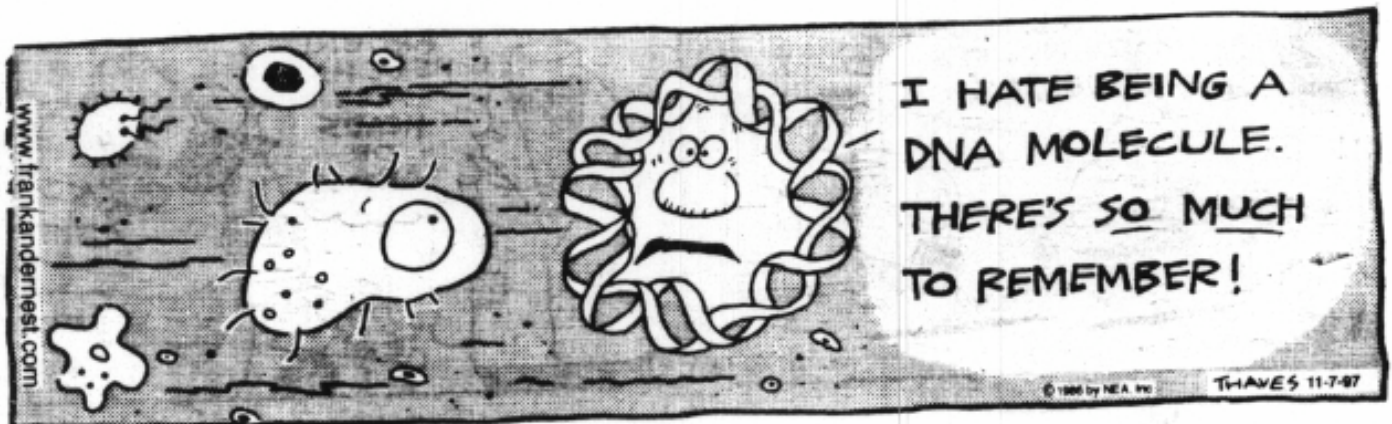


UNIT FIVE: MITOSIS, MEIOSIS, AND PATTERNS OF INHERITANCE

Chapters 6 (omit 6.2), 7.1 (omit 7.2), and 8

1. Explain the role of cell division in growth, repair, and reproduction.
2. Explain what a karyotype is and how it is used by genetic counselors to diagnose genetic disorders including monosomy and trisomy.
3. Compare and contrast meiosis and mitosis.
4. Relate genetic variation to cell division and evolution.
5. Distinguish between dominant traits and recessive traits.
6. Explain the relationship between genotype and phenotype using the terms homozygous and heterozygous.
7. Explain Mendel's three laws of inheritance.
8. Explain how probability is used in genetic predictions.
9. Construct and analyze Punnett squares for monohybrid and dihybrid crosses.
11. Perform a test cross to determine the genotype of an unknown individual.
12. Interpret pedigrees to determine the likelihood of an individual having a genetic disorder.
13. Perform crosses for dominant and recessive genetic disorders.
14. Explain and perform crosses involving codominance, incomplete dominance, multiple alleles, polygenic traits, and sex-linked alleles.
15. Explain how traits are influenced by the environment.



Part A:

DIRECTIONS: BEFORE looking in your textbook, write phrases, definitions, information that you know relating to cell division, mitosis, and or meiosis. Also, indicate the grade you were in when you learned the information and the school you attended.

Part B:

Directions: We are not going to READ all of chapter 6 and 7. Instead we are going to pick and choose the important concepts and topics addressed in these chapters. Then, we'll apply these terms and concepts to our study of inheritance for various traits. Using your textbook as a reference, define each of the terms in the word pairs, then identify, based on definitions and context clues within the textbook, how the terms are similar and how they differ. (compare and contrast) You can create a Venn diagram if you wish!

1. Mitosis / Meiosis

2. Haploid / Diploid

3. Gamete / Somatic Cell

4. Spermatogenesis / Oogenesis

5. Sperm cell / Egg cell

MITOSIS / MEIOSIS CONCEPT GENERALIZATION VOCABULARY

GROUP 1:

mitosis	DNA
chromosome	daughter cell

GROUP 2:

asexual reproduction	mitosis
sexual reproduction	meiosis
gamete	somatic cell

GROUP 3:

meiosis	homologous chromosomes
diploid (2n)	gamete
haploid (n)	crossing over

GROUP 4:

sperm (spermatozoa)	oogenesis	haploid
spermatogenesis	gametogenesis	gamete
egg (ovum)	meiosis	

GROUP 5:

mitosis	two daughter cells	haploid
meiosis	four daughter cells	diploid
variation		

Cell Division: Comparing Mitosis and Meiosis

Characteristic	<i>MITOSIS</i>	<i>MEIOSIS</i>
Parent Cell Chromosome Number		
Daughter Cell Chromosome Number		
# Daughter Cells Produced		
Is DNA replicated? When?		
How many times do cells divide?		
Kind of cell produced: somatic or gamete		
Type of reproduction? asexual OR sexual		
Creates variation?		

