Omics & Space Travel

Curricular Unit
Teacher Materials

OVERVIEW

This unit is intended to engage and bridge high school students into learning about omics. It can be used as-is or section-by-section as needed for your classroom context. The activities are designed using an interactive, digital model of instruction and is intended to be used alongside classroom discussions and collaborative student work.

Within this unit, students explore the work NASA has done in human space travel with an emphasis on the Artemis missions and NASA's Twin Study. They will be connecting the concepts about NASA's research into space biology (and astrobiology) to why it is valuable to learn about omics in order to travel in space. Throughout this process, students are engaged in discourse with omics-based vocabulary and concepts that provide context for understanding the central dogma of biology.

IMPORTANT: Please note that student versions of this lesson plan's interactive document works best on Google Documents. It can work as a Word Document, but there may be some limitations in functionality depending on tools your students want access to.

CONTENT OBJECTIVES

- Students will be able to explain why biological studies are important for future human space travel using multiple lines of evidence.
- Students will be able to differentiate space biology from astrobiology.
- Students will be able to investigate and explain terms associated with omics.

PACING AND SCHEDULING

Pacing can vary based on student progress, but generally each section may take one or two 50 minute class periods. If choosing to do this unit as entirely in-class work, it is suggested that one section is assigned at a time to leave some time for discussion and clarification. The estimated duration of this unit is eight 50 minute periods. This unit can also be scheduled as stand-alone sections as needed, but it is best to maintain the same order of events because they are designed to build upon each other.

As a conclusion to this unit, there is an optional project that may take about 3-5 days, depending on your teaching preference and time constraints. The presentation component can be done in-class or as a video submission for peer review. Rubric suggestions are provided, but it can be graded based on your context. If possible, share student work to the school community in some way as a showcase of student learning.

TEACHING METHODS

- **Direct Instruction**: Suggested to be prepared with slides that addresses student misconceptions encountered regarding topics explored, if needed. Topics covered are space biology and astrobiology, omics, details on the hazards of spaceflight, and the NASA Twin Study. Resources provided at bottom of the document.
- **Interactive Digital Student Activity:** This model lends itself to multimodal and

differentiated learning experiences, so it works best with internet and computer access.
    - Encourage students to work chronologically or assign certain sections to do each day to make work manageable. (Suggested to permit revision to prior work.)
    - The digital worksheet can be done in class or as homework.
    - Answer formats can vary from written text in boxes, slide creation, and verbal. You can specify the desired response format to tailor it for your class.
- **Vocabulary Book**: There are various ways to encourage students to learn vocabulary associated with the content. You are free to use any method you prefer, but the following contains the suggested use case.
    - Students can customize their own vocabulary book to meet their needs, especially if they need additional support in pronunciation and contextualization. Encourage students to think about the digital vocabulary book as a tool to better understand scientific language rather than an assignment in itself because students can add whichever words they need.
    - For students who need additional direction, a vocabulary list can be provided to prompt students to look up terms beforehand and be prompted to pay attention to them when encountered.
- **Discussion-based learning**
    - Encourage students to collaborate, but emphasize the importance of not simply copying responses.
    - In-class discussions can occur as small group discussions or as whole class discussions.
    - Discussion formats you can consider: inquiry-based discussion techniques🔗, Socratic seminar🔗, and other ideas you can find HERE🔗.
- **Reflection**: Intent is to support student metacognition
    - Try using a warm-up reflection question of the day at the beginning of class to support student recall and provide an opportunity to see areas of difficulty (ex. Rose-bud-thorn activity).
- **Accessibility**: Share these tools with all students to facilitate accessibility
    - Text-to-speech screen readers (available on Windows, Chrome, and Apple products for free in the accessibility features)
    - Flipgrid: a useful program to encourage practice with verbal skills and supports students who have difficulty writing in expressing their thoughts
    - Padlet: Can be used to generate collaborative discussion virtually or to provide supplemental resources to students.

