Introduction to Model Organisms

Curricular Unit
Teacher Materials

CONTENT OBJECTIVES

- Students will be able to list characteristics of model organisms.
- Students will be able to explain what qualifies a species as a model organism.
- Students will be able to justify the role of model organisms in Space Biology research.

KEY CONCEPTS

- Model organisms are any non-human species that are widely studied in the laboratory setting and have a very particular experimental advantage.
- Model organisms are easy to maintain and breed in a controlled environment.
- Model organisms are Domesticated for empirical studies but can also be found in the wild.

PACING AND SCHEDULING

→ This lesson was designed to fit one section (part) in a 55-minute period.
→ Part 1 and 2 is intended to be taught during one class period
→ Part 3 will require students to do an extensive reading and therefore is good for two class periods.
→ This unit is intended to be taught over one week.

TEACHING METHODS

- This lesson is designed for 9th and 10th grade HS Biology students

This lesson is designed to be introduced to the students AFTER the unit of Genetics and/or during the Biotechnology unit

- Teacher should review students in basic terms of genetics and heredity
- Part 3 of this lesson may require 2 - 3 days of work time with a group of 3 - 4 students, depending on class size.
- Part 4 can be utilized as an “Exit Ticket” at the end of the unit lesson.

CURRICULAR CONTENT

Day 1: (1st two days of the week preferred)

PART 1: What are model organisms?

Complete the right column of the table below using the links posted on the left column to have a quick overview of what model organisms are.

Table 1:

	How “model organisms” are explained from

	each source:
Video Source: https://www.youtube.com/watch?v=CqF8KeQU4hw	
Literature Source: https://www.yourgenome.org/facts/what-are-model-organisms/	

Day 2:

Part II: What makes a 'Model Organism'?

1. Click this link and watch the video while completing Table 2 with the correct information below: https://www.yourgenome.org/facts/what-are-model-organisms/

2. Watch the video below for Organism #4: https://www.youtube.com/watch?v=zoKhiU2ncLw

3. Identify the three model organisms discussed in the video and describe their importance to scientific research:

Table 2:

Organism # 1: Fruit Fly (*Drosophila melanogaster*)	Organism # 2 Baker's Yeast (*Saccharomyces cerevisiae)*	Organism # 3 Roundworm (*Caenorhabditis elegans)*	Organism # 4 Thale cress (*Arabidopsis thaliana*)
Importance to Scientific Research:	Importance to Scientific Research:	Importance to Scientific Research:	Importance to Scientific Research:

3. In the box below, summarize/list the organisms in table 2's key features that makes them great Model Organisms:

→ fast reproductive rate → small genome size → small (doesn't take a lot of space in ground and in space flight setting) → non-human

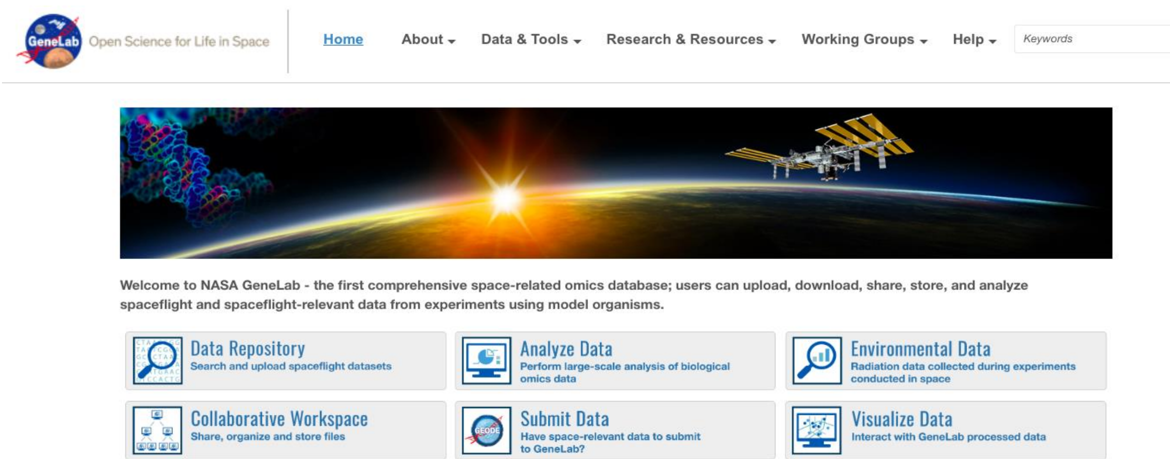
Day 3 and 4 (time should be flexible between 2 - 3 days)

