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Topic: Meiosis Worksheet – Linked Genes

Summary: Students will practice citing evidence of gene linkage using crossover frequencies to defend a claim.

NGSS Standards: *HS-LS3-2.* Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

Time Length: ~60 minutes

Prerequisite Knowledge: Students know the structure of a chromosome, what is an allele, a gene, and a trait.

Materials:
Class notes or textbook or online textbook

- https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/section/3.10/primary/lesson/genetic-linkage-bio/

Procedures:
1. Review with the class about crossing over in meiosis, chromosome structure, and Punnett squares.
2. Students work on the handout by themselves.

Accommodations: Students with an IEP can take the handout home if they need extra time, or you provide the answers to questions 1, 3, 5 and they do questions 2 and questions 4 and 6.

Editable DOCX File and Answer Key:
Available at www.ngsslifescience.com

Name: _____ Row: _____

Date:_____ Period:_____

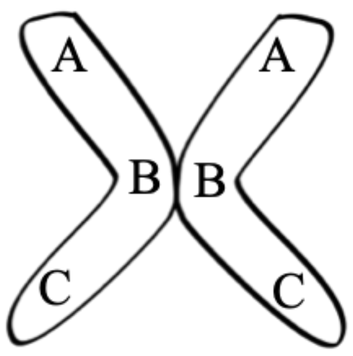
Meiosis Worksheet – Linked Genes

Simple Punnett squares do not work for genes found on the same chromosome. Scientists call these genes linked, since if an individual inherits that chromosome, they get both genes. But what about crossing over in meiosis? Crossing over has the potential to unlink these genes. Scientists call two or more genes linked genes. When two genes cross over more frequently, the farther apart the two genes are on the same chromosome.

Example: Look at the cross over frequency in the data table below. Notice gene A and B are close to each other (because they are crossed over less often) but gene A and C are farther apart (because they are crossed over more often).

Genes	Crossover Frequency
A & B	5%
A & C	10%
B & C	5%

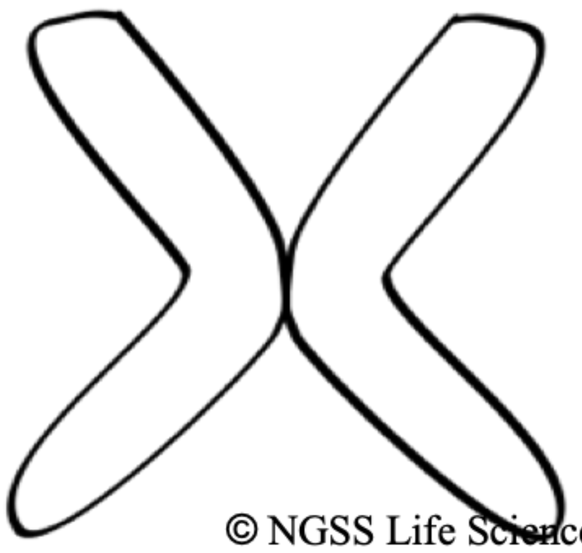
This would create the following order genes on the chromosome on the right.



1. In *Drosophila*, the gene for eye color (A), wing shape (B), and body color (C) are all found on the same X chromosome. The following crossover frequencies for these genes were determined by experiments.

Genes	Crossover Frequency
A & B	12.5%
A & C	6.0%
B & C	18.5%

What is the correct sequence of the genes A, B and C on the chromosome? Write in the order of these genes in the chromosome on the right.



2. What is an allele? Why do alleles come in pairs? Below is a diagram of crossing over of chromosomes. On the right, write in the alleles that were crossed over.