CURRICULAR CONTENT

Module	Why Space Biology and an Introduction to NASA Twin Study
Estimated time: 8 days (50 min), may be longer if including the project assignment.	Students learn about and explore space biology using selected NASA resources before being introduced to NASA's Twin Study. This module serves to engage students in scientific practices and generate curiosity about omics.
Instructional Notes	1. Begin the class by explaining to students how science is an interdisciplinary discipline involving biology, math, language, and

	even history. You can mention that NASA is a good example of how interdisciplinary science can work and show the following NASA “We Are Going” (4 min) video [https://youtu.be/vl6jn-DdafM?si=yigfcQWRJ4rtVU82 🔗]. 2. Transition students into thinking about how we need to study space through the lens of biology to be successful in the type of missions NASA is doing. If possible, lead a class discussion on what they find interesting about exploring space and write down their ideas for later reference. 3. If it helps you develop a narrative for the lesson, explain to students that they are scientists who are going to investigate how humans can possibly survive in space travel and what are the effects of spaceflight on living things. 4. In order to be able to investigate, provide students with the vocabulary book template by explaining it serves as their investigation log. There will be key words that they will encounter frequently and it is important to be able to say and use these words accurately to be able to communicate their findings. [For students who need more structured guidance on what words are important to consider, a list of starter terms are provided in the last box of this table.] 5. Introduce students to the digital interactive worksheet and provide class time to work on it. Emphasize to students that responses should be typed in the appropriate box and to read prompts carefully to fully answer them. (Note: I recommend having some discussion or share-out after each section, depending on how students are progressing. If you want to do these steps asynchronously and/or virtual-only, it is possible to use a shared Google Document or Google Sheets, Padlet, or Flipgrid to accomplish this.) 6. Once students have all completed the assignment, provide an opportunity to go over responses to clarify missed concepts and allow student revisions. An answer guide can be provided upon request. 7. The final section refers to a project students can do to demonstrate their understanding of the content. It can be skipped if necessary. This component may take a few days to do and involves class presentation. 8. As students complete the assignment, there are further extended learning links for students who finish early or are curious to learn

	more.
Student Activity	**Vocabulary Book Template (Student): Google Slides Link🔗** [https://docs.google.com/presentation/u/1/d/1PdpnAvtMaEUDmv81wr01__4wZMorxEHH1WtNXkr2lD4/copy] **Make a Google Doc copy of the student worksheet: LINK🔗** [https://docs.google.com/document/d/1Jh0HGIGbUIU72deQBt6S-KAk-YXllxpHvsrH6flOHtA/copy] **Teacher Answer Guide**: Submit request to arc-gl4hs@nasa.gov *[Teaching Note: You can pick and choose sections to assign to your class as desired.]* **Overview of Sections:** 1. Going to Space 2. Space biology vs Astrobiology ● Discussion Guide for Astrobiology Case Study (HERE🔗) ● Omics Playlist (HERE🔗) 3. NASA Twin Study Introduction 4. Apply & Share Your Knowledge Project **Project Description:** Make a product to explain why space biology and omics research is important for future human space travel. Your product can be a slide presentation, artwork, song, or any way to creatively teach someone about what you have learned. **Your content MUST include the following:** ● What are the 5 hazard of space ● Reasoning for why omics-related research is needed (use 3 omics terms) ● Use supporting details from the NASA Twin Study or other provided resources to strengthen your reasoning ● Why (or why not) you would want to go to space ● Proper citations **Audience**: Peers, teacher, and school community **Presentation**: May be in-class or a video recording. Aim for 5-8 minutes. **Rubric Suggestions**: Grading for this assignment can vary depending on your grading preferences. A sample rubric is provided at the section below curricular content. Some suggested rubric templates are also provided as websites.

	• https://www.aacu.org/initiatives/value-initiative/value-rubrics/value-rubrics-oral-communication 🔗 • https://www.aacu.org/initiatives/value-initiative/value-rubrics🔗	
Vocabulary	Space Biology Astrobiology Adaptation Gene DNA RNA Gene expression	Omics Genomics Epigenomics Metabolomics Proteomics Transcriptomics Microbiomics
Direct Instruction & Discussion Resources	• Teacher Version Vocabulary Book Google Slides🔗 • Discussion techniques from "The Inquiry Project"🔗 to learn ways to hold classroom science discussions • Astrobiology Learning Progressions🔗 (a good website to reference for astrobiology resources) • NASA OMICS: Exploring Space Through You🔗 video series on omics	

Sample Screenshots of Student Worksheet (Make a Copy of Student Worksheet 🔗)

Name:_____ **Period:**_____
Date:_____

Instructions:
On a computer?
💾 Save this document as **Last name-First name-period#-spacebio**.

