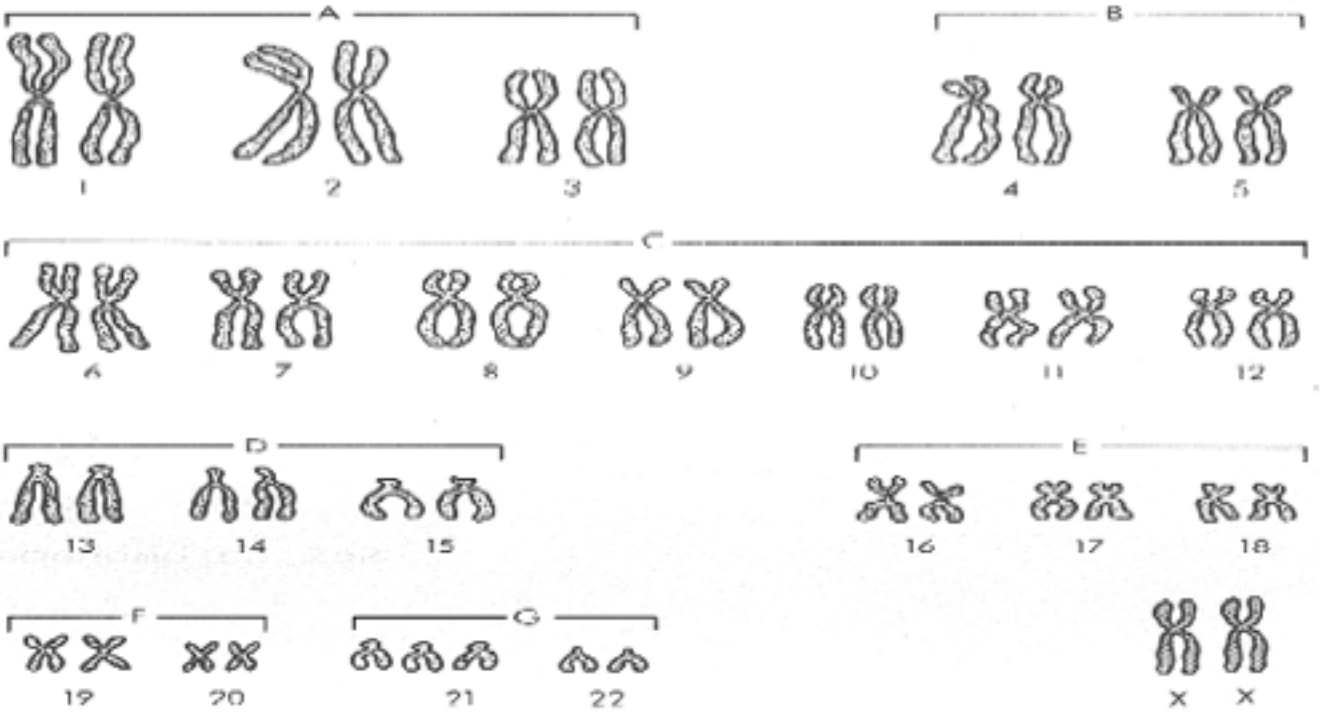
A. Is the karyotype below for a male or female? Circle the chromosome pair in the picture below that provides evidence for your conclusion. Does the person have any chromosomal abnormalities? If yes, then draw a box around the abnormal chromosomes and state the name of the chromosomal abnormality. (Know IV)



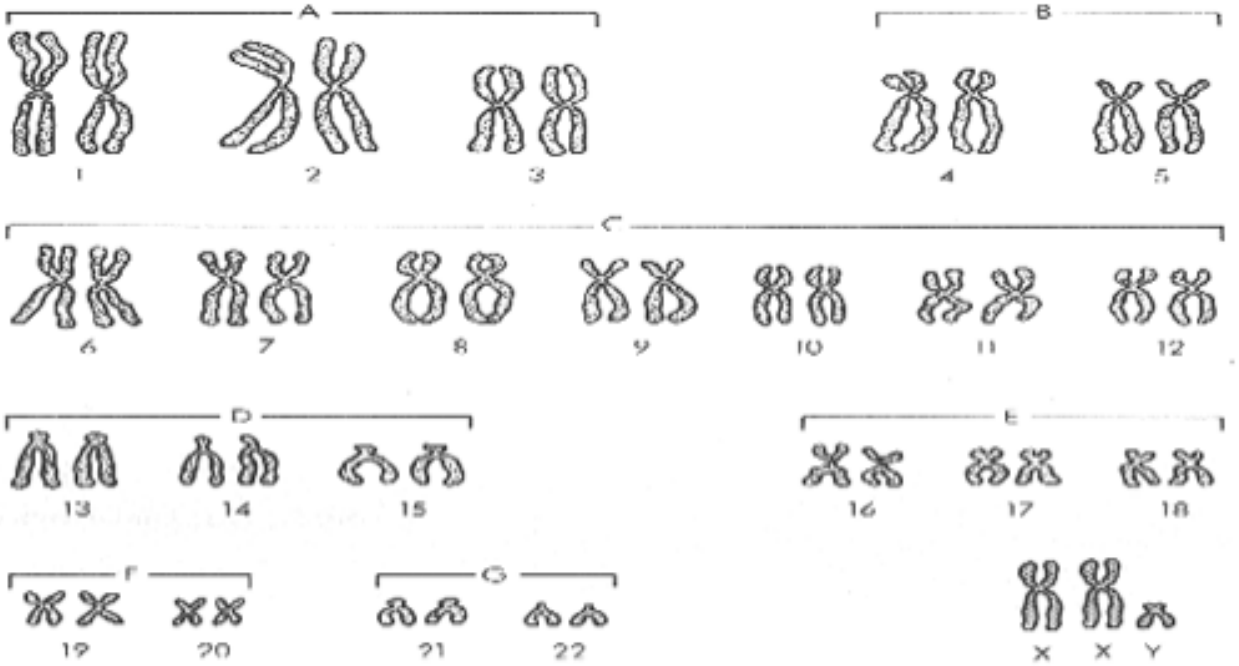
B. Is the karyotype below for a male or female? Circle the chromosome pair in the picture below that provides evidence for your conclusion. Does the person have any chromosomal abnormalities? If yes, then draw a box around the abnormal chromosomes and state the name of the chromosomal abnormality. (Know IV)