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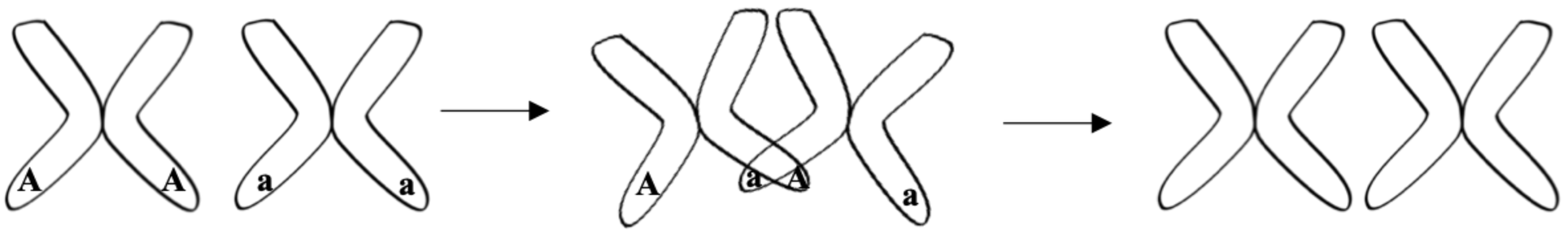
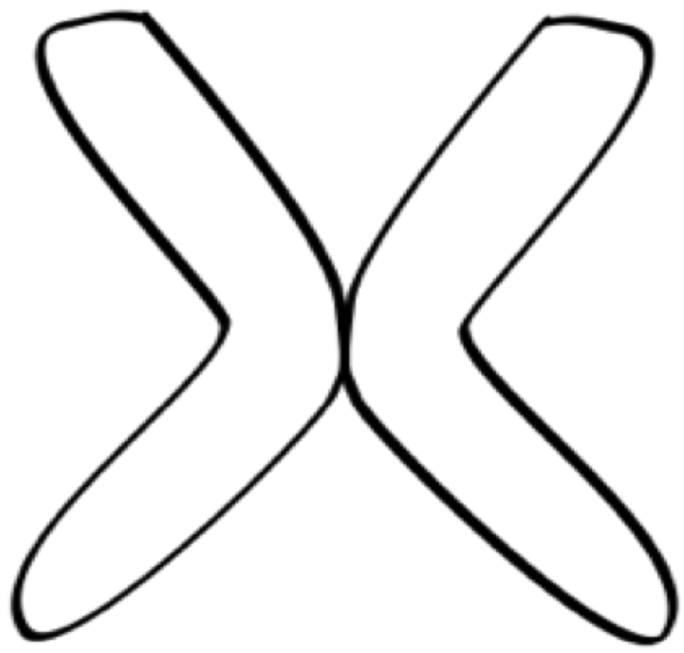


3. In 1911, Thomas Hunt Morgan collected the following crossover gene frequencies while studying *Drosophila*. Bar-shaped eyes are indicated by the (B) allele, and carnation eyes are indicated by the allele (C). Fused veins on wings (A) and scalloped wings (S) are located on the same chromosomes. Write the order of the genes in the chromosome on the right.

Gene Combinations	Recombination Frequency
A/B	2.5%
A/C	3.0%
B/C	5.5%
B/S	5.5%
A/S	8.0%
C/S	11.0%



4. Use the gene map from question 3 to explain the claim that <u>inheritable genetic variations may result from new genetic combinations through meiosis</u>. Be sure to include keywords like allele, gene, homologous chromosome & crossing over.

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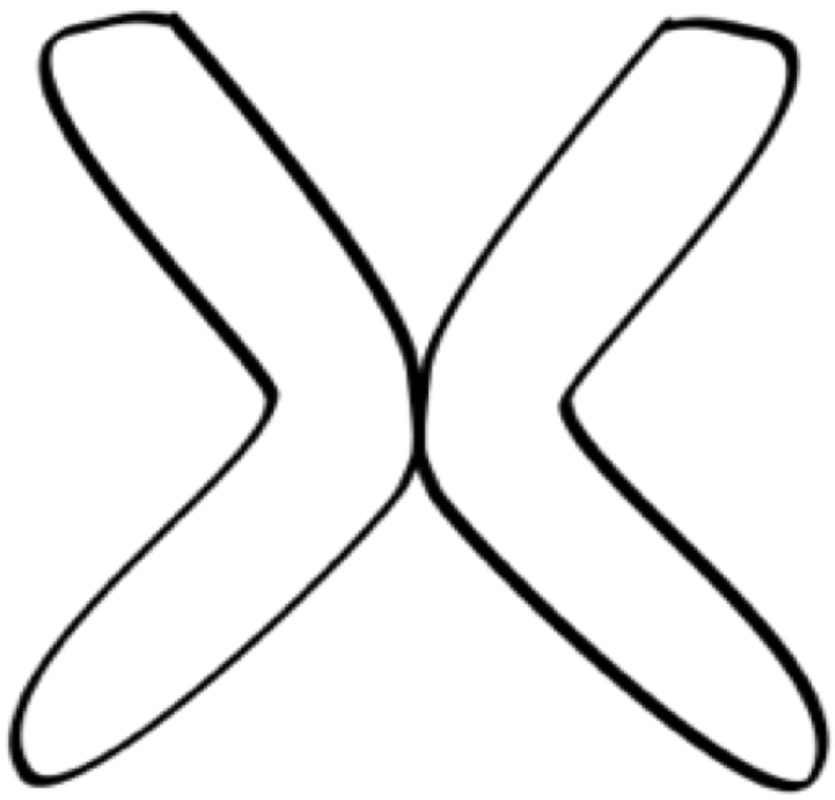
5. Five traits found in *Drosophila* are yellow body color (y), white eye color (w), vermilion eye color (v), miniature wing (m) and rudimentary wing (r). Given the following crossover frequencies, construct a genetic map on the next page.