You may type or use speech-to-text for your response in the answer boxes. Please use **complete sentences** in your final response, but you can use bullet points to outline your ideas first. Please avoid editing the prompts! You don't want to lose information.

ENGAGE
Before you start this section, you will learn a little bit about the National Aeronautics and Space Association (NASA) and why biology is important for NASA. Watch NASA's "We are Going" video as an introduction to the topic. 👀 **Watch the NASA "We Are Going" (4 min)** video [https://youtu.be/vl6in-DdafM?si=vigfcQWRJ4rtVU82]

EXPLORE - GOING TO SPACE!	
👀 **Watch NASA Explorers: Artemis Generation (11 min)** **OR** **Yo Soy Artemis (6 min, Español)**	https://plus.nasa.gov/video/nasa-explorers-season-5-episode-1/ https://plus.nasa.gov/video/yo-soy-artemis/
🖍️ Where are people planning on traveling to in space? Have we reached that destination yet?	Answer:
1. 🔗 Check out this website https://www.nasa.gov/image-of-the-day/ and look at the pictures.	Answer:

EXPLAIN - SPACE BIOLOGY VS ASTROBIOLOGY	
As you have read and watched the videos about space missions, you have learned about various reasons why people aim to travel to space. Some are fascinated by just having the chance to experience space, but many are interested in making new discoveries about the universe we live in. In this section, you will learn the difference between space biology and astrobiology in detail. **Answer the questions in the boxes as you read/watch the resources provided. Make sure to read instructions carefully. You can always do more if you have time.**	
1. **Read** about the difference between astrobiology and space biology from NASA's website HERE.	https://science.nasa.gov/biological-physical/stories/space-biology-and-astrobiology-whats-the-difference/
Write a definition for astrobiology and space biology in your own words. *You can look up any words you don't yet know to figure out their meaning. Work with a partner to come up with a good definition you all understand.*	**Astrobiology**: **Space Biology**:
Do you think astrobiology or space biology is more interesting? Why? Answering with neither will not be accepted.	Answer: TEACHER NOTE - Good opportunity to incorporate FlipGrid if you choose to.
2. Astrobiology	**Choose (Read & Watch) then respond to the questions in each column.**
Read about how did life form Read a section of Issue #7 of *Astrobiology: The Story of our Search for Life in the Universe* comic. • Read Pg 20 - 33 (or printed page	**Watch** "Astrobiology Case Study: E•NIG•MA" (9 min) • https://youtu.be/DGTPPv2fNyc?si=dQ1qd1vqRYETuGFn **Tips:**

Sample Rubric

	4 Mastery	3 In-Progress	2 In-progress	1 Emerging
Research	Synthesizes in-depth information from various resources. Sources are reputable and cited.	Presents in-depth information from various resources. Sources are cited.	Presents information from relevant sources.	Presents information from irrelevant sources.
Creativity	Information is presented in a unique format or product that creates new knowledge.	Information is presented in a unique format or product.	Experiments with presenting information in a unique format or product.	Information is presented as a collection of ideas.
Conclusion	Conclusion is clearly stated and logically explained.	Conclusion is clearly stated.	Conclusion is too general but is clearly relevant to space biology and omics research.	Conclusion is ambiguous or illogical.
Presentation Organization	Organization creates a clear introduction, body, and conclusion. The content of the presentation is clearly observable and creates a cohesive presentation.	Organization creates a clear introduction, body, and conclusion.	Organization intermittently creates a clear introduction, body, and conclusion.	Organization is unclear or confusing.
Presentation Delivery	Voice volume is appropriate and provides good attention to the audience. Presentation is compelling. Speaker is polished and confident.	Voice volume is appropriate and provides attention to the audience. Speaker appears comfortable.	Voice volume is occasionally appropriate and provides some attention to the audience.	Voice volume and attention to audience detract from understandability of presentation.

