

**Honors Biology Bellringer:**

Use the biology book to look up the definitions of each term below:

Monohybrid Cross:

Cross between individuals with one contrasting trait

Dihybrid Cross:

Cross between individuals with two contrasting traits

Now let's try a dihybrid cross!



In rabbits, grey hair is dominant to white hair.  
Also in rabbits, black eyes are dominant to red eyes.  
These letters represent the genotypes of the rabbits:

GG = gray hair	BB = black eyes
Gg = gray hair	Bb = black eyes
gg = white hair	bb = red eyes

1. List the phenotypes of rabbits that have the following genotypes:

Ggbb gray; red      ggBB white; black  
ggbb white; red      GgBb gray; black

2. A male rabbit with the genotype  $GgBb$  is crossed with a female rabbit with the genotype  $ggBb$ . The square is set up below. Fill it out and determine the phenotypes and proportions in the offspring.

	Gb	Gb	Gb	Gb
gB	GgBb	GgBb	GgBb	GgBb
gB	GgBb	GgBb	GgBb	GgBb
gb	Ggbb	Ggbb	Ggbb	Ggbb
gb	Ggbb	Ggbb	Ggbb	Ggbb

How many out of 16 have grey fur and black eyes? 8

How many out of 16 have grey fur and red eyes? 8

How many out of 16 have white fur and black eyes? 0

How many out of 16 have white fur and red eyes? 0

3. A male rabbit with the genotype  $GgBb$ . Determine the gametes produced by this rabbit (the sperm would have these combinations of alleles) Hint there are 4 combinations.

Gb Gb gB gb

4. A female rabbit has the genotype  $ggBb$ . Determine the gametes produced by this rabbit.

gB gb gB gb

5. Use the gametes from #3 and #4 to set up the Punnett square below. Put the male's gametes on the top and the female's gametes down the side. Then fill out the square and determine what kind of offspring would be produced from this cross and in what proportion.

	Gb	Gb	gB	gb
gB	GgBb	GgBb	ggBb	ggBb
gb	GgBb	Ggbb	ggBb	ggbb
gB	GgBb	GgBb	ggBb	ggBb
gb	GgBb	Ggbb	ggBb	ggbb

gray + black

$6/16 = 37.5\%$

white + black

$6/16 = 37.5\%$


gray + red

$2/16 = 12.5\%$

white + red

$2/16 = 12.5\%$

6. An aquatic arthropod called a Cyclops has antennae that are either smooth or barbed. The allele for barbs is dominant. In the same organism, resistance to pesticides is a recessive trait. Make a "key" to show all the possible genotypes (and phenotypes) of this organism. Use the rabbit key to help you if you're lost.



Handwritten key:

- $BBRR$  } barbed
- $BBRr$  } Barbed & resistant
- $BbRR$  } not resistant
- $BbRr$  } resistant
- $bbRR$  } smooth & not resistant
- $bbRr$  } not resistant
- $bbrR$  } smooth & resistant
- $bbrR$  } smooth + resistant

7. A Cyclops that is resistant to pesticides and has smooth antennae is crossed with one that is heterozygous for both traits. Show the genotypes of the parents.

$bbrR \times BbRr$

	BR	Br	bR	br
br	$BbRr$	$Bbrr$	$bbRr$	$bbrR$
br	$BbRr$	$Bbrr$	$bbRr$	$bbrR$
br	$BbRr$	$Bbrr$	$bbRr$	$bbrR$
br	$BbRr$	$Bbrr$	$bbRr$	$bbrR$

8. Set up a Punnett square for the cross.

F:  $br$        $BR$   
 O:  $br$        $Br$   
 I:  $br$        $bR$   
 L:  $br$        $br$

9. What are the phenotypic ratios of the offspring?

- 25% barbed & not resistant
- 25% barbed & resistant
- 25% smooth & not resistant
- 25% smooth & resistant

1) Explain the difference between an autosomal and a sex-linked trait.

not on a sex chr. ←      → found on a sex chr. (X)

2) Explain the difference between genotype and phenotype.

what alleles are present ←      → physical appearance of trait

3) Albinism is an autosomal recessive trait. Write the genotypes of:

- A woman who is a carrier:  $Aa$
- A homozygous dominant man:  $AA$
- Their possible offspring (including % of each phenotype):  
 0% albino (50% carriers)

Draw Punnett Square here:

	A	A
A	AA	AA
a	Aa	Aa

4) Dwarfism is an autosomal dominant trait. Write the genotypes of:

