

Partner 1: \_\_\_\_\_

Date \_\_\_\_\_

Partner 2: \_\_\_\_\_

AP Biology

www.biologylabsonline.com • USERNAME: dahs2008 • PASSWORD: apbi0l0gy

**LAB \_\_\_\_\_ : GENETICS OF ORGANISMS— VIRTUAL FLY LAB**

For your assigned set of traits, go to the Virtual Fly Web site ([www.biologylabsonline.com](http://www.biologylabsonline.com)) and use the tools there to determine the genetics of the 4 traits assigned to you (recessive, dominant, X-linked, lethal, etc.). In the second part of this lab, you will also need to determine the genetic relationships between the 4 traits (epistasis, linkage, etc.).

You *must* develop Punnett squares as hypotheses before you complete crosses and Chi-square analyses. Print out the lab notebook pages from Virtual Fly for each of your crosses to include in your lab report and complete this lab worksheet as your final lab write-up.

**SPECIAL NOTE:** As a general rule, parental flies in FlyLab are true breeding homozygotes. However there is one critical exception: In FlyLab, if a trait is lethal dominant, it is only lethal in the homozygote (AA). Therefore, when you set up the cross, FlyLab software *automatically* makes the breeding fly with that trait a heterozygote (Aa), because if she were homozygous dominant (AA), she'd be dead — so the heterozygote is the only way to get the trait into the breeding pair.

No.	Student Name	Trait 1	Trait 2	Trait 3	Trait 4
1	<b>RESERVED AS CLASS EXAMPLE</b>	SE	L	T	D
2		AP	L	Y	AR
3		BL	VG	W	CY
4		C	AP	SN	SB
5		DP	VG	SD	ST
6		E	SS	S	ST
7		PR	L	M	SB
8		RI	VG	F	D
9		BW	AP	CV	CY
10		SS	L	Y	AR
11		SV	EY	B	AR
12		VG	L	W	CY
13		AP	L	T	D
14		EY	BW	SN	SB
15		VG	L	SD	ST

**YOU MUST USE ONLY PENCIL ON THIS LAB!!!!**

**DROSOPHILA MUTATIONS**

<b>Abbreviation</b>	<b>Mutant Phenotype</b>
<b>AP</b>	Apterous Wings
<b>AR</b>	Aristapedia Antennae
<b>B</b>	Bar Eyes
<b>BL</b>	Black Body
<b>BW</b>	Brown Eyes
<b>C</b>	Curved Wings
<b>CV</b>	Crossveinless Wings
<b>CY</b>	Curly Wings
<b>D</b>	Dichaete Wings
<b>E</b>	Ebony Body
<b>EY</b>	Eyeless Eyes
<b>DP</b>	Dumpy Wings
<b>F</b>	Forked Bristles
<b>L</b>	Lobe Eyes
<b>M</b>	Miniature Wings
<b>PR</b>	Purple Eyes
<b>RI</b>	Radius Incompletus Wings
<b>S</b>	Sable Body
<b>SB</b>	Stubble Bristles
<b>SD</b>	Scalloped Wings
<b>SE</b>	Sepia Eyes
<b>SN</b>	Singed Bristles
<b>SS</b>	Spineless Bristles
<b>ST</b>	Star Eyes
<b>SV</b>	Shaven Bristles
<b>T</b>	Tan Body
<b>VG</b>	Vestigial Wings
<b>W</b>	White Eyes
<b>Y</b>	Yellow Body

**YOU MUST USE ONLY PENCIL ON THIS LAB!!!!**



Partner 1 \_\_\_\_\_

Partner 2 \_\_\_\_\_

f. Draw your proposed Punnett square for the Parental cross generating the F2 offspring.

**F1 x F1 → F2**

_____ X _____ female                      male <b>phenotype</b>		
_____ X _____ female                      male <b>genotype</b>		

g. List the data generated by Virtual Fly for the F1 x F1 → F2 cross.

Phenotype	Numbers	Ratio
<b>TOTAL</b>		

h. Did your Chi-square analysis of this cross support this proposed inheritance pattern? Explain.

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i. Which cross offered the strongest evidence supporting your proposed inheritance pattern for this trait?

