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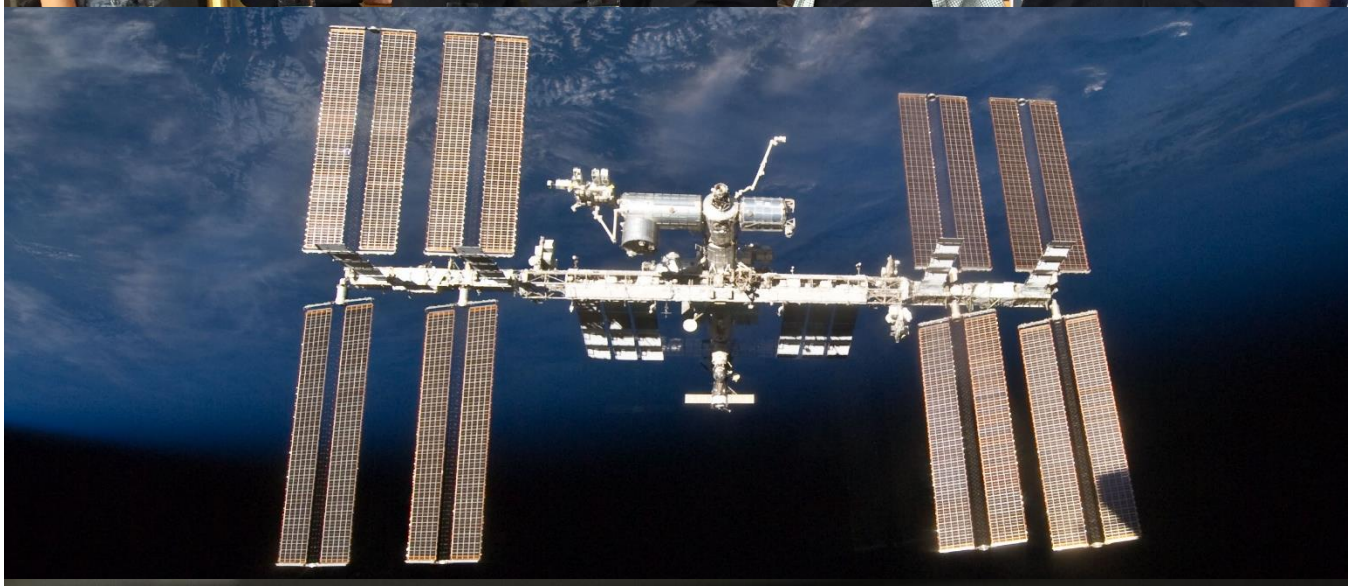

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Implementing *Genes in Space* in your classroom

Genes in Space™ is a free national contest where teachers and students participate in an authentic research experience with real-world outcomes. Design pioneering DNA experiments that address the challenges and opportunities of spaceflight and space exploration. **The winning experiment will be conducted by astronauts aboard the International Space Station!**

Why bring the *Genes in Space* challenge to your classroom?

- The contest **pioneers DNA research in space:**
  - Students' entries push the boundaries of DNA research in space, research that is critical for the next phase of space exploration.
  - Students can make a real contribution to space DNA research. For example, high school student and Genes in Space winner Anna-Sophia Boguraev designed the first PCR experiment ever conducted in space!

- The contest is an **authentic and self-driven research experience:**
  - Students think like scientists to solve real-life problems.
  - Participants are engaged and excited by this student-led exercise.
  - Participation is simple and entirely free, no equipment or prior knowledge necessary.

- The contest has **real-world outcomes:**
  - **The winning experiment will be conducted in space!**
  - Finalists **present their projects** to scientists and astronauts at the International Space Station Research and Development Conference (ISS R&D).
  - Finalists and their teachers receive **travel awards** to go to the ISS R&D Conference and the winning team gets to go to the space launch of their experiment.
  - Student-led research yields **meaningful findings**: Anna-Sophia Boguraev is now the lead author of a peer-reviewed article in *Nature Microgravity.*

- The contest generates opportunities for **mentorship and community:**
  - Students participate in peer review and work together towards an optimum solution.
  - Teachers mentor students through the submission process and gain professional resources and development opportunities.
  - Finalists work with Harvard and MIT scientists to improve their proposals and present their ideas to the scientific community.

