Fruit Fly Exercise 1 - Level 2

Description of StarGenetics
In this exercise you will use StarGenetics, a software tool that simulates mating experiments, to analyze the nature and mode of inheritance of specific genetic traits.

Getting started with StarGenetics
• To get to StarGenetics, please navigate to: http://web.mit.edu/star/genetics/.
• Click on the Start button to launch the application.
• Click Trust when a prompt appears asking if you trust the certificate.
• Click on File → New in the drop-down menu in the upper left hand corner.
• Click on the Fruit Fly Exercise 1 – Level 2 file.

You have begun an undergraduate research project in a genetics laboratory that studies the fruit fly Drosophila melanogaster. You are interested in uncovering new genes that play a role in body plan development in this fly. Aware of your interest, your research advisor decides to give you an interesting fly, Mutant 1, that has just been discovered in one of the fly vials in the lab.

1 First, describe the sex and phenotype of Mutant 1.
• The sex and phenotype of each fly should be visually obvious.
• You can also obtain this information by clicking on the fly and looking at the Properties window.

Answer

2 You want to determine the genotype of Mutant 1. To do this you decide to set up a cross between Mutant 1 and one of the wild type flies you have been given. Observe the F1 progeny that is generated by this cross and answer the questions below. Please describe the type of F1 progeny you observe.
• Set up a cross between Mutant 1 and a wild type fly by dragging them to the Mating Site and by clicking on the Mate button.
• Each resulting offspring can be viewed within the Individual tab or a summary of the results is available on the Summary tab.

Answer

How many F1 flies look like the wild type parent? _________
How many F1 flies look like the Mutant 1 parent? _________
What is the total number of progeny generated? _________
What is the ratio of wild type to mutant flies (ex: 0:1, or 2:1, or 1:1, or 1:2)? _________
3 You hypothesize that the mutant phenotype is determined by a single gene. Based on the results of you obtained in question 2, does this mutant phenotype seem to be dominant or recessive? Why?
   • You can keep track of the information you have collected about Mutant 1 by renaming it using the Properties window and/or by adding information on the nature of the mutant allele (dominant, recessive, etc) within the Notes section of Properties.

   Answer

4 What is the likely genotype of the original Mutant 1? Please explain.
   • You can use the Punnett Square tool to help determine genotypes for a given trait.
   • In the Punnett Square tool, click on the different genotype options to see the resulting genotypic ratios.

   Answer

5 Do you expect the mutant F1 flies to be homozygous or heterozygous for the mutation in question? Design a genetic cross (mating) that would test your prediction. Provide the phenotypic ratios expected if the phenotypically mutant F1 flies are (i) homozygous for the mutation or (ii) heterozygous for the mutation.

   Answer
6 Mate a mutant F1 female fly with a mutant F1 male fly.
   • You can collect individual flies that you have generated (for use in future experiments) by dragging
     them to Strains box or by clicking the Add to strains button underneath within the Strains box.
   • To start a new mating experiment, click on the Save experiment button.

Use the Chi Square test to determine if the observed phenotypic ratios are consistent with the hypothesis
of Mendelian segregation of a mutant allele for a single gene that shows simple dominance over the wild
type allele for that gene.
   • Generate 100 F2 flies for this analysis.
   • To add additional flies to one cross click on the Mate button again after the initial mating between the
two F1 mutant flies.
   • You can use the Punnett Square tool to help decipher the expected phenotypic ratios for this
   mating.
   • Refer to the Chi Square Table at the end of the exercise to relate the Chi Square calculation to a
   probability (p) value.

<table>
<thead>
<tr>
<th></th>
<th>Observed</th>
<th>Expected</th>
<th>(O – E)</th>
<th>(O – E)²</th>
<th>(O – E)²/ E</th>
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<tr>
<td>Mutant</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Wild type</td>
<td>25</td>
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<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
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<td>-</td>
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Degrees of freedom = ______  \( \chi^2 \) value = ______  p value = ______

Answer

7 Your advisor suggests that you perform a Chi Square test with a larger data set. To do this you decide
to do generate a total of 1000 progeny between the same two F1 mutant flies that you mated in question
6. Using the Chi Square test, determine if this outcome is consistent with expected
Mendelian phenotypic ratios. Explain your conclusions.

<table>
<thead>
<tr>
<th></th>
<th>Observed</th>
<th>Expected</th>
<th>(O – E)</th>
<th>(O – E)²</th>
<th>(O – E)²/ E</th>
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<tbody>
<tr>
<td>Mutant</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild type</td>
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<tr>
<td>Total</td>
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<td>1000</td>
<td>-</td>
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Degrees of freedom = ______  \( \chi^2 \) value = ______  p value = ______

Answer
8 Your results in question 7 surprise you. You decide to cross many F2 mutant flies back with wild type flies.

a) Can you find an F2 fly that expresses the mutant phenotype and that, when crossed with a wild type fly, gives only mutant progeny? Are you surprised by these results? Explain your answer.

*Hint: you do not need to cross all the mutant F2 flies to do this analysis.*

Answer

b) You are still very puzzled by your results. You then remember finding an usually large number of underdeveloped dead embryos in your vial from the matings between the two F1 mutant flies in question 7. *Formulate a new hypothesis to explain the F2 generation data and test this hypothesis using the Chi Square test on the large data set results.* Explain your reasoning.

```
<table>
<thead>
<tr>
<th></th>
<th>Observed</th>
<th>Expected</th>
<th>(O – E)</th>
<th>(O – E)²</th>
<th>(O – E)²/ E</th>
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<tbody>
<tr>
<td>Mutant</td>
<td></td>
<td>666</td>
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<tr>
<td>Wild type</td>
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<tr>
<td>Total</td>
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Degrees of freedom = _____  \( \chi^2 \) value = _____  p value = ______

Answer
Chi Square Table

<table>
<thead>
<tr>
<th>Degrees of freedom</th>
<th>0.99</th>
<th>0.9</th>
<th>0.5</th>
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<th>0.05</th>
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<td>1.06</td>
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<td>9.49</td>
<td>13.28</td>
<td>18.47</td>
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<tr>
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<td>0.55</td>
<td>1.61</td>
<td>4.35</td>
<td>9.24</td>
<td>11.07</td>
<td>15.09</td>
<td>20.52</td>
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