Name: Key Date: 2021 Block: _____

Honors Biology: Genetics Packet #1

Vocabulary, One-factor Cross, Two-factor Cross & Test Crosses

Please bring this packet with you to class every day.

Read pages 152-157

Know these terms: (*please note: it is **essential** that you are comfortable with this vocabulary in order to fully grasp the unit.*)

heredity, genetics, trait, hybrid, genetic cross, monohybrid cross, gene, allele, homozygous, heterozygous, dominant, recessive, phenotype, genotype

1. Describe the P generation, F1 generation, F2 generation as it relates to Mendel's experiments with pea plants.
2. Carefully read through Mendel's four hypotheses and describe 1-3 in your own words.
3. Differentiate between allele, gene and trait
4. Describe the Law of Segregation.
5. If gamete formation segregates alleles, what process creates allele pairs again?
6. What is a Punnett square and how is it used?
7. Describe the relationship between genotype and phenotype.
8. Can 2 plants have the same phenotype but different genotypes? Provide an example to support your answer.
9. What makes chromosomes 'homologous'? How many homologous chromosome pairs do humans typically have?

Read pages 158-163

10. What is a dihybrid cross?
11. Describe the Law of Independent Assortment.
12. What is a test cross and how is it used?
13. Use the rules of probability found on page 160 to determine the probability of a AABBCC offspring produced from parents AABbCC and AaBbCc. What is the probability of a aaBBCC offspring from those same parents?
14. What is a pedigree? How are they used?
15. Look at page 161. Be familiar with the key of the pedigree. Sometimes the circles and squares are half-shaded. What could that indicate about that individual? Can you always deduce the genotypes of the individuals shown in a pedigree? Why or why not?
16. Check out table 9.9 on page 162. What does it show? Are all human disorders inherited as a recessive trait?

Vocabulary Review

1. For each genotype below, indicate whether it is heterozygous (He) or homozygous (Ho)

AA Ho Ee He Dd He mm Ho Pp He BB Ho

2. For each of the **genotypes** below determine what **phenotypes** would be possible.

Purple (P) flowers are dominant to **white (p)** flowers

PP purple
Pp purple
pp white

Brown eyes are dominant to **blue** eyes

BB Brown
Bb Brown
bb blue

3. For each **phenotype** below, list the possible **genotypes**.

Straight hair is dominant to curly

HH Straight
Hh Straight
hh Curly

Round seeds are dominant to wrinkled seeds

RR Round
Rr Round
rr Wrinkled

Crosses Involving One Trait

For the crosses in this activity, we will use some of the traits Mendel observed in garden peas. The expression of the dominant and recessive alleles for the gene controlling one of these traits are described in the chart below along with the letter symbols that represent each allele.

Trait/Gene	Dominant Allele	Recessive Allele
Seed coat color	Brown (B)	white (b)

The genotype of each plant must have two letters that represent the alleles received from each parent during fertilization. For example, if a seed had a brown seed coat, it could have two possible genotypes -- BB or Bb. BB is homozygous since the two alleles are identical and Bb is heterozygous, since the two alleles are different. Its phenotype is also round because the allele for brown seed coat (B) is dominant over the gene for white seed coat (b)

In the examples that follow we will predict the phenotypes of the offspring that result from selected crosses. Keep in mind that the predictions are based on probability theory. The problems are used to predict expected outcomes but actual results may vary from these predicted results.

(important!!)

SAMPLE PROBLEM 1

Predict the result of a cross between a pea plant that is homozygous for brown seeds and a plant that has white seeds.

Step 1 Determine the genotypes of the parents.

Since the plant with brown seeds is homozygous for the trait, its genotype must be BB. However the problem does not tell us if the plant with white seeds is homozygous or heterozygous. But we know that white seed coat is a recessive trait, and that recessive

Punnett squares show what is probable; but it's still random.

traits are expressed only if they are homozygous. Therefore the genotype of this plant must be bb. The cross therefore is BB x bb.

Step 2 Determine the gamete genotypes produced by each parent.
The two alleles of any gene segregate during meiosis and, consequently end up in separate gametes. Thus, the brown seed parent (BB) will produce gametes all of which have the genotype B. The white seed parent (bb) will produce gametes that are all of the genotype b.

Step 3 Set up a Punnett Square using the gamete genotypes.

	B	*B*
b		
b		

Step 4 To predict the offspring genotypes, combine the gamete genotypes of one parent with the gamete genotypes of the other parent.