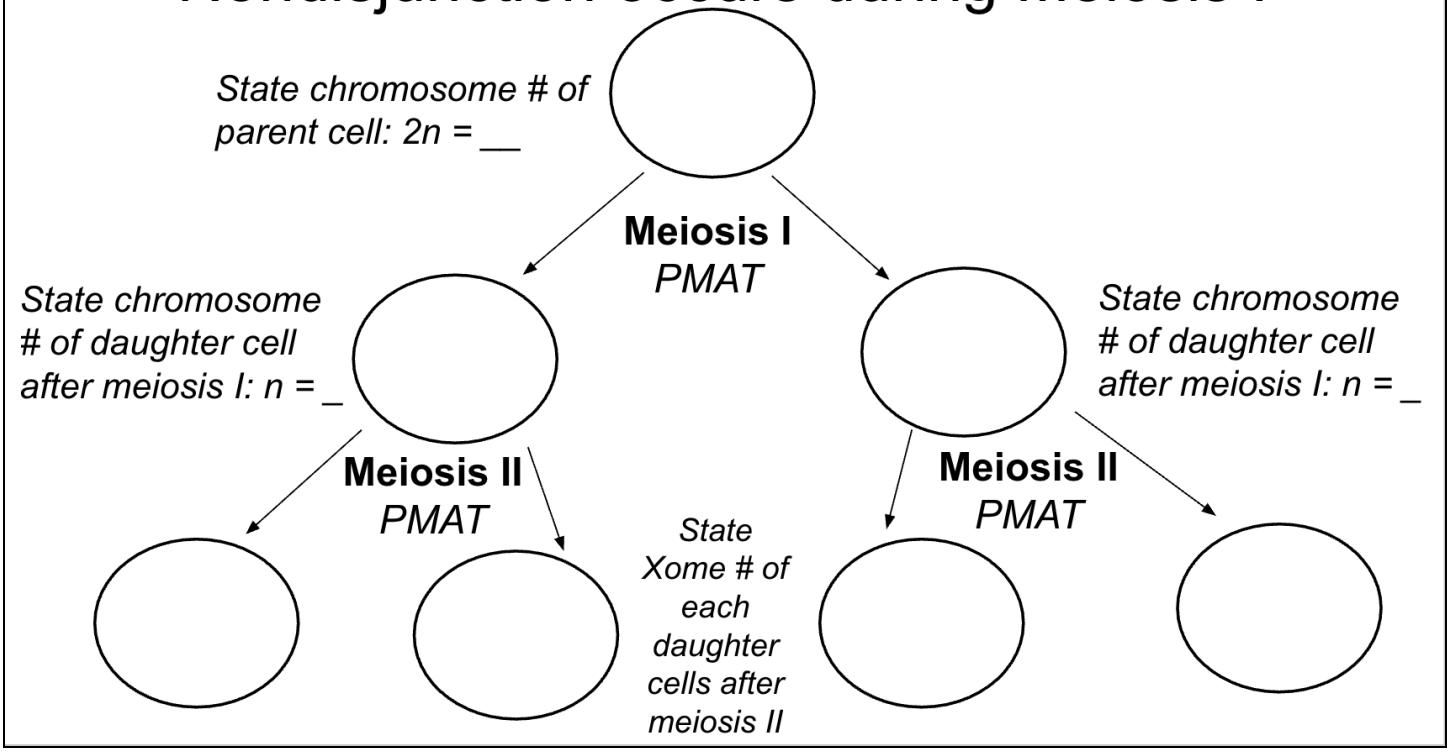
C. Is the karyotype below for a male or female? Circle the chromosome pair in the picture below that provides evidence for your conclusion. Does the person have any chromosomal abnormalities? If yes, then draw a box around the abnormal chromosomes and state the name of the chromosomal abnormality. (Know IV)



D. Is the karyotype below for a male or female? Circle the chromosome pair in the picture below that provides evidence for your conclusion. Does the person have any chromosomal abnormalities? If yes, then draw a box around the abnormal chromosomes and state the name of the chromosomal abnormality. (Target IV)



Nondisjunction occurs during Meiosis I



Nondisjunction occurs during Meiosis II