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j. Is the trait **dominant** or **recessive**? \_\_\_\_\_

k. Is the trait **X-linked** or **autosomal**? \_\_\_\_\_

l. Is the trait **lethal** or **non-lethal**? \_\_\_\_\_

**NOTE:** Keep a Word file of all data from Virtual Fly to support your conclusions.

For your assigned fly trait, complete the following statements or answer the questions.

**2. Trait 2: Monohybrid cross**

- a. The name of the mutant trait is \_\_\_\_\_
- b. The symbol of the mutant trait is \_\_\_\_\_
- c. Draw your proposed Punnett square for the Parental cross generating the F1 offspring. Use the symbol of the mutant trait as your allele letter and remember a plus sign (+) signifies “wild type”, which means a fly without the mutant trait. Also remember to use the convention that male gametes are listed on the top of the Punnett square.

**P x P → F1**

<table style="border: none; margin: 0 auto;"> <tr> <td style="border: none; padding: 0 10px;">_____</td> <td style="border: none; text-align: center;"><b>X</b></td> <td style="border: none; padding: 0 10px;">_____</td> </tr> <tr> <td style="border: none; text-align: center;">female</td> <td style="border: none;"></td> <td style="border: none; text-align: center;">male</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;"><b>phenotype</b></td> <td style="border: none;"></td> </tr> <tr> <td style="border: none; padding: 0 10px;">_____</td> <td style="border: none; text-align: center;"><b>X</b></td> <td style="border: none; padding: 0 10px;">_____</td> </tr> <tr> <td style="border: none; text-align: center;">female</td> <td style="border: none;"></td> <td style="border: none; text-align: center;">male</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;"><b>genotype</b></td> <td style="border: none;"></td> </tr> </table>	_____	<b>X</b>	_____	female		male		<b>phenotype</b>		_____	<b>X</b>	_____	female		male		<b>genotype</b>				
_____	<b>X</b>	_____																			
female		male																			
	<b>phenotype</b>																				
_____	<b>X</b>	_____																			
female		male																			
	<b>genotype</b>																				

- d. List the data generated by Virtual Fly for the P x P → F1 cross.

Phenotype	Numbers	Ratio
<b>TOTAL</b>		

- e. Did your Chi-square analysis of this cross support this proposed inheritance pattern? Explain.

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Partner 1 \_\_\_\_\_

Partner 2 \_\_\_\_\_

f. Draw your proposed Punnett square for the Parental cross generating the F2 offspring.

**F1 x F1 → F2**

_____ X _____			
female                      male			
<b>phenotype</b>			
_____ X _____			
female                      male			
<b>genotype</b>			

g. List the data generated by Virtual Fly for the F1 x F1 → F2 cross.

Phenotype	Numbers	Ratio
<b>TOTAL</b>		

h. Did your Chi-square analysis of this cross support this proposed inheritance pattern? Explain.

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i. Which cross offered the strongest evidence supporting your proposed inheritance pattern for this trait?

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j. Is the trait **dominant** or **recessive**? \_\_\_\_\_

k. Is the trait **X-linked** or **autosomal**? \_\_\_\_\_

l. Is the trait **lethal** or **non-lethal**? \_\_\_\_\_

**NOTE:** Keep a Word file of all data from Virtual Fly to support your conclusions.

For your assigned fly trait, complete the following statements or answer the questions.

**3. Trait 3: Monohybrid cross**

- a. The name of the mutant trait is \_\_\_\_\_
- b. The symbol of the mutant trait is \_\_\_\_\_
- c. Draw your proposed Punnett square for the Parental cross generating the F1 offspring. Use the symbol of the mutant trait as your allele letter and remember a plus sign (+) signifies “wild type”, which means a fly without the mutant trait. Also remember to use the convention that male gametes are listed on the top of the Punnett square.