	B	*B*
b	***Bb***	***Bb***
b	***Bb***	***Bb***

Step 5 State the genotype and phenotype proportions of the offspring.
As the Punnett square indicates, the only possible offspring in this cross is Bb. All the offspring would have the genotype Bb and have the brown phenotype.

SAMPLE PROBLEM 2
Predict the results of a cross between heterozygous brown seed plant and a white seed plant.

Step 1 Determine the genotypes of the parents.
Heterozygous brown parent → Bb white parent → bb
Bb x bb

Step 2 Determine the gamete genotypes produced by each parent.
Bb → B, b bb → b, b

Step 3 Set up a Punnett Square using the gamete genotypes.

	B	*b*
b		
b		

Step 4 Combine the gamete genotypes of one parent with those of the other parent to show all possible offspring genotypes.

	B	*b*
b	***Bb***	***bb***
b	***Bb***	***bb***

Step 5 State the genotype and phenotype proportions of the offspring.
Genotypes: ½ Bb, ½ bb Phenotypes: ½ brown, ½ white

EXERCISES

For the crosses shown in exercises xx-xx (a) draw a Punnett Square in the space provided and write (b) the genotype proportions and (c) the phenotypic proportions in the indicated line.

Trait	Dominant	Recessive
Seed Coat	Round (R)	Wrinkled (r)
Pod Color	Green (G)	Yellow (g)
Height of Plant	Tall (T)	Short (t)

1. Rr x RR
   a.

	R	R
R	RR	RR
r	Rr	Rr

   b. Genotype: ½RR, ½Rr
   c. Phenotype: All round

2. Gg x gg
   a.

	g	g
G	Gg	Gg
g	gg	gg

   b. Genotype: ½Gg, ½gg
   c. Phenotype: ½green, ½yellow

3. Ttx Tt
   a.

	T	t
T	TT	Tt
t	Tt	tt

   b. Genotype: ¼TT; ½Tt; ¼tt
   c. Phenotype: 3/4 Tall; ¼ Short

4. Cross two heterozygous plants with green pods.
   a. Gg x Gg

	G	g
G	GG	Gg
g	Gg	gg

   b. Genotype: ¼GG; ½Gg; ¼gg
   c. Phenotype: 3/4 green; ¼ yellow

5. Cross a homozygous tall plant with a short plant.

a. TT x tt

b. Genotype: All Tt

c. Phenotype: All tall (100% tall)

6. Cross a plant that is heterozygous for round-shaped seed coats with a plant that has wrinkled seeds.

a. Rr x rr

	r	r
R	Rr	Rr
r	rr	rr

b. Genotype: ½ Rr; ½ rr

c. Phenotype: ½ round; ½ wrinkled

Crosses Involving Two Traits

Predicting the outcome of crosses involving two traits requires basically the same procedure as that for crosses involving one trait. Keep in mind that in these practice crosses, the genes controlling the two different traits are located on non-homologous chromosomes. During meiosis, non-homologous chromosomes assort randomly, or independently. This means that each of the chromosomes of any pair of homologous chromosomes has an equal probability of ending up in a gamete with either chromosome from any other pair of homologous chromosomes.

* read carefully!!

To illustrate this situation, consider a plant that is heterozygous tall (Tt) and heterozygous green (Gg). This plant has the genotype TtGg. The height gene and the color gene are on different chromosomes. This means that each allele for height, T and t, has an equal probability of assorting in the same gamete with either allele for color, G or g. To determine the possible gamete genotypes that this plant will produce, you must combine each height allele with each color allele. Think about foiling the genes present in the parent to determine the gametes that can be produced. This can be done as follows:

Parent Genotype	Gametes			
TtGg	TG	Tg	tG	tg

Thus, this plant will produce equal numbers of gametes with the genotypes TG, Tg, tG, and tg.

SAMPLE PROBLEM

Predict the results of a cross between a heterozygous round, homozygous tall plant and a homozygous round, short plant.

Step 1 Determine the genotypes of the parents.
Parent 1 (RrTT) *Parent 2 (RRtt)*

Step 2 Determine the gamete genotypes produced by each parent.
RrTT → RT, rT *RRtt → Rt*

Step 3 Set up a Punnett Square using the gamete genotypes.

	Rt	*Rt*	*Rt*	*Rt*
RT				
RT				
rT				
rT				

Note: since the gamete genotypes repeat, the Punnett Square can be simplified.