THE LAWS OF PROBABILITY

PURPOSE:

Determine the operations involved in the laws of probability.

The basic question of probability is: How often should we expect a particular event in a given number of events? The simplest way to express probability is with fractions. When a coin is tossed, there are the possibilities that it may come up heads or tails. Suppose you want to know the probability that heads will appear. You are looking for one specific event (heads) from the two possibilities (heads or tails). The number of specific events, 1, is the numerator of the fraction. The number of possibilities, 2, is the denominator of the fraction. Thus, the probability of a coin landing heads up is $1/2$. We can also write this as 0.5, or 50%, but the common fraction is the starting point.

Part 1 - Hypothesis

- A. If you flip one coin 10 times, then you expect the coin to land on heads _____ times and on tails _____ times.
- B. If you flip one coin 100 times, then you expect the coin to land on heads _____ times and on tails _____ times.

Part 1 - Procedure

1. With your partner, each of you should have the same value coin. One partner should perform trials 1-5, the other partner should perform trials 6-10. Record whether the coin landed heads or tails.
2. Perform the procedure a total of 10 times. Record the total number of heads and tails in Table 1, in the line marked "Trial 1".
3. Continue alternative roles and recording results until the coin has been tossed a total of 100 times. (ten trials total)

Trial	No. Heads	No. Tails
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Totals		

Part 1 - Discussion Questions

1. How many heads did you predict to occur out of 10 tosses of the single coin (within one 'trial')? _____ (Hypothesis A)
 2. How many heads did you predict to occur out of 100 tosses? _____ (Hypothesis B)
 3. Did you ever obtain the expected results in any series of 10 tosses? _____ If yes, for how many trials?
 4. Are the expected results (hypothesis) and observed results (data in table) for 100 tosses the same? Can they be the same? Explain
-

5. How does increasing the number of tosses affect the amount of difference from the expected value? (How does increasing the number of trials affect obtaining the expected results?)
-

Part 2 - Hypothesis:

If you flip two coins 60 times, then you'd expect both coins to land on heads _____ times, both to land on tails _____ times and one to land on heads and the other coin to land on tails _____ times.

Part 2 - Procedure

Trial	H ₁ H ₂	H ₁ T	H ₂ T	T ₁ T
1				
2				
3				
4				
5				
6				
Totals				

Coin #1 =

1. Repeat the procedure in Part 1, using two coins of different value(preferably different colors, too). Record the results in Table 2, indicating "H₁H₂" if both coin landed heads, "H₁T₂" if the coin #1 landed heads and coin #2 landed tails, and so on, as shown in the Table above.
2. You should perform trials 1-3 and your partner should perform trials 4-6. Make sure you are using the same values of coins. Remember: each trial =10 tosses.

Part 2 - Discussion Questions

1. In what fraction of the total number of tosses did heads for both coins appear? _____
Tails for both coins? _____ Heads for one coin, and tails for the other? _____
2. Compare your results to your hypothesis. Why or why not were the actual and expected values the same?

3. Is the probability for flipping two heads closest to the sum, difference, or product of the two individual probabilities of flipping heads? _____ Is the probability the same for two tails? _____ Explain your answer and show your calculations to support statement: _____
-

PROBABILITY-RELATED ANALYSIS QUESTIONS

1. You toss two pennies in the air. What is the probability that both coins will land as “tails”? HINT: Determine the individual probabilities of each coin, then determine probability of them occurring together.
2. Your aunt is pregnant. She already has two sons. What is the probability that this child will be a daughter?
3. What is the probability that a family of two children will have:
 - a. two boys?
 - b. a boy first and then a girl?
 - c. two girls?
4. A die (singular of “dice”) has 6 sides. You throw a die. What is the probability it will come up “5”?
5. A person tosses two dice. What is the probability of both coming up “3”?
6. What is the probability of having 4 boys in a row?

HUMAN CHARACTERISTICS

CHARACTERISTIC	DOMINANT	RECESSIVE
1. Hair color	dark hair	light hair
2. Chronic sneezing(achoo syndrome)	chronic sneezing	normal
3. Widow's	widow's peak(V shaped hair line)	continuous line
4. Eye color	non-blue eyes	blue eyes
5. Farsighted	farsighted	normal
6. Blue offspring	normal color skin	bright blue
7. Astigmatism	astigmatism	normal
8. Ear lobes	free	attached
9. Mid digital hair on any segments of fingers	present	absent
10. Second finger shorter than fourth finger	2nd shorter	2nd longer
11. Handedness(questionable though)	right handed	left handed
12. Interlocking of hands when folded	left thumb over right	right thumb over left
13. Tongue Rolling	rolling	non-rolling
14. Cleft chin	cleft	non-cleft
15. High blood pressure	high blood pressure	normal
16. PTC	taster	non taster
17. Migraine headaches	migraines	normal
18. Hitchhikers thumb-thumb curved outward	curved thumb	straight thumb
19. Diabetes	normal	diabetes
20. Crooked little finger last segment bends toward fourth finger	straight finger	bent finger
21. Nostril size	broad nostrils	thin or normal
22. Nose bleeding	spontaneous bleeding	normal