**P x P → F1**

<table style="border: none; margin: 0 auto;"> <tr> <td style="border: none; padding: 0 10px;">_____</td> <td style="border: none; text-align: center; padding: 0 10px;"><b>X</b></td> <td style="border: none; padding: 0 10px;">_____</td> </tr> <tr> <td style="border: none; text-align: center; padding: 0 10px;">female</td> <td style="border: none;"></td> <td style="border: none; text-align: center; padding: 0 10px;">male</td> </tr> <tr> <td colspan="3" style="border: none; text-align: center; padding: 0 10px;"><b>phenotype</b></td> </tr> <tr> <td colspan="3" style="border: none; padding: 10px 0 0 0;"> </td> </tr> <tr> <td style="border: none; padding: 0 10px;">_____</td> <td style="border: none; text-align: center; padding: 0 10px;"><b>X</b></td> <td style="border: none; padding: 0 10px;">_____</td> </tr> <tr> <td style="border: none; text-align: center; padding: 0 10px;">female</td> <td style="border: none;"></td> <td style="border: none; text-align: center; padding: 0 10px;">male</td> </tr> <tr> <td colspan="3" style="border: none; text-align: center; padding: 0 10px;"><b>genotype</b></td> </tr> </table>	_____	<b>X</b>	_____	female		male	<b>phenotype</b>						_____	<b>X</b>	_____	female		male	<b>genotype</b>			
_____	<b>X</b>	_____																				
female		male																				
<b>phenotype</b>																						
_____	<b>X</b>	_____																				
female		male																				
<b>genotype</b>																						

- d. List the data generated by Virtual Fly for the P x P → F1 cross.

Phenotype	Numbers	Ratio
<b>TOTAL</b>		

- e. Did your Chi-square analysis of this cross support this proposed inheritance pattern? Explain.

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For your assigned fly trait, complete the following statements or answer the questions.

**4. Trait 4: Monohybrid cross**

- a. The name of the mutant trait is \_\_\_\_\_
- b. The symbol of the mutant trait is \_\_\_\_\_
- c. Draw your proposed Punnett square for the Parental cross generating the F1 offspring. Use the symbol of the mutant trait as your allele letter and remember a plus sign (+) signifies “wild type”, which means a fly without the mutant trait. Also remember to use the convention that male gametes are listed on the top of the Punnett square.

**P x P → F1**

<table style="border: none; margin: auto;"> <tr> <td style="border: none; padding: 0 10px;">_____</td> <td style="border: none; text-align: center; padding: 0 10px;"><b>X</b></td> <td style="border: none; padding: 0 10px;">_____</td> </tr> <tr> <td style="border: none; padding: 0 10px;">female</td> <td style="border: none;"></td> <td style="border: none; padding: 0 10px;">male</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;"><b>phenotype</b></td> <td style="border: none;"></td> </tr> <tr> <td style="border: none; padding: 0 10px;">_____</td> <td style="border: none; text-align: center; padding: 0 10px;"><b>X</b></td> <td style="border: none; padding: 0 10px;">_____</td> </tr> <tr> <td style="border: none; padding: 0 10px;">female</td> <td style="border: none;"></td> <td style="border: none; padding: 0 10px;">male</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;"><b>genotype</b></td> <td style="border: none;"></td> </tr> </table>	_____	<b>X</b>	_____	female		male		<b>phenotype</b>		_____	<b>X</b>	_____	female		male		<b>genotype</b>		<table border="1" style="border-collapse: collapse; width: 150px; height: 100px;"> <tr><td style="width: 50px; height: 50px;"></td><td style="width: 50px; height: 50px;"></td></tr> <tr><td style="width: 50px; height: 50px;"></td><td style="width: 50px; height: 50px;"></td></tr> </table>				
_____	<b>X</b>	_____																					
female		male																					
	<b>phenotype</b>																						
_____	<b>X</b>	_____																					
female		male																					
	<b>genotype</b>																						

- d. List the data generated by Virtual Fly for the P x P → F1 cross.

Phenotype	Numbers	Ratio
<b>TOTAL</b>		

- e. Did your Chi-square analysis of this cross support this proposed inheritance pattern? Explain.

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Partner 1 \_\_\_\_\_

Partner 2 \_\_\_\_\_

f. Draw your proposed Punnett square for the Parental cross generating the F2 offspring.

**F1 x F1 → F2**

_____ X _____			
female                      male			
<b>phenotype</b>			
_____ X _____			
female                      male			
<b>genotype</b>			

g. List the data generated by Virtual Fly for the F1 x F1 → F2 cross.