Part III: Navigating through the GeneLab Data Repository

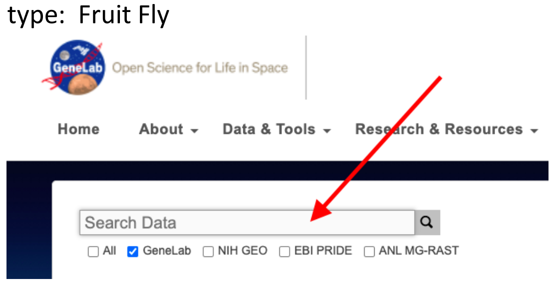
Now that you know what Model Organisms are, their importance and key features, we will look into the model organisms that you listed in Table 2 using the GeneLab Data Repository. GeneLab is an open access system that compiles '-omics' experiments done by scientists worldwide conducted either on a "Space Shuttle, the International Space Station and/or in ground-based simulation models" (Blaber & Gebre, 2021).

1. Click this → https://genelab.nasa.gov/
2. You should be able to see this page:

Note to teacher: Teacher may want to show your computer screen as you navigate the site to get the students familiar with its components.



1. Click the **Data Repository**.
2. In the **Search Data** bar, type: Fruit Fly



1. Scroll down and look for "Drosophila melanogaster gene expression changes after spaceflight."
2. Read the **Description** and **Protocols** then fill up Table 3 below.

Note to the teacher: You may want to show students procedure 1 - 2 by projecting your screen to guide them on this process specially as they transition to organism # 2.

3. Do steps 4 - 6 for organisms 2 and 3: (Yeast and *C. elegans*)
4. For the model organism Yeast, click this from the list: "Genes Required for Survival in Microgravity Revealed by Genome-Wide Yeast Deletion Collections Cultured during Spaceflight"
5. For the model organism *C. elegans*, click this: "Microgravity effect on C. elegans N2/VC (CERISE 4 days)"

Note: You may also click the **Publications** on the left hand side of your screen for a more detailed discussion of the studies. They are also hyperlinked below for your convenience. Teacher may want to

Fruit Fly (*Drosophila melanogaster*): https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0015361
Baker's Yeast (*Saccharomyces cerevisiae)*: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4309212/
Roundworm (*Caenorhabditis elegans*): https://www.nature.com/articles/npjmgrav201522
Thale cress (*Arabidopsis thaliana*): https://www.hindawi.com/journals/bmri/2015/547495/

Table 3:

Model Organism	**Assays used in this study**	**Role of the genes affected by the spaceflight**	**Briefly describe one or two methods conducted in the studies that cannot be done to Human species**
Fruit Fly (*Drosophila melanogaster*)	Transcription profiling	→ Involved in the maturation of plasmatocytes (macrophages) and their phagocytic response → Pattern recognition receptors and opsonins that specifically recognize bacteria → Lysozymes → Antimicrobial peptide pathway → Immune stress (hallmarks of humoral immunity)	1. Housing, breeding for only 12 days. 2. Extracting RNA from the whole body
Baker's Yeast (*Saccharomyces cerevisiae)*	Deletion Pool Profiling	→ Cell fitness	→ working with 4800 homozygous and 5900 heterozygous humans in space flight
Roundworm (*Caenorhabditis elegans)*	Transcription profiling	(Gene & Protein Expression) → Muscular thickness → Cytoskeletal elements → Mitochondrial metabolic enzyme rate → Movement, body length, fat accumulation	1. Freezing (-80 °C) 2. Conducting all experiments on the organism for only 4 days (from embryonic stage to adulthood)
Thale cress (*Arabidopsis thaliana*)	Transcription Profiling	→ involved in protein phosphorylation & MAPK cascade-related signaling processes → cellular defense and stress responses → involved in the plastid-associated translation machinery, mitochondrial electron transport, and energy production.	→whole-genome gene expression analysis in a very limited time.

Part IV: My takeaway

In the box below, explain your take on why Model Organisms are vital in Science Research specially in Space Biology studies?

→ Students may cite two or more answers from their entry to Table 3, column 4.
→ Students may emphasize that studies involving humans in any way are cumbersome and rely heavily on bioethics and human rights.

STANDARDS ALIGNMENT

NM STEM Ready! Standards (NGSS):

HS-LS1-1: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Farmington Municipal School District Measurement Topics:

→ C1: HS-LS3-1 : Understand and ask questions that arise from examining models or a theory to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

→ C2: HS-LS1-1 : Understand and construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.

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