26.	Pointing finger shorter than ring finger is a sex influenced trait, a shorter pointing finger being dominant in a male (F) and recessive in female (f). Sex influenced:		
27.	Freckles:	present	not present
28.	Cleft Chin:	Absent	present
29.	Eyebrows:	Bushy	thin
30.	Eyebrows:	Not connected	connected
31.	Eyelashes:	Long	short
32.	Lips	Thick	thin
33.	Dimples:	Present	absent
34.	Freckles / cheek	Present	absent
35.	Freckles / forehead	Present	absent

TRAITS THAT ARE BLENDS-INCOMPLETE DOMINANCE

35. Hair Body:	Curly (CC)	Straight (cc)	Wavy (Cc)
36. Color of Eyebrows:	Darker than Hair (HH)	Same color as Hair (Hh)	Lighter than Hair (hh)
37. Size of Eyes:	Large (EE)	Medium (Ee)	Small (ee)
38. Mouth:	Long (MM)	Average (Mm)	Short (mm)
39. Nose:	Big (BB)	Medium (Bb)	Small (bb)

TRAITS CONTROLLED BY MULTIPLE GENES

40. Hair Color: Dark hair is dominant to light hair. To determine the color of your baby'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 | Brown |
| Aabb | Regular blond | aabb | Pale blond |

41. Eye Color: Dark eyes is dominant over light. To determine the color of you baby's eyes, assume there are two gene pairs involved, on which codes for the depositing of pigments in the front of the iris and one which codes for depositing color in the back of the iris.

AABB	Intense Brown	AAbb	brown
AABb	Intense Brown	Aabb	Gray-Blue
AaBb	Brown with green flakes	aaBB	Green
AaBb	Brown	aaBb	Dark blue
aabb	pale blue		

GENETICS PROBLEMS

Define these terms / concepts **OR** make your own groups of terms and organize into concept map / concept generalization!

chromosome
autosome
sex chromosome
gene
allele
genotype
phenotype
gamete
haploid
diploid
probability
homozygous
heterozygous
true breeding (pure bred)
hybrid
test cross
back cross
P₁
F₁
P₂
F₂

I. MONOHYBRID CROSS 8.3

1. In a certain plant, the allele for tall, P is dominant to the allele for short, t. Write the genotype and phenotype for each of the following plants.

Plant Genotype Phenotype

- A. Heterozygous _____
- B. Homozygous dominant _____
- C. Homozygous recessive _____

2. In certain plants, blue flowers are dominant over purple flowers.

What is the phenotype of the offspring from crossing a homozygous blue plant with a homozygous purple plant?

(Remember to show your letters for the traits, genotypes of parents, gametes, punnett square, genotypes and phenotypes of off spring)

6. A blue eyed man, whose parents were both brown eyed, marries a brown eyed woman whose father had brown eyes but her mother had blue eyes. They had one child who is blue eyed. Write the genotype of each person in this family in the blank provided. **HINT:** Construct a pedigree to help you solve this problem! (see textbook section 8.3 for help with pedigrees)

The man _____ His father _____ His mother _____

The woman _____ Her father _____ Her Mother _____

What is the probability that they could have another blue eyed child? (Show Your Work)

7. Two brown-eyed people have a blue-eyed child.

a. What are the parents' genotypes? _____ x _____

b. What are the genotypic and phenotypic ratios of their children?

c. What are the chances that their children will be brown-eyed?

8. The allele for brown hair is dominant over that for blond hair.

a. If two heterozygous people have children, what hair colors would you expect to find in their offspring?

b. What is the phenotypic ratio for this cross?

9. The allele for astigmatism (a type of eye problem where the eye or lens is oblong) is dominant over normal eyes (lacking astigmatism). If the two people, one that is heterozygous and the other homozygous recessive have children, what are the chances that their children will have astigmatism?

10. In humans, the allele for farsightedness is dominant to normal eyes. A man and a woman who are both heterozygous for the trait, have children. What are the chances of their children being farsighted?
11. In humans, normal skin pigmentation is due to a dominant allele. The recessive allele causes albinism. A normal skinned man and an albino woman have children. Their first child is an albino. Use this information to answer the following questions:
- What is the father's genotype?
 - What is the albino mother's genotype?
 - What is the albino child's genotype?
 - What are the chances of these parents having albino children?
12. In sheep, white wool is dominant to black. At times black wool appears in a flock of sheep. Black wool is worthless because it can not be dyed. How can you eliminate the alleles for black wool in your flock? This is called artificial selection. HINT: perform a **test cross**; term defined on pkt page 11! (text 8.3)
13. Usually, tomato plants have purplish stems, but in some varieties the purple pigment is lacking, and the stem is green. True-breeding, purple-stemmed tomatoes crossed with green-stemmed plants gave all purple stemmed F₁ plants. When these plants were **back crossed** to green-stemmed plants, the offspring were: 482 purple stemmed, 526 green stemmed. Diagram the crosses, showing all genotypes, phenotypes, and gametes.