Genes	Crossover Frequency
y & w	2.2%
v & m	3.0%
v & r	26.6%
v & w	30.0%
v & y	32.2%
w & m	33.0%
y & m	35.2%
w & r	56.6%



6. Use the gene map from question 5 to support the claim that <u>inheritable genetic variations may result from new genetic combinations through meiosis</u>. Be sure to use as evidence the cross over frequencies for the listed traits in question 5.

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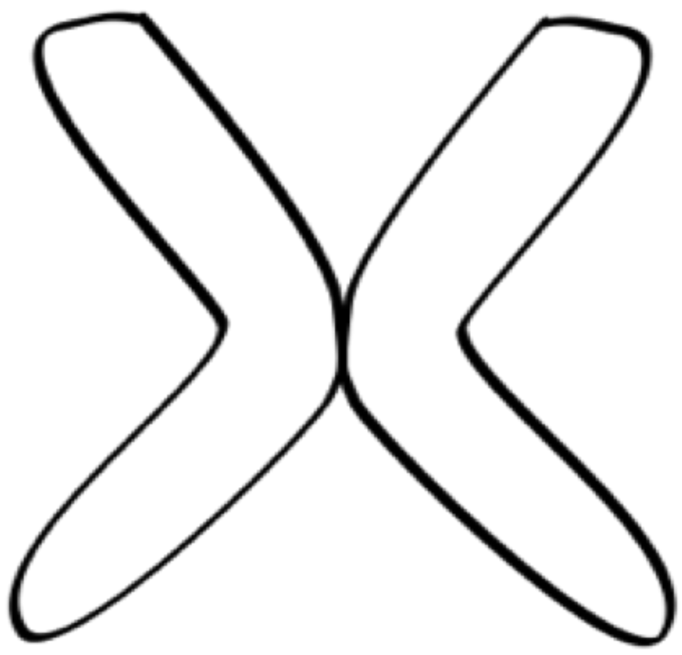
Challenge Questions:

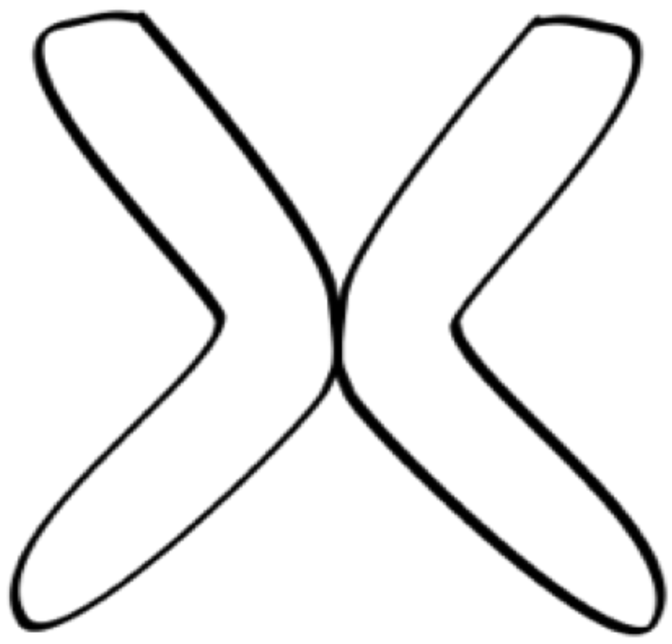
7. The following chart shows the crossover frequencies for some genes on an autosome of organism Z. Construct a gene map. Write the order of the genes in the chromosome on the right.