Phenotype	Numbers	Ratio
<b>TOTAL</b>		

h. Did your Chi-square analysis of this cross support this proposed inheritance pattern? Explain.

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i. Which cross offered the strongest evidence supporting your proposed inheritance pattern for this trait?

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j. Is the trait **dominant** or **recessive**? \_\_\_\_\_

k. Is the trait **X-linked** or **autosomal**? \_\_\_\_\_

l. Is the trait **lethal** or **non-lethal**? \_\_\_\_\_

**NOTE:** Keep a Word file of all data from Virtual Fly to support your conclusions.

**Multiple Gene Interactions (Dihybrid Crosses)**

For each of the **autosomal** traits, design **test crosses** (individual with dominant trait crossed with an individual with recessive trait) that will determine how the traits work in combination. Through dihybrid crosses, you will be able to determine epistasis, independent assortment, gene linkage, recombination frequency, and map units.

1. Use the following dihybrid cross worksheets to plan and analyze your dihybrid crosses.

**HINT:** The proposed Punnett square that you develop on these worksheets serves as your hypothesis and then you will test this hypothesis by making that cross in Virtual Fly. You can only draw conclusions by comparing your hypothesized results (the expected Punnett square) to the observed results in Virtual Fly. And then analyzing the differences using a Chi-square test.

2. Here is a suggested plan of action:
  - a. Make a  $P \times P \rightarrow F_1$  generation test cross using two of your monohybrid traits mixed into one individual (dihybrid) — individual homozygous dominant for both traits crossed with an individual homozygous recessive for both traits (AABB x aabb) — that will create a **heterozygote dihybrid** (AaBb) in the F1 generation.
  - b. Then make a “**test cross**” with this **heterozygote dihybrid** to create an F2 generation. Remember a **test cross** = individual with dominant trait (in this case the AaBb heterozygote) crossed with an individual with recessive trait, but in this case it must be AaBb x aabb.
  - c. Remember we are talking about dominant and recessive traits. Don't assume your wild type is dominant and your mutant is recessive. Go back to the data from your monohybrid crosses to determine which is dominant and which is the recessive trait.
3. Compare the “observed” data generated by Virtual Fly to the “expected” Punnett square data generated by you.
4. Complete a Chi-square analysis for each cross and determine if you **accept** or **reject** the null hypothesis. If you **reject** the null hypothesis, then you are saying that the genes and traits are not independent from each other. If they are not, then you have two choices here:
  - a. the genes are **linked**, which means they are on the same chromosome, and therefore do not assort independently during meiosis
  - b. the genes have an **epistatic interaction** where one gene masks the other in specific genotype combinations.
5. If the genes are linked, determine the **crossing over frequency** and complete the Summary Chart. Then determine the **map units** between the linked loci and complete the Summary Chart.
6. If the traits exhibit epistatic properties, list which trait masks which.

Partner 1 \_\_\_\_\_

Partner 2 \_\_\_\_\_

**MULTIPLE GENE INTERACTIONS: DIHYBRID CROSS 1**

1. Traits being tested: \_\_\_\_\_ & \_\_\_\_\_

**Phenotype:**

\_\_\_\_\_ X \_\_\_\_\_  
dominant heterozygote female                      recessive male

**Genotype:**

\_\_\_\_\_ X \_\_\_\_\_  
dominant heterozygote female                      recessive male

2. Complete the Punnett square for the AaBb x aabb **dihybrid testcross**.


3. List your expected & observed ratios for the dihybrid testcross.

Expected Genotype	Expected Genotype Ratios	Expected Phenotype	Expected Phenotype Ratios	Observed Phenotype	Observed Phenotype Ratios	Observed Phenotype Number
Total Number of Fly Offspring						

4. Did you **accept** or **reject** your null hypothesis in your Chi-square test? \_\_\_\_\_

5. Are these genes linked (on the same chromosome)? \_\_\_\_\_

6. Do these traits exhibit epistasis? \_\_\_\_\_

7. What is your evidence/explanation to support this presumed inheritance pattern?

\_\_\_\_\_

Partner 1 \_\_\_\_\_

Partner 2 \_\_\_\_\_

**MULTIPLE GENE INTERACTIONS: DIHYBRID CROSS 2**

1. Traits being tested: \_\_\_\_\_ & \_\_\_\_\_

**Phenotype:**

\_\_\_\_\_ X \_\_\_\_\_  
dominant heterozygote female                      recessive male