14. In cattle the horned condition is recessive to the polled, or hornless. Many matings were made between these two types from which the results were derived in phenotypic groups shown below: Give the genotypes of the parents of each group. If there is more than one combination, show all combinations.

Parents' Genotypes

A. Group 1; all offspring with horns: _____

B. Group 2; all offspring without horns: _____

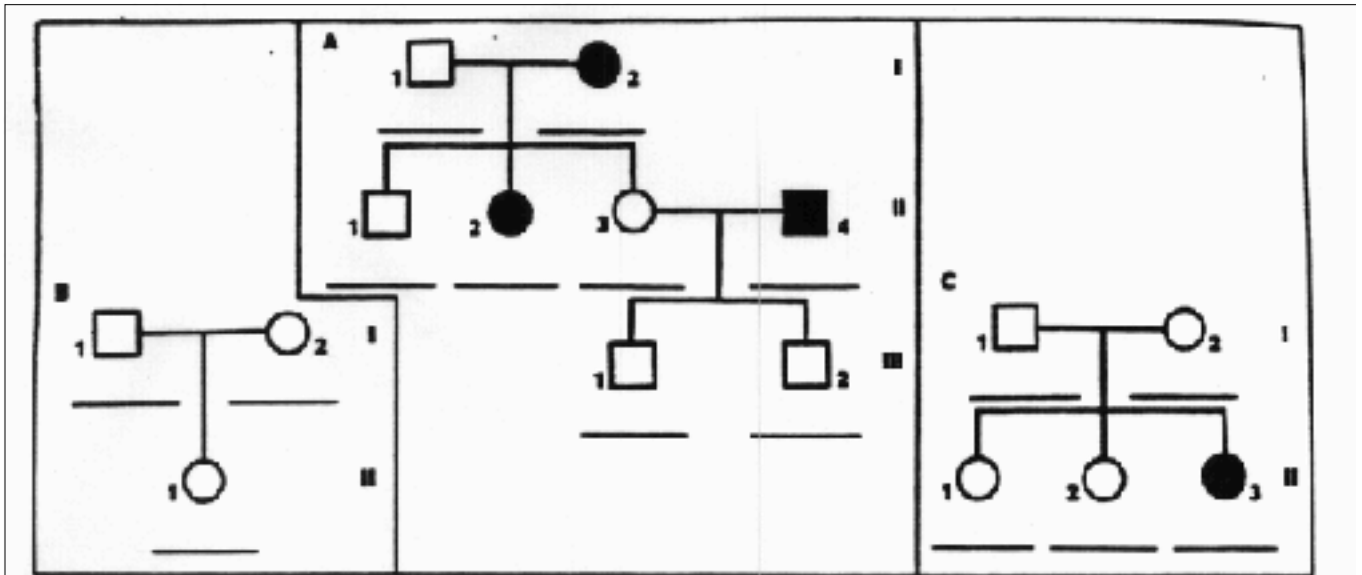
C. Group 3; a phenotypic ratio of 3 hornless to 1 horned: _____

