Genes in Space Virtual Lesson Plan

Lesson Overview:
The goal of these lessons is to engage students in using the scientific method under authentic research scenarios. Through three sequential activities, students will research problems, formulate hypotheses and design original experiments to address yet unanswered scientific questions. No actual experimentation is needed to complete these activities—the goal is to engage students through to the point of experimental design. This lesson plan aligns with NGSS and the Common Core standards (see page 4).

Because Genes in Space focuses on space biology research, the thematic thrust of these lessons is how life adapts to space conditions, with an emphasis on the role of DNA. At the culmination of these lessons, students will have developed the core of a submission to the Genes in Space contest.

With a little more work, students may be able to complete a submission to the Genes in Space contest, and enter for a chance to see their own experiment performed on the International Space Station!

Summary:
We present 3 lessons, all appropriate for virtual or hybrid learning. Each lesson builds on the previous, culminating in the production of an originally designed space biology experiment. Depending on time available and course objectives, teachers may choose to do one, two, or all three of these lessons as a small unit exploring the scientific method, experimental design, DNA science, and space exploration.

Lesson 1: *Students watch short videos describing current research in the field of space biology. Students work in groups to summarize scientists' research and then share those findings with their classmates.*

> ***Time required:*** *One 45-60 minute period. Optional second period if including more formal presentations.*

Lesson 2: *Students, individually or in pairs, will build on their work in Lesson 1 to develop their own space biology question that could be investigated by astronauts on the International Space Station.*

> ***Time required:*** *One to two 45-60 minute periods with internet access or other research methods available.*

Lesson 3: *Students will design an experiment that could answer the question developed in Lesson 2.*

> ***Time required:*** *One to two 45-60 minute periods with internet access or other research methods available.*

Lesson 1.

Objectives:
Students will describe space conditions and their impacts on biological systems.
Students will identify a key challenge or opportunity of engaging in a manned deep-space mission such as a mission to Mars.

Part 1:
Divide students into groups and have each group watch one of the Genes in Space educational videos focused on ongoing space biology research or have the students select a video:

- DR. GIOIA MASSA - FRESH FOOD FOR THE RIDE TO MARS
- DR. MICHAEL ROBERTS - MICROBES ON THE INTERNATIONAL SPACE STATION
- DR. LIZ WARREN - SKELETONS IN SPACE
- DR. ARUN SHARMA - HEART CELLS BEATING IN ORBIT
- DR. SYLVAIN COSTES - GENETIC DATA FROM SPACE

Students should complete page 1 of the virtual lesson plan student worksheets after watching the video.

Optional flipped classroom approach: *Part 1 can be assigned as homework.*

Part 2:
In their groups, students should share their answers to the questions from part 1. Students will present this information to the class. Each group should agree on a consensus answer to each question. Have students as a group choose their 3 best questions.

Optional: Have each group develop a short Google Slides presentation or poster summarizing their video and their discussion.

Part 3: Share out
Each group presents a short summary of their video, the key points from their discussion, and their 3 questions to the rest of the class. Allow time at the end of each presentation for questions from other groups.

Time required: One 45-60 minute period. Optional Second period if including more formal Presentations.

Lesson 2:

Objectives:
Students will develop a question about space biology.
Students will use previously conducted research to refine and focus their question.

In class:
Students develop their own questions and use the scientific method to devise a DNA analysis experiment that addresses their question. After the group presentations done during Lesson 1, students will select the video whose topic interests them the most. Students will work either individually or in pairs to research a challenge or opportunity related to space biology.

Students will find three relevant resources to their question or opportunity. They will then summarize these resources.

From the information they find through their research and based on the original Genes in Space video, students will pose a question that could be answered through experimentation on the International Space Station.

Students should use page 2 of the virtual lesson plan student worksheets for this activity.

Time required: One to Two 45-60 minute periods with internet access or other research methods available.

Lesson 3:

Objectives:
Students will conduct research to develop an original hypothesis
Students will apply the scientific method to develop their own original experiment

In class:
Students will use the scientific method to develop a hypothesis and design an experiment to answer the question they developed in lesson 2.

Developing an experimental design requires an understanding of basic DNA experimentation techniques, such as PCR and DNA sequencing. For resources including worksheets and educational videos to help your students master these techniques visit: https://www.genesinspace.org/interact/

Students should use pages 3-5 of the virtual lesson plan student worksheets for this activity.

Optional: Have each student or pair develop a short Google Slides presentation or poster summarizing their hypothesis and experiment.

Time required: One to two 45-60 minute periods with internet access or other research methods available.

Submitting a proposal to Genes in Space

When complete, students can use these worksheets as the basis for a Genes in Space proposal. Students will wish to refine their question, hypothesis, and experimental design further before submitting to the contest. To submit proposals and for a chance to have their DNA experiment conducted on the International Space Station, visit www.genesinspace.org!

Next Generation Science Standards Alignment

Students who demonstrate understanding can:

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.

HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

Science and Engineering Practice	Disciplinary Core Ideas	Crosscutting Concepts
• Asking Questions and Defining Problems • Planning and Carrying Out Investigations • Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information	LS1: From Molecules to Organisms: Structures and Processes LS3: Heredity: Inheritance and Variation of Traits HS-LS4 Biological Evolution: Unity and Diversity	– Cause and Effect – Structure and Function – Stability and Change – Interdependence of Science, Engineering, and Technology

Common Core ELA/Literacy Standards

CCSS.ELA-LITERACY.RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CCSS.ELA-LITERACY.RST.9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

*For simplicity, this activity has been aligned to high school NGSS and grades 9-10 Common Core standards. For information aligning this activity to other grade levels or standards, namely middle school or Advanced Placement, please contact Genes in Space (genesinspace@minipcr.com).