UNIT 4.1

D. Melanogaster Biology

Presented by:
Dr. Sharmila Bhattacharyya
UNIT 4.1

D. melanogaster Biology

Dr. Sharmila Bhattacharya

Vocabulary:

- Gene
- Genotype
- Gravitaxis
- Heterozygous
- Homozygous
- Invertebrate
- Phenotype
- Species

Purpose:

Drosophila melanogaster, is the classic organism for the study of animal genetics. It was introduced to the lab early in the 20th century by Thomas Hunt Morgan. Mutant flies, with defects in any of several thousand genes, are now used for the study of genetics, development, behavior, and other topics.

Objectives:

a) Describe the basic characteristics of Drosophila Melanogaster “D. melanogaster.”

b) Describe the basic life cycle of D. melanogaster.

c) Explain why D. melanogaster is critical to basic research.

d) Describe the Gravitaxic Maze and its use in research.

e) Describe gravity response behavior of D. melanogaster.

f) Recall results from past D. melanogaster flights.
Basic Characteristics

**Size:**
- Adults: 3mm
- Eggs: 0.5mm

**Diet:**
- Rotten fruit

**Life cycle:**
- 2-8 weeks

**Reproduction:**
- Females can lay up to 100 eggs in one day

**Development:**
- 10 days from fertilization to adult

---

‘Oomics

**Genome size:** 180 Mb
**Chromosomes:** 3 autosomes, plus X and Y
**Number of genes:** ~13,639 predicted
**Average gene:** 3 kb, 4 exons per gene
**Proteins:** 77% have a match with other organisms

---

The Scientist, June 2, 2003
Why are flies critical to basic research -- especially gravity research?

- Breeding generations is convenient and fast (multigenerational studies, and statistically significant numbers in small volumes).
- Intrinsic gravity responsive behavior (negatively gravitaxic).
- Sophisticated genetic tools and markers readily available.
- Multitude of genetic mutants characterized -- help identify genes involved in process of interest; e.g., gravity perception and response.
- Genome has been completely sequenced.
- Several fundamental processes conserved with higher organisms such as humans and rodents; e.g., nervous system function.
- Well-studied developmental stages of growth -- can look at perturbations in muscle, nerves, etc. after altered gravity exposure.
NEGATIVE GRAVITAXIS

Gravitaxic Maze

- Populations of 25 flies used per run
- Flies attracted to traverse the maze with light
- Eight up/down choice points so that flies exit at nine possible positions

(Armstrong & Beckingham)

Close-Up of Vertical Choice Point

Tubing is only wide enough for flies to walk the maze, not to fly.

Several Mazes In Operation

Collection tubes at the nine exits have “one-way” entry devices.
The mazes measure a response to gravity

Mutant Lines that show high and low behavior have been isolated
HOW DOES A HOMOZYGOUS GRAVITAXIC MUTANT BEHAVE IN SPACE COMPARED TO THE HETEROZYGOUS SIBLING?

Eye Color Gene as a Marker on Balancer Chromosomes
Behavior

- Has the advantage of being a multi-cellular organism.
- Flies sleep, move, mate, show food and odor preferences, etc.
- Flies can learn.
- Flies learn less well when sleep deprived. *(Does this sound familiar?)*

Gravity related changes in behavior

- Our data shows that in hypergravity there is a change in behavior.
- Little past data from behavior in space, but consistent with increased movement in microgravity; gravity-effect seems to be a continuum.

*Drosophila* as a molecular biology tool

- Genome has been sequenced (microarrays available to probe all genes turned on and off in response to changing environment).
- Mutant lines are readily available.
- Molecular determinants (genes) responsible for essential biological processes conserved between flies and mammals:
  - Disease paradigms: Parkinson’s, Huntington’s diseases, etc.
  - Nervous system function
  - Circadian (day/night sleep) rhythms
  - Learning and memory, etc.
Past Studies From Space Flight

- Effects of radiation: mutagenesis and effects on chromosomes

- How gravity affects:
  
  - Development: It is known that muscle activity can affect nervous system development. A detailed analysis of the development of these systems in space will be important and preliminary results appear interesting.

  - Movement and behavior: There is some scanty evidence from the past that these are affected. Video images, large sample sizes, multiple generations will help confirm results.

  - Growth and reproduction: No gross morphological changes, but there are alterations at the tissue level.

  - Aging: Studies in the past show some indication that space flights affect aging in fruit flies - Needs further experimentation.

In Summary So Far

- Flies show measurable behavior changes in response to gravity (negative gravitax).  

- Flies have useful mutants related to gravity and behavior that we can study (genetic system).

- Flies are a powerful molecular biological tool (sequenced genome, tools to manipulate genome/transgenic flies, microarrays to probe gene expression, etc.). They are a Multi-cellular organism with many vital processes similar to mammals and therefore of relevance to multiple species.
Conclusions

- *Drosophila melanogaster* is a powerful research tool.

- There is still much that we need to know about the effects of gravity on living organisms.

- Flies occupy little space, air, and their food consumption is low; large populations can be maintained; multiple generations can be studied; and there is conservation of essential processes with other animals including mammals.

Reference Materials

The following online resources are available for more information about *Drosophila Melanogaster*:

**Drosophila Virtual Library:**
http://www.ceolas.org/fly/index.html

**Flybase:**
http://www.flybase.bio.indiana.edu

**Drosophila DNA Microarray Homepage:**