D. Group 4; a phenotypic ratio of 2 hornless to 2 horned. _____

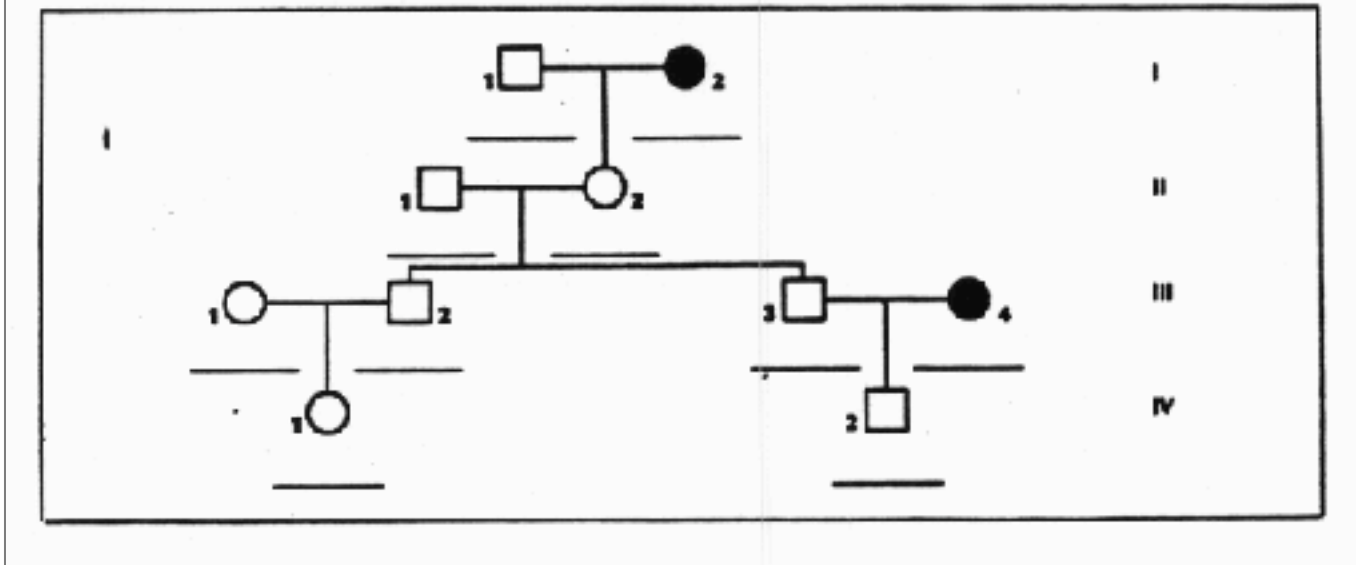
II. PEDIGREE WORKSHEET

Fill in the following pedigrees for the trait of either attached ear lobes (f) or free ear lobes (F). Free ear lobes are dominant to attached ear lobes. Place the genotype below each individual in the pedigrees. Remember the two rules--first give all shaded symbols two recessive genes and give unshaded symbols one dominant gene.

15.



16.



III. INCOMPLETE DOMINANCE (Blending of alleles) (text p. 177)

17. In radishes, the shape may be long (RR), round (rr), or oval (Rr). Crosses between long and oval radishes gave 161 long and 159 oval. Crosses between oval and round gave 204 oval and 200 round. Crosses between oval and oval gave 120 long, and 245 oval, and 113 round.

A. Since there are **three** different phenotypes in this monohybrid cross, what inheritance pattern do these ratios show? _____ (Hint: See Title of this section.)

B. What are the genotypes for long? _____ round? _____ oval? _____

C. What offspring genotypes are expected from a cross between two long radishes? _____

D. What offspring genotypes are expected from a cross between two round radishes?

E. What offspring genotypes are expected from a cross between two oval radishes? _____

18. In plants called four-o'clocks (because their flowers open at this time of day), the allele for red flowers is incompletely dominant to the allele for white flowers. The heterozygote genotype has a pink phenotype. A gardener crosses a red four-o'clock with a pink four-o'clock. What are the expected genotypic and phenotypic ratios of offspring from this cross?

19. In a type of chicken (Andalusian fowl), the allele for black feathers is incompletely dominant to the allele for white feathers. The heterozygote has bluish feathers. Determine the genotype of the parents of the following crosses, and the phenotypic ratios of their offspring.

Genotype Genotype Offspring phenotypic ratios

- A. black _____ x blue _____
- B. blue _____ x blue _____
- C. blue _____ x white _____

IV. CODOMINANCE (Each allele is expressed in the pure form) (text p. 178)

20. In some types of cattle, red coat color is codominant with white coat color. The heterozygote is a color mixture called roan where both red and white hairs are mixed together. Determine the parents' genotypes and the coat color, (phenotypic ratios) of the offspring in the following crosses?

- | Genotype of Female | Genotype of Male | Offspring ratios |
|---------------------|----------------------|------------------|
| A. a red cow _____ | x a white bull _____ | _____ |
| B. a roan cow _____ | x a roan bull _____ | _____ |
| C. a roan cow _____ | x a red bull _____ | _____ |

V. MULTIPLE ALLELES (More than 2 forms of an allele for one trait) (text p. 178)

21. Complete the following table: A and B are dominant and independently expressed, O(ii) is recessive. A is one type of protein on the Red Blood Cell and B is another type of protein on a Red Blood Cell. the ability to make these proteins is carried on the genes. O means the person lacks that particular type of protein and lacks those genes. If a person receives blood that has proteins not normally found in their body, those blood cells are attacked by the persons immune system which causes complications which could result in death.

Blood type (Phenotype)	Possible Genotypes
A _____	
AB _____	
B _____	
O _____	

22. What are the possible blood types of children of the following couples?

A. Mother: AB x Father: AB

Children's possible genotypes _____
 Children's possible blood types _____

B. Mother: AB x Father: ii

Children's possible genotypes _____
 Children's possible blood types _____

C. Mother: ii x Father: ii

Children's possible genotypes _____
Children's possible blood types _____

D. Mother: Ai x Father :Bi

Children's possible genotypes _____
Children's possible blood types _____

23. Four babies were born at practically the same time in a small hospital. It was a hectic few minutes and in the confusion, none of the four babies were properly identified with their mothers. Luckily, the babies all had different blood types. From the information below, PLEASE make a happy ending for this mess. Assign each baby to its correct parents.

Baby phenotypes:

- Baby Aaron - Type O
- Baby Charlie - Type B
- Baby Daniel - Type AB
- Baby Bobby - Type A

Parent phenotypes:

- 1. Type O and Type O
- 2. Type B and Type B
- 3. Type AB and Type O
- 4. Type A and Type B

Baby Parents of Baby

Aaron _____
Bobby _____
Charlie _____
Daniel _____

24. A man with type AB blood marries a woman with type O blood. What are the possible blood types of their offspring?

25. A child has O blood. Her three siblings (brothers & sisters) have the following blood types: A, B, and AB. What is the genotype of each parent? What is the genotype of each of the four children?

