Model Organisms – Fly School

Model organisms are a particular species of animal that can substitute for humans in research. With model organisms, answers to scientific questions can usually be obtained faster and without many of the ethical dilemmas caused by using human subjects. Discoveries made using model organisms provide insight into the workings of other organisms, including humans.

This activity examines learning and memory in the common fruit fly, *Drosophila melanogaster*. Fruit flies are easy to breed, reach maturity in days, and have many of the same genes that humans have. As a result of their popularity as a model organism, much is known about their genes and the role of the environment in the expression of these genes.

In this activity, the genes responsible for learning and memory in humans are examined in the fruit fly. Investigations of the genes involved in these processes may lead to treatments for disorders of learning and memory such as Alzheimer's disease. Fruit flies are sensitive to a wide variety of odors. By conducting a series of experiments online, it is your task to determine the conditions in which fruit flies learn to avoid a specific odor. Once the flies have learned which odor to avoid, you will want them to remember for as long as possible.

A simple T-maze training chamber allows your flies to move to the right or the left. By manipulating a number of variables such as fly type, odor, number of training sessions, or whether to administer an electric shock, you can design the experiment you would like to conduct.

Begin your task by accessing *Genes to Cognition Online* (www.g2conline.org). Access *Fly School (#551)*, found under *Model Systems* > Genes, and read the introduction.

Part 1: Model Organisms

1. Roll over the *wild-type* flies icon to read about this particular fly strain. After reading the information, explain why your first round of experiments should be done with wild-type flies and not with a variant.

2. Click on the *wild-type* fly icon to load your flies in the training device. They are now ready to learn.

   a. Select the number of training sessions. To begin with, select *1 time*. Do you think the flies will learn better and remember longer if they go through the training process one time or ten times?

   b. Your flies will be exposed to two different odors during the training. One of the odors must be associated with electrical shock and the other not. Attempt to train the flies to avoid the odor associated with shock. Select *OCT* and *Shock* for training session 1 and click *continue*. For training session 2, select *MCH* and *No Shock*. *Continue*.

   c. Remember, the goal is to train your flies to learn to avoid a specific odor and to remember to avoid it for as long as possible. First, choose the *30 minutes* time option.

   d. Now the moment of truth! Did you train your flies? Do they remember which odor is associated with the electrical shock? Click on *Results*. Were you successful? Explain.

3. Many variables are to be considered during your investigations. Work through Experiments 1-3 using the *Fly Training Matrix*. NOTE: Rolling over any of the icons will give you more information on the relevant variable.

4. What do the results of this series of experiments indicate about the ability of the wild-type fruit flies to remember what they have learned?

5. Repeat the complete exercise. This time, check to see if the flies remember their training after *1 day* (experiments 4-7). Use the *Fly Training Matrix* to guide and record your results.

6. The flies were learning to avoid a specific odor because it was associated with receiving an electrical shock. What variable(s) directly influence the formation of long-term memory? Support your answer with evidence from this series of experiments.

7. What does Experiment 7 tell you about the CREB A fly strain?

8. If learning in fruit flies and humans is similar, describe what this experiment indicates about the ideal combination of variables when studying for a science test, learning a new dance step, or memorizing lines for a play.

Fly Training Matrix: After 30 minutes

Experiment	**Exp. 1**	**Exp. 2**	**Exp. 3**
Fly variant	wild type	wild type	wild type
No. of training sessions	1	10	10
Type of training	n/a	massed	spaced
Training session 1	OCT & shock	OCT & shock	OCT & shock
Training session 2	MCH & No shock	MCH & No shock	MCH & No shock
When to test	After 30 minutes	After 30 minutes	After 30 minutes
Results			

Fly Training Matrix: After 1 day

Experiment	**Exp. 4**	**Exp. 5**	**Exp. 6**	**Exp. 7**
Fly variant	wild type	wild type	wild type	CREB A
No. of training sessions	1	10	10	1
Type of training	n/a	massed	spaced	n/a
Training session 1	OCT & shock	OCT & shock	OCT & shock	OCT & shock
Training session 2	MCH & No shock	MCH & No shock	MCH & No shock	MCH & No shock
When to test	After 1 day	After 1 day	After 1 day	After 1 day
Results				

Part 2: Model Organisms

Your research lab is investigating long-term memory formation in fruit flies. The hope is to learn more about the genes that directly affect the ability of people to retain information. From your work, you will observe distinct differences in the learning abilities of CREB A, CREB B, rutabaga (rut), shibire, and wild-type fruit flies.

1. Access *G2C Online*. Locate *Fly School (#551),* found under *Model Systems> Genes*, and read the introduction. Read about each type of fruit-fly variant by rolling over the relevant icon.

2. Formulate a hypothesis about the ability of one of the variants to learn as compared to wild-type flies. Record your hypothesis.

3. Design and conduct a series of experiments to test your hypothesis. Construct a data table to organize and record your work. Do the results of your experiment support your hypothesis? Explain.

Part 3: Model Organisms

In the quest for more information about how people learn, your lab is ready to expand its research to other model organisms. However, you are not sure which would be the best for what you want investigate.

1. Go to *Model Center* (#548) in the GENES content section of *Model Systems* and read the introduction.

2. Close the introduction by clicking in the circle in the top-left corner of item #548. You will be prompted to *Choose A Gene* from a drop-down menu. Several genes are listed. The creb1 and rut genes are both important in your research. Click on the *creb1* gene. All of the organisms for which creb1 data is available will be highlighted.

3. Click on the organisms you wish to compare. You can read about each organism by clicking on the red "i" in the top right of each icon.

4. A table, which is relevant only to the gene you have selected (in this case, creb1), will appear. The table allows you to see the similarities in the creb1 gene in each of the organisms you have selected. It does this by aligning the respective amino acid sequence of creb1 from each organism.

   Creb1 is highly conserved, which is means that the amino acid sequence is very similar across species. An asterisk (*) under the sequences indicates that they are the same in every organism selected.

5. Next, click on *% Protein the same*. You will see that although the amino acid sequences may not have been identical, the organisms generally have a very high proportion of proteins that are the same.

6. Explain why knowing the proportion of protein that is common across species would be important in selecting new model organisms for your research.

7. Based on your observations, which three species would you select to research the role of the *creb1* gene in human learning and long-term memory formation?

8. Now, you can only select one! For each of the three you selected, list two positives and two negatives that would influence your final decision. Indicate which species you would recommend for use.

9. Would the same species be the best model organism to use when you investigate the influence of the *rut* gene on learning and memory formation in humans? Explain why or why not.