- The contest **develops essential skills and aligns to nationwide standards:**
  - Students develop research and scientific communication skills to write a proposal based on specific evidence with meaningful justification from multiple sources.
  - Students review fundamental concepts related to DNA analysis.
  - Students think critically to link concepts bridging the biological and physical sciences.
  - Students practice the scientific method by constructing a hypothesis and designing an experiment to test it.
  - See appendix for details on how Genes in Space **integrates Common Core Learning Standards (CCLS) and Next Generation Science Standards (NGSS)**.

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How to submit a Genes in Space proposal

To submit an idea to the Genes in Space contest, your students will answer seven questions, 4 of which, the bolded questions, are scored during the judging process:

1. Describe your project in tweetable form (140 characters)

2. Describe the scientific problem that you propose to address. What is the question you are trying to answer? What makes it significant, relevant, or interesting? (200 words)

3. State your hypothesis. What are your objectives? (200 words)

4. Explain how the unique environment aboard the ISS is required to test your hypothesis. What conditions of the space station are essential for your research? (200 words)

5. Outline your experimental plan. How will you use PCR to test your hypothesis? Specify for example: the samples you will analyze, controls that you will use, and the possible experimental outcomes. (200 words)

6. How did you hear about Genes in Space?

7. Citations

Download a sample application form and the Genes in Space detailed scoring criteria

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Genes in Space classroom activity – brainstorm!

This challenge allows for large amounts of creativity and student imagination. By allowing students to design their own protocol rooted in scientific concepts, students bridge the gap between reading about science and transforming this to real-world applications. **This activity integrates Common Core Learning Standards (CCLS) and Next Generation Science Standards (NGSS).**

Students may use the questions below as a guide for building their proposal. Students can work in groups up to four and/or use peer review to enhance their proposals.

Start thinking about Genes in Space:

Defining the problem

1. What is the question you are trying to answer? Be specific.
2. Why is this question relevant? Name what answering this question would allow humans to do.

Developing a hypothesis

3. What is your hypothesis?
4. Diagram your hypothesis with step-by-step justifications found during your research.

Testing your hypothesis

5. How would you design an experiment to test your hypothesis? Highlight how the PCR technique is needed for this type of research. Are other techniques necessary?
6. How does testing your hypothesis require the unique environment of the International Space Station?
7. What are the possible experimental outcomes and how would they support/refute the hypothesis?

Designing the experimental plan

8. What data would you collect?
9. What samples will be required for your experiment as inputs to the miniPCR machine?
10. Which physical variables should be considered to complete this experiment aboard the International Space Station?
11. What research or scientific principles in science can you use to explain or justify your experimental design?

Summary:

12. How would you explain your project to a fellow student, in less than 50 words? Be specific.

After peer review, go to www.genesinspace.org to submit your proposal!

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Run a hands-on Genes in Space activity in your classroom

miniPCR™ Lab in a Box – a free Genes in Space Resource

Request a 2 week FREE* loan of a miniPCR™ equipment kit to teach DNA science in your classroom. For programs serving USA middle and high school students ONLY.

The kit will include:

- 4 DNA Discovery Systems™ (miniPCR™ machine, blueGel™ electrophoresis system, and micropipette (2-20 µL)
- 2 micropipettes for instructor use (20-200 µL and 1-10 µL)
- miniPCR™ Genes in Space food safety Learning Lab: reagents, consumables, and lesson plan (ideal for up to 64 students
- Live support for you and your students from the miniPCR™ team via Genes in Space Chat (optional)

Learn more and request your box full of DNA science!

*We ask that recipients pay a $100 shipping fee. For needs-based exceptions please contact genesinspace@minipcr.com

Genes in Space – Your DNA Experiment in Space!

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APPENDIX: Genes in Space aligns to nationwide standards

NGSS Standards:

HS-ETS1-2-3. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering; Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
Multiple content specific standards will be addressed, depending on student proposal. Refer to http://www.nextgenscience.org/next-generation-science-standards for a complete set of the NGSS Standards.

CC English standards: http://www.corestandards.org/wp-content/uploads/ELA_Standards.pdf

RH.9-10.1-3/11-12.1-3 Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

RST.9-10.1-4,7,9/ 11-12.1-4,7,9 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole. Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas. Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain. Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem. Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

WHST.9-10.1/11-12.1 Write arguments focused on discipline specific content.

WHST.9-10.4-6/11-12.4-6 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

WHST.11-12.7-8, 10 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

CC Math standards: http://www.corestandards.org/wp-content/uploads/Math_Standards.pdf

MP.1 Make sense of problems and preserve in solving them.
MP.2 Reason abstractly and quantitatively.
MP.3 Construct viable arguments and critique the reasoning of others.
MP.4 Model with mathematics.
MP.6 Attend to precision.