26. Cross a man with type A blood (**hint**: he is homozygous) with a woman with type B blood (**hint**: she is heterozygous). What are the possible genotypes and phenotypes of their offspring?

VI. SEX LINKAGE: (text page 175)

(Genes for some traits are found on the X chromosome. Females have two X chromosomes and males have one X and one Y chromosome.)

27. Colorblindness is a sex-linked characteristic in humans. If a normal woman has a genotype XX, what would a normal male be? _____

If a colorblind female is $X^C X^C$, what would a colorblind male be? _____

What would be the genotype of a woman who is a carrier? _____

28. Cross a woman who is colorblind and a man with normal vision. Describe expected offspring.

29. Cross a woman with normal vision who carries a gene for colorblindness with a man with normal vision. Describe expected offspring.

30. Cross a woman whose vision is normal with a man who is colorblind. Describe expected offspring.

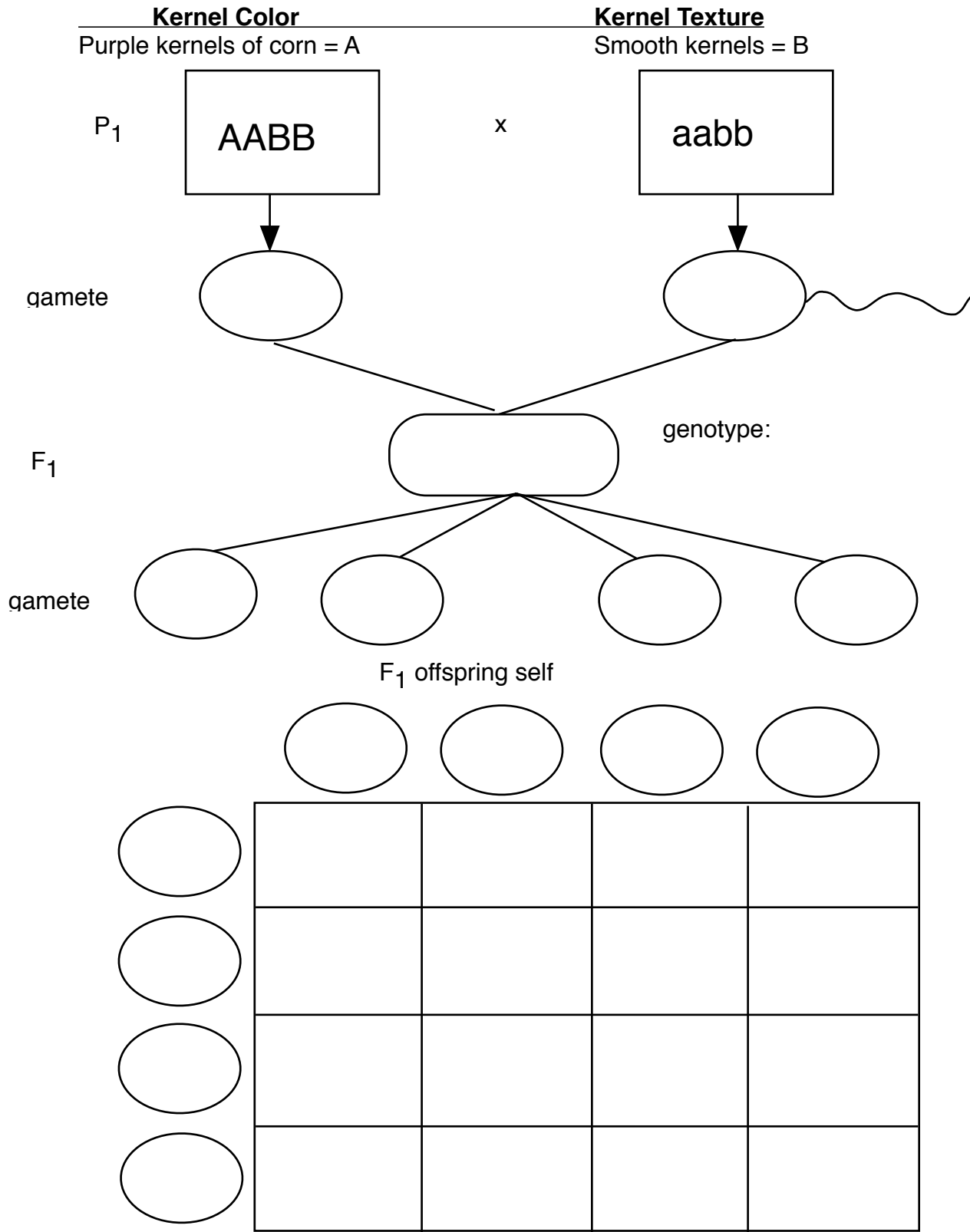
31. A man with normal vision whose father was colorblind marries a colorblind woman. What would be the probabilities of their sons and daughter being colorblind?

32. A boy whose parents and grandparents have normal vision is colorblind. Draw a family chart which gives genotypes for this boy, his mother and father, and his maternal grandparents.