- A woman who is a carrier: heterozygous  $Dd$
- A homozygous dominant man:  $DD$
- Their possible offspring (including % of each phenotype):  
 100% dwarfism

Draw Punnett Square here:

	D	D
D	DD	DD
d	Dd	Dd

5) Typical male pattern baldness is a sex-linked recessive trait. Write the genotypes of:

- A woman who is a carrier:  $X^B X^b$
- A homozygous dominant man:  $X^B Y$
- Their possible offspring (including % of each phenotype):  
 50% non-bald females  
 25% bald male  
 25% non-bald male

Draw Punnett Square here:

	$X^B$	Y
$X^B$	$X^B X^B$	$X^B Y$
$X^b$	$X^B X^b$	$X^b Y$

- 6) You are doing an experiment to determine whether tan body color is an autosomal or sex-linked trait in fruit flies, so you perform two crosses. In cross #1 you mate a tan colored male with a wild-type female and produce 498 wild-type males and 503 wild-type females. In cross #2 you mate a wild-type male with a tan female and produce 501 tan males and 499 wild-type females. What can you conclude from these data? Use a Punnett Square to justify your answer. You may assume that all parent flies are true-breeding.

$X^T Y$        $X^T Y$       50% wild-type female  
 $X^w X^w$        $X^w X^w$       50% wild-type male  

$X^w X^T$	$X^w X^w$
$X^w X^T$	$X^w X^w$

  
 It is sex-linked.

- 7) You are doing an experiment to determine whether the "eyeless" condition in fruit flies is autosomal or sex-linked, so you perform two crosses. In cross #1 you mate an eyeless male with a female with normal eyes and produce 532 males with normal eyes and 529 females with normal eyes. In cross #2 you mate a normal-eyed male with a female that is eyeless to produce 540 normal-eyed males and 544 females, also with normal eyes. What can you conclude from these data? Use a Punnett Square to justify your answer. You may assume that all parent flies are true-breeding.

E: normal      #1      e e      #2      E E  
 e: eyeless  

E	Ee	Ee
E	Ee	Ee

  
 100% normal  

e	Ee	Ee
e	Ee	Ee

  
 100% normal  
 It is autosomal!

- 9) Explain the difference between incomplete dominance and codominance.

two traits are blended ← (red + white = pink)  
 ↳ both traits expressed fully (red + white = roan)

- 10) Human blood type is controlled by multiple alleles. These alleles are normally denoted as  $I^A$ ,  $I^B$ , and  $I^O$ . You inherit one version of the allele from each parent.  $I^A$  and  $I^B$  are codominant and  $I^O$  is recessive. Write all of the different possible genotypes and phenotypes for this trait. If you are unsure about your answer, you can find this in the textbook.

$I^A I^A$        $I^A I^O$        $I^B I^B, I^B I^O$        $I^A I^B$        $I^O I^O$   
 type A      type B      type AB      type O

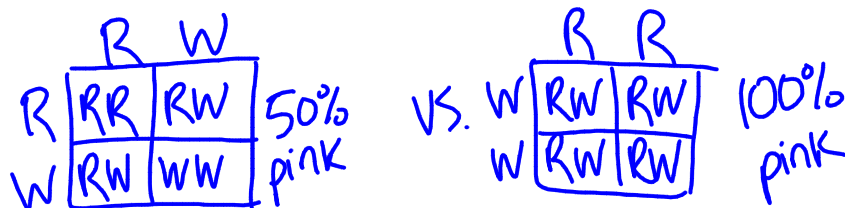
- 11) Is it possible for a man with blood type AB and a woman with type O blood to have a child that also has type O blood? Use a Punnett square to justify your answer.

$I^A I^B$        $I^A I^B$   
 $I^O I^O$        $I^O$ 

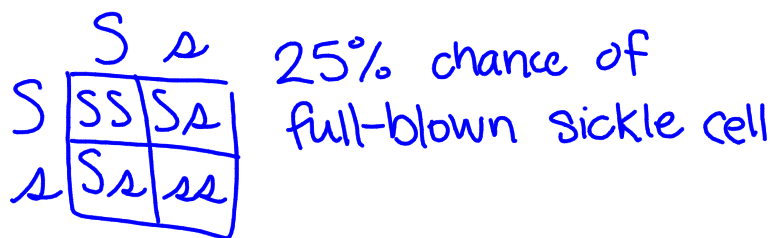
$I^A I^O$	$I^B I^O$
$I^A I^O$	$I^B I^O$

  
 It is not possible.