Step 4 Combine the gamete genotypes of one parent with those of the other parent to show all possible offspring genotypes.

	Rt	**Rt**	**Rt**	**Rt**
RT	*RRTt*	*RRTt*	*RRTt*	*RRTt*
RT	*RRTt*	*RRTt*	*RRTt*	*RRTt*
rT	*RrTt*	*RrTt*	*RrTt*	*RrTt*
rT	*RrTt*	*RrTt*	*RrTt*	*RrTt*

Step 5 State the genotype and phenotype ratio of the offspring as a fraction.
Genotype ratio: *½ RRTt* *½ RrTt*
Phenotype ratio: *All round and tall*

EXERCISES

1) In mice, the ability to run in a straight line is a dominant trait. Mice with this trait are called running mice (R). The recessive trait causes mice to run in circles only. Mice with this trait are called waltzing mice (r). Hair color is also inherited in mice. Black hair (B) is dominant over brown hair (b).

Cross a heterozygous running, heterozygous black mouse with a homozygous running, homozygous black mouse. Determine the genotype and phenotype ratios of the offspring. Express those ratios as fractions.

RrBb × RRBB*

	RB	Rb	rB	rb
RB	RRBB	RRBb	RrBB	RrBb

**

*Since all these gametes will be the same, you can reduce ↳ save work/time

Genotype ratio: ¼ RRBB, ¼ RRBb : ¼ RrBB; ¼ RrBb

Phenotype ratio: 100% running, black-haired mouse

**By convention, always put big letter 1st while maintaining original order of alleles.

2) Use the information from the previous problem to cross a heterozygous running, homozygous black mouse with a heterozygous running, brown mouse. Determine the genotype and phenotype ratios of potential offspring. Express those ratios as fractions.

RrBB x Rrbb

	Rb	rb
RB	RRBb	RrBb
rB	RrBb	rrBb

Genotype ratio: ¼ RRBb; ½ RrBb; ¼ rrBb

Phenotype ratio: ¾ Running, Black-haired; ¼ waltzing, Black-haired

3) In peas, tall is dominant over short and red flower color is dominant over white. If two heterozygous tall, heterozygous red plants are crossed, what is the probability that the offspring will be tall and white?

TtRr x TtRr

	TR	Tr	tR	tr
TR	TTRR	TTRr	TtRR	TtRr
Tr	TTRr	TTrr	TtRr	Ttrr
tR	TtRR	TtRr	ttRR	ttRr
tr	TtRr	Ttrr	ttRr	ttrr

9/16 Tall, red

3/16 Tall, white

3/16 Short, Red

1/16 Short, White

Genotype ratio: Generally, you will not be asked this in a 2-factor cross

Phenotype ratio: 9 tall, red : 3 tall, white : 3 short Red : 1 short white

4) In guinea pigs, dark fur (D) is dominant to light fur and rough coat texture (R) is dominant to smooth coat texture. What are the predicted genotype and phenotype ratios of a cross between a guinea pig that is heterozygous for both traits with another light-furred guinea pig who is heterozygous for texture?

DdRr x ddRr

	DR	Dr	dR	dr
dR	DdRR	DdRr	ddRR	ddRr
dr	DdRr	Ddrr	ddRr	ddrr

Genotype ratio: _____

Phenotype ratio: 3/8 Dark, rough; 3/8 light, rough, 1/8 Dark, smoth, 1/2 light, Smooth

5) In watermelon, the allele for short fruit (S) is dominant to the allele for long fruit (s), and the allele for green fruit (G) is dominant to the allele for mottled fruit (g). Each of four short, green plants were crossed with a different long, mottled plant. The phenotypes of the offspring of these crosses are shown below:

important!

*Note: This is considered a **test cross**. The genotypes of phenotypically dominant individuals can be determined through crossing them with homozygous recessive individuals.*

Plant	Short, green	Short, mottled	Long, green	Long, mottled
1	28	30	33	31
2	71	0	60	0
3	109	0	0	0
4	49	56	0	0

What are the genotypes of plants 1-4? Hint: Consider each trait by itself.

Plant: Short, Green x long, mottled

F__, G__ ffgg

we don't know these b/c the plants show the dominant phenotype. This is an example of a test cross

Plant 1: FfGg

Plant 2: FfGG

Plant 3: FFGG* most likely but don't know for sure!!*

Plant 4: FFGg