33. In humans, the gene for hemophilia is sex-linked on the X chromosome. A young woman whose brother has hemophilia is contemplating marriage to a young man who has no history of hemophilia in his family. What is the probability that any of her children have hemophilia? Show your work-A pedigree is recommended!!

How to do dihybrid crosses: The hard way!

Dihybrid means paying attention to two traits at the same time:



Genotypic Ratio:

Phenotypic Ratio:

Now, let's do the dihybrid cross the EASY way:

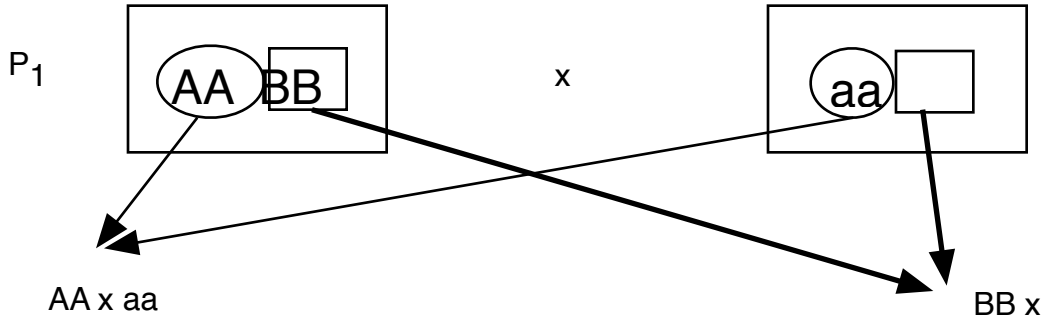
Dihybrid means paying attention to two traits at the same time:

Kernel Color Kernel Texture

Purple kernels of corn = A Smooth kernels = B

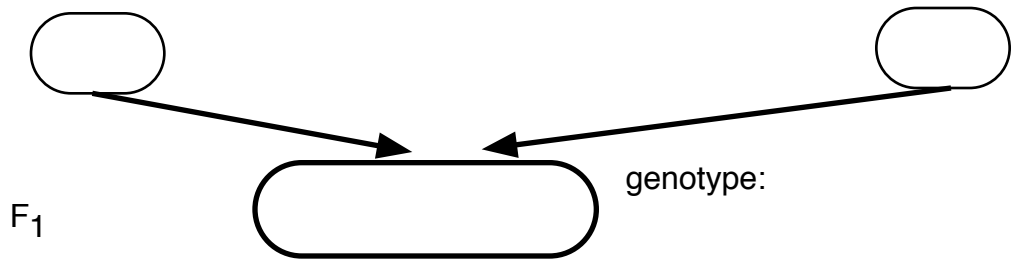
Yellow kernels of corn = a wrinkled kernels = b

But now, let's do each cross each separately and multiply the individual probabilities of each traits' genotype and phenotype together. Why can we multiply? Because of the AND Law; we want



Do the Punnett Square for this cross

Do the Punnett Square for this cross



F₁ offspring self-pollinate

Punnett Square for Aa x Aa

Punnett Square for Bb x

What is probability of AAbb genotype?

What is probability of yellow/wrinkled offspring?

VII. DIHYBRID CROSSES:

34. Write the possible allele combinations that would be found in the gametes (sex cells) of parents with the following genotypes. Remember--each gamete is monoploid. That means that gamete has one allele from each pair of alleles in the parent's genotype and half the total number of alleles in the parents' genotypes. A gamete can never have both alleles from a given pair.

GENOTYPES ALL POSSIBLE GAMETES

- A. AaBb _____
- B. AABb _____
- C. aaBb _____
- D. AAbb _____
- E. AaBB _____

35. In a certain plant, red fruit is dominant to yellow fruit, and tall is dominant to short.

- a. Write the genotype of a parent that is homozygous for both red fruit and tall. _____
- b. Write the genotype of a parent that is heterozygous for both red fruit and tall. _____
- c. Complete a Punnett Square using the above two genotypes as the parents in the cross.
What is the genotypic ratio of the offspring? What is the phenotypic ratio?

36. In a selected plant, blue flowers are dominant over purple flowers and long stems are dominant over short stems. What is the phenotypic ratio for a cross between two plants that are heterozygous for both traits (flower color and stem length?)

37. In horses, black coat is dominant over chestnut coat color. The trotting gait is dominant over the pacing gait. A pure breeding homozygous black trotter is crossed with a pure breeding homozygous chestnut pacer.
- A. What are the genotypic and phenotypic ratios from this cross?
 - B. If two offspring from part A mate, what is the phenotypic ratios from this cross? (Indicate the P_1, P_2, F_1 and F_2 generations)

VII. Dihybrid Sex-linked Problems: You can do it!

38. A brown eyed man whose mother was colorblind and whose father had blue eyes is engaged to marry a woman whose colorblind mother had blue eyes and whose normal vision father had blue eyes.
- HINT:** create a pedigree (family tree) and write genotypes of all individuals before performing any crosses

A. What is the genotype of the young man?

B. Of the young woman?

If they marry and have a family, what are the chances of having:

C. A brown-eyed, normal vision child?

D. A blue-eyed, colorblind child?

E. A brown-eyed, normal vision daughter?

F. A blue-eyed, colorblind son?

39. In chickens, a sex-linked dominant allele causes a feather pattern known as “barred”. If a barred hen is mated with a non-barred rooster, what will be the feather pattern and sex of the offspring?

