BioEd℠

Designing Your Investigation

BCM® Baylor College of Medicine

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Cover photo: Seventh grade student Jessica Hawkins (right) displays her Spiders in Space project poster with her teacher Tanya Griego, Aurora Hills Middle School, Aurora, CO. Ms. Hawkins presented her award-winning poster at the 2009 American Arachnological Society meeting. Photo courtesy of Ms. Griego.

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From left, Samantha Longoria of Mission, Jennica Pilayan of Mission and Daniel Salinas of Edinburg participating in the Butterflies in Space project at South Texas Preparatory Academy in Edinburg, Texas. The butterfly habitat was created out of inexpensive materials.

Photo of the four butterflies that successfully emerged from their pupas in microgravity onboard the Space Station.

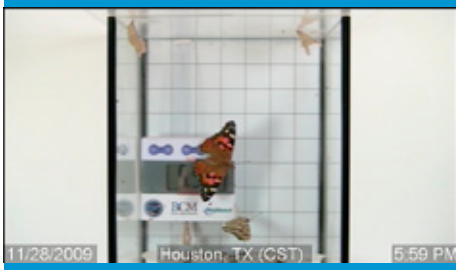

Photo of two butterflies and one pupa from the ground-based habitat at Baylor College of Medicine in Houston.

Life Science Investigations

When conducting life science science investigations in the classroom, have students follow the same procedures as professional scientists follow in their work, including observations, questions, controls, variables, data collection and analysis.

Suggested Research Framework

1. Divide your class into research teams of two to four students.
2. Instruct teams to learn as much as they can about the proposed research organism (including care and feeding, watering, etc.) before the investigation begins. Use the "Proposed Investigations" chart from the *Butterflies in Space Teacher's Guide* (page 20 as a guide.
3. Have teams prepare and present research reports or essays, computer presentations, or posters about the study organism, summarizing what they have learned about its anatomy, feeding, growth, reproduction, behavior, etc.
4. Ask each team to develop a research question to guide its investigation. You also may want older students to devise a hypothesis, which states a possible answer (or set of alternative answers) to their research questions.
5. Ask each team to write a proposal detailing its research question or hypothesis, its plans for answering the question, the types of evidence to be collected, and ways the team will use evidence to support—or not support—its hypothesis.
6. Have each team write a set of guidelines regarding proper care of its research organism.
7. Review team proposals and offer advice, if needed, on how to improve them (see page 3).
8. Designate an area of the classroom where teams can safely store their research organism habitat or experiment chambers.

During a life science investigation, students track the behavior or growth properties of their research organisms and compare their data to that from the flight organisms. Basic data can be maintained in tabular form. Graphs and illustrations are useful for collecting data and reporting results.

Research Question or Hypothesis

A guiding research question is an open-ended approach to the investigation. Almost all scientific investigations begin with a question. Students should use what they have learned about the research organism to devise a question to investigate. Students will observe and record growth or behavior related specifically to their question. Sample questions include the following.

- Can a butterfly use its wings to fly in microgravity?
- Will a plant form the same number of leaves as Earth-based plants do?
- Will a web spun by a spider in space be similar or equivalent to a web spun on Earth?

POTENTIAL INVESTIGATIONS: *BUTTERFLIES IN SPACE TEACHER'S GUIDE*		
Behavior/Variable	**Data/Categories**	**Notes**
Average temperature	Temperature	Temperature can affect an animal's behavior. If the temperature is too high or too low, an animal may act unnaturally, and even perish.
Relative humidity	Humidity	Humidity can affect animals. If the humidity is too low, larvae food may dry out, larvae may not be able to molt, and butterflies may not be able to exit their pupae. If humidity is too high, food may mold.
Activity levels	Activity	Compare the types and frequency of activities carried out by animals on Earth with those of animals in microgravity.
Growth of larvae	Size	Measure the initial size and growth rate of the larvae.
Larval feeding	Feeding	Are the animals feeding? Do animals on Earth feed more or less frequently, or at different times than the animals in space?
Larval survival	Success	What percentage of the larvae survived to pupate?
Pupating	Ability to pupate	Are the animals in microgravity molting and pupating correctly?
Emergence	Ability to emerge	Do the butterflies in microgravity emerge from their pupae? What is the success rate?
Locomotion	Flight ability/ walking behavior	Do the butterflies in microgravity fly, or do they only walk? If they fly, how does their flight compare to the flight of butterflies on Earth?
Adult feeding	Feeding	Are the adults able to find and eat their food?
Mating	Ability to mate	Do the adults exhibit mating behavior? (This question applies only if a male and female are present.)
Egg laying	Ability to lay eggs	Did the butterflies lay eggs? If so, how many? Where did they lay their eggs?
Larval emergence	Eggs hatching	Was fertilization of the eggs successful? (In other words, how many eggs hatched?)

A hypothesis is a kind of research question that leads to a "yes" or "no" answer. It also can be thought of as a possible answer (or set of alternative answers) to a research question. Data collected will support the hypothesis, or provide evidence for rejecting it. Some sample hypothesis statements include the following.

- A butterfly in space will use its wings to fly in the habitat.
- Webs spun by spiders in space will be indistinguishable from webs spun on Earth.
- It takes more time for a spider to spin a web in microgravity than on Earth.
- The plant in space will form more leaves than the plant on Earth does.

Reporting the Results

When the investigation concludes, student teams should wrap up their work. Have teams review their data, determine whether or not their research questions were answered and why, or whether their hypotheses were supported by the evidence gathered. Then, each team should produce a final investigation report, to be submitted for assessment. Possible reporting formats include posters that display teams' results, PowerPoint® or podcast presentations, or written documents.

Research Proposal

Team Member Names:

1. What is your research question?

2. Why did you select this question?

Research Plan

1. What variable or variables will you investigate?

2. What data will you collect/what observations will you make?

3. How often will you collect data or observations?

4. How will you record your data or observations?

5. What do you predict might happen (hypothesis)?