**Genotype:**

\_\_\_\_\_ X \_\_\_\_\_  
dominant heterozygote female                      recessive male

2. Complete the Punnett square for the AaBb x aabb **dihybrid testcross**.


3. List your expected & observed ratios for the dihybrid testcross.

Expected Genotype	Expected Genotype Ratios	Expected Phenotype	Expected Phenotype Ratios	Observed Phenotype	Observed Phenotype Ratios	Observed Phenotype Number
Total Number of Fly Offspring						

4. Did you **accept** or **reject** your null hypothesis in your Chi-square test? \_\_\_\_\_

5. Are these genes linked (on the same chromosome)? \_\_\_\_\_

6. Do these traits exhibit epistasis? \_\_\_\_\_

7. What is your evidence/explanation to support this presumed inheritance pattern?

\_\_\_\_\_

Partner 1 \_\_\_\_\_

Partner 2 \_\_\_\_\_

**MULTIPLE GENE INTERACTIONS: DIHYBRID CROSS 3**

1. Traits being tested: \_\_\_\_\_ & \_\_\_\_\_

**Phenotype:**

\_\_\_\_\_ X \_\_\_\_\_  
dominant heterozygote female                      recessive male

**Genotype:**

\_\_\_\_\_ X \_\_\_\_\_  
dominant heterozygote female                      recessive male

2. Complete the Punnett square for the AaBb x aabb **dihybrid testcross**.


3. List your expected & observed ratios for the dihybrid testcross.

Expected Genotype	Expected Genotype Ratios	Expected Phenotype	Expected Phenotype Ratios	Observed Phenotype	Observed Phenotype Ratios	Observed Phenotype Number
Total Number of Fly Offspring						

4. Did you **accept** or **reject** your null hypothesis in your Chi-square test? \_\_\_\_\_

5. Are these genes linked (on the same chromosome)? \_\_\_\_\_

6. Do these traits exhibit epistasis? \_\_\_\_\_

7. What is your evidence/explanation to support this presumed inheritance pattern?

\_\_\_\_\_

Partner 1 \_\_\_\_\_

Partner 2 \_\_\_\_\_

**MULTIPLE GENE INTERACTIONS: DIHYBRID CROSS 4**

1. Traits being tested: \_\_\_\_\_ & \_\_\_\_\_

**Phenotype:**

\_\_\_\_\_ X \_\_\_\_\_  
dominant heterozygote female                      recessive male

**Genotype:**

\_\_\_\_\_ X \_\_\_\_\_  
dominant heterozygote female                      recessive male

2. Complete the Punnett square for the AaBb x aabb **dihybrid testcross**.


3. List your expected & observed ratios for the dihybrid testcross.

Expected Genotype	Expected Genotype Ratios	Expected Phenotype	Expected Phenotype Ratios	Observed Phenotype	Observed Phenotype Ratios	Observed Phenotype Number
Total Number of Fly Offspring						

4. Did you **accept** or **reject** your null hypothesis in your Chi-square test? \_\_\_\_\_

5. Are these genes linked (on the same chromosome)? \_\_\_\_\_

6. Do these traits exhibit epistasis? \_\_\_\_\_

7. What is your evidence/explanation to support this presumed inheritance pattern?

\_\_\_\_\_

**FLY LAB SUMMARY**

For each of your assigned fly traits, summarize your findings in the following chart.

Abbr	Mutant Phenotype	DOM/rec	X-linked (✓ or -)	Lethal (✓ or -)	Epistatic (✓ or -)

For your investigation of multiple gene interactions, complete the following chart to summarize your findings.

**NOTE: BOTH crossing over frequency & map units = (# recombinants / total offspring) x 100**  
 (if this number is >50 then we consider the genes *unlinked*)

Abbr	Mutant Phenotypes	Linkage (Yes or No)	If linked...	
			Cross-over frequency (%)	Map Units (morgans)