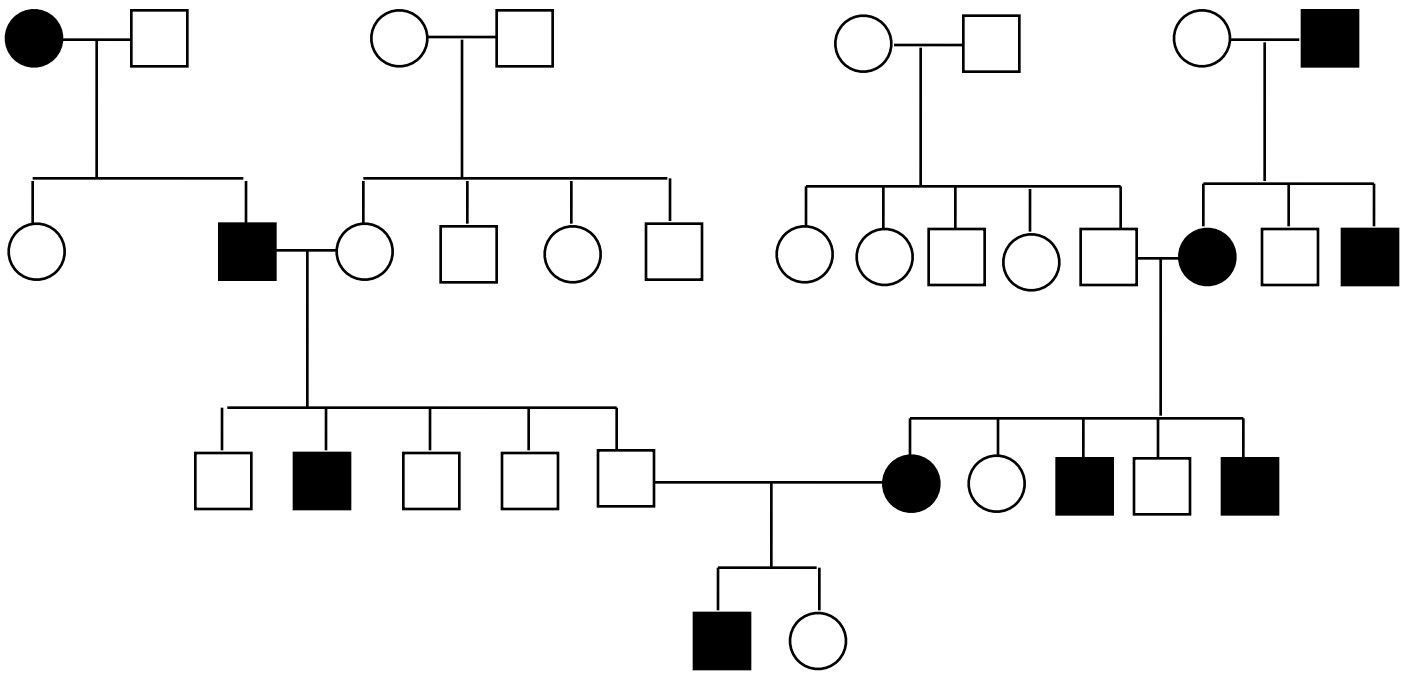
II. Dominant Genetic Diseases (text p. 181 - Huntington’s Disease)

Some genetic disorders and traits are the result of expression of one or more dominant alleles. An example of dominant diseases or disorders include Huntington’s Disease and polydactyly. Huntington’s disease is a fatal genetic disorder that results in the deterioration of the brain and nervous system later in life. Usually individuals with Huntington’s disease have only one copy of the dominant allele. The most unfortunate aspect of Huntington’s disease is the person who has the dominant allele passes the allele to their children before the parent’s symptoms of the disorder are present.

A person with Huntington’s disease has the following genotype: _____ and shape in pedigree is: _____

A person without Huntington’s disease has the following genotype: _____ and shape in pedigree is: _____

40. Determine the genotypes for every member of the family:



41. Polydactyly a condition in which a person has an extra finger or toes on one or both hands or feet. A mother with polydactyly marries a man without polydactyly. If the couple has 20 children, how many children would you expect to have polydactyly?

42. Sometimes a dominant allele may be carried on the X chromosome. In this case, the trait is sex-linked AND dominant. The trait is handedness* and right-handedness is dominant to left-handedness AND the genes for handedness are carried on the X chromosome. Cross a left-handed woman with a right-handed man. HINT: make sure you define your symbols first!!

What are the possible genotypes and phenotypes of their offspring?

What are the chances the couple will have a left handed female child?

**Handedness is not really a sex-linked dominant trait. The trait is used only to practice sex-linked and dominant inheritance.*