Genes	Crossover Frequency
P & Q	5%
P & R	8%
P & S	12%
Q & R	13%
Q & S	17%

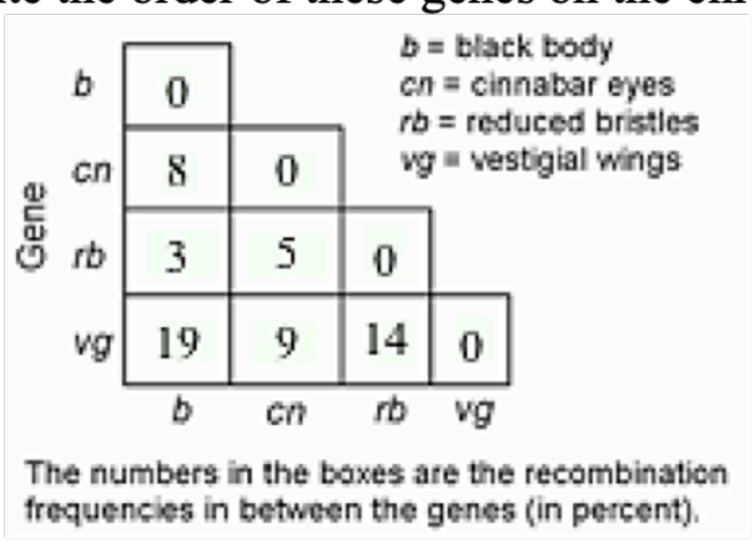


8. Construct a gene map given the following information. Write the order of the genes in the chromosome on the right.

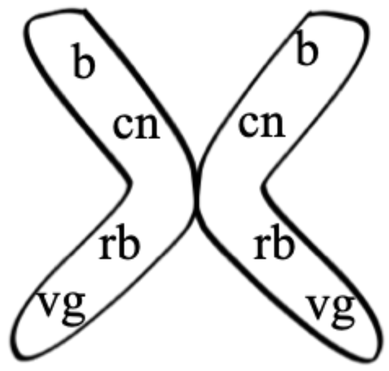
Genes	Crossover Frequency
A & B	24.0%
A & C	8.0%
C & D	2.0%
A & F	16.0%
F & B	8.0%
D & F	6.0%

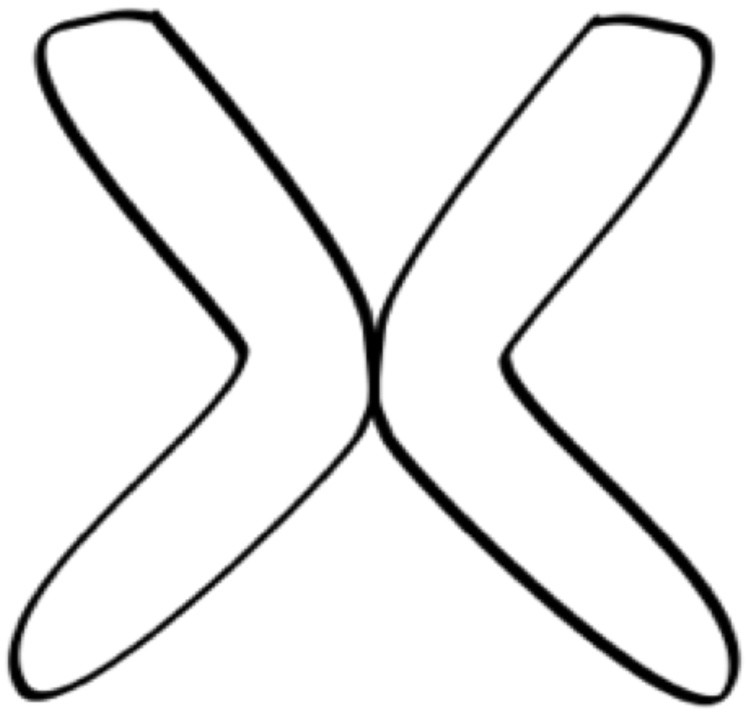


9. In a series of mapping experiments, the recombination frequencies for four different linked genes of *Drosophila* (fruit fly) were determined as shown in the figure above. Write the order of these genes on the chromosome on the right.



Example:





10. For a series of experiments, a linkage group composed of genes W, X, Y and Z was found to show the following gene combinations. (All recombinations are expressed per 100 fertilized eggs). Construct a gene map on the chromosome below.

Genes	W	X	Y	Z
W	–			
X	5	–		
Y	7	2	–	
Z	8	3	1	–