VOCABULARY BOOKLET (Teacher Link🔗 | Student Link🔗)

Vocabulary Book Template Teacher Notes

The intent is to have students log words they are unfamiliar with and build upon their knowledge over time. It is an iterative process, so students should have the means to go back to their vocabulary book and make revisions or additions as necessary.

Encourage students to look into roots, prefixes, and suffixes of words to recall the meaning of words.

An optimal way to assess if students understood the meaning of the vocabulary is a combination of application and short quizzes.

How to use template:

Students should have creative freedom for their vocabulary books. They can decorate or add sections that they believe helps them better understand the terms (ex. Pronunciation guides, videos). Students should be encouraged to revisit terms for revision and add additional unrequired terms as needed.

Vocabulary Book Template
Teacher Notes

Alternative Options:

If making slides does not work for your context, here are some alternatives and their limitations.

Online

- Quizlet
- Padlet

Limitations: Online tools vary in customizability and price. There may be limits in how many files can be made or time limits, so read user limits carefully to ensure they meet student need.

Paper

- Flashcards: word, definition, and sentence on one side + picture on reverse
- Zine
- Vocabulary quadrant

Limitations: Does not provide multimedia and reliant on neat penmanship. May cause more fatigue which reduces student desire to make or revise them. Can be costly in terms of materials.

Vocabulary Book
Student Instructions

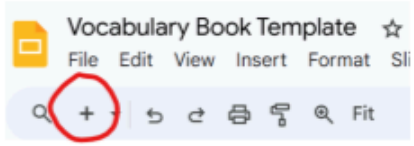
1. Make sure you save your file as **"last name.first name.period-vocabularybook"**
2. As you read and encounter new words to explore, add them to your vocabulary book.
3. Customize your book as much as you like!

Expectations:

- Keep your book organized so you can easily find your words.
- The boxes provided are only suggestions, so you don't have to do every word the same way. Add or remove items as you like.
- **Goal**: Learn the words well to understand what they mean.

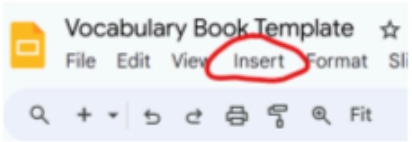
Vocabulary Book
Student Instructions

To add slides: Click on the plus (+) symbol at the top.

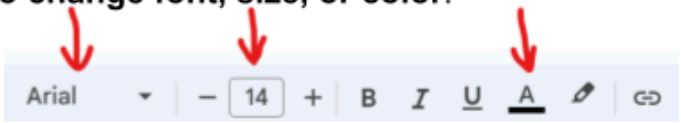


To delete slides: Right click on the slide to delete and select “delete”

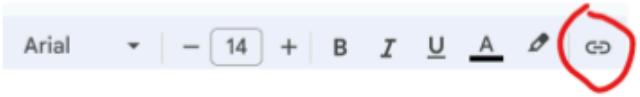
To add pictures: Go to “Insert” then “image” and choose from the options.



To change font, size, or color:



To make a hyperlink (clickable button): Highlight the text or object. Click on the paperclip looking icon then paste in your link.



My Vocabulary Book

Name:
Period:

Word “Parking Lot”

Add words here as you find words you don’t know and want to learn.

Word: 

Optional: Hyperlink to pronunciation guide

Word roots:

Definition:

Image/Drawing/illustration:

Context: (Ex. use the word in a sentence, where did you see the word, how do you use the word)

STANDARDS ALIGNMENT
Next Generation Science Standards

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.

Science and Engineering Practices	Disciplinary Core Ideas	Cross-cutting Concepts
Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	• Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1)	Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

HS-LS1-6 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Science and Engineering Practices	Disciplinary Core Ideas	Cross-cutting Concepts
Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the	• The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other	Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6	

California Common Core Literacy Standards

CA.CCSS.ELA.W.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation including footnotes and endnotes.

CA.CCSS.ELA.SL.9-10.1.a-d Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively

CA.CCSS.ELA.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.

CA.CCSS.ELA.RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

CA.CCSS.ELA.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.

CA.CCSS.ELA.WHST.9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

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