12) A supplier for a local florist wants to produce the maximum number of pink blooms possible in preparation for Valentine's day. He knows that red and white alleles for flower color are incompletely dominant, and is considering either self-pollinating a pink flower or crossing a white and a red flower. Provide advice for the supplier, using Punnett squares to back up your choice.



13) Sickle-cell anemia is a disease that results in the production of mutated hemoglobin that no longer carries oxygen correctly. Heterozygous individuals have both the normal and the mutated hemoglobin in their blood. What type of dominance is this? codominance  
 Draw a Punnett Square and give the probability of two heterozygous individuals having a child with full-blown sickle-cell anemia.



### Practice with Non-Mendelian Genetics

- Practice writing **genotypes** for the phenotypes listed in each set. Remember that the "medium" trait must always be heterozygous.
  - Birds can be blue, white, or white with blue-tipped feathers.  
 blue: BB    white: WW    blue-tipped: BW
  - Flowers can be white, pink, or red.  
 white: WW    pink: WR    red: RR
  - A Hoo can have curly hair, spiked hair, or a mix of both curly and spiked.  
 curly: CC    spiked: SS    mix: CS
  - A Sneech can be tall, medium, or short.  
 tall: TT    medium: TS    short: SS
  - A Bleexo can be spotted, black, or white.  
 spotted: BW    black: BB    white: WW



- Now determine which of the letters represent codominant traits and which are incomplete.  
 Write the letters of the **codominance** examples here: a, c, e  
 Write the letters of the **incomplete dominance** examples here: b, d

3. In Smileys, eye shape can be starred, circular, or a circle with a star. Write the *genotypes* for the pictured phenotypes.



4. Show the cross between a star-eyed smiley and a circle eyed smiley.

List the possible *genotypes* and the corresponding *phenotypes* of the offspring.

100% CS, which have circle-star eyes

	S	S
C	CS	CS
C	CS	CS

5. Show the cross between a circle-star eyed smiley, and a circle eyed smiley.

What percentage of the offspring are circle-eyed? 50%

What percentage of the offspring are circle-star eyed? 50%

	C	S
C	CC	CS
C	CC	CS

6. Show the cross between two circle-star eyed smileies.

What percentage of the offspring are circle-eyed? 25%

What percentage of the offspring are circle-star eyed? 50%

What percentage are star eyed? 25%

	C	S
C	CC	CS
S	CS	SS

Calico is a coat color found in cats, which is caused by a SEX-LINKED, CODOMINANT allele. Cats have an allele for black fur and a different allele for orange. If both alleles are present, the cat is calico.

Possible Alleles:  
 $X^B$  = black,  $X^R$  = orange

Write the genotypes of the following cats:

Black female:  $X^B X^B$

Orange female:  $X^R X^R$

Calico female:  $X^B X^R$

Black male:  $X^B Y$

Orange male:  $X^R Y$





Show each of the crosses below and include the percentage of each possible phenotype.

1. A black male crossed with an orange female

50% calico ♀  
 50% orange ♂

	$X^O$	$Y$
$X^R$	$X^R X^O$	$X^R Y$
$X^R$	$X^R X^O$	$X^R Y$

4. An orange male crossed with an orange female

50% orange ♀  
 50% orange ♂

	$X^R$	$Y$
$X^R$	$X^R X^R$	$X^R Y$
$X^R$	$X^R X^R$	$X^R Y$

2. An orange male crossed with a calico female

25% calico ♀  
 25% orange ♀  
 25% black ♂  
 25% orange ♂

	$X^R$	$Y$
$X^O$	$X^O X^R$	$X^O Y$
$X^R$	$X^R X^R$	$X^R Y$

5. A black male crossed with a calico female

25% black ♀  
 25% calico ♀  
 25% black ♂  
 25% orange ♂

	$X^B$	$Y$
$X^O$	$X^O X^B$	$X^O Y$
$X^R$	$X^R X^B$	$X^R Y$

3. A black male crossed with a black female

50% black ♀  
 50% black ♂

	$X^B$	$Y$
$X^B$	$X^B X^B$	$X^B Y$
$X^B$	$X^B X^B$	$X^B Y$

6. What type of parents should you choose to have the MOST number of calico kittens?

black ♂ + orange ♀ (or vice versa)  
 7. Why aren't there any male calico cats?  
 because calico requires 2 X chromosomes