

## Lesson outline

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## Extreme life in ocean worlds

**Topic:** **The Future of Humanity Beyond Earth**

**Students' age:** **16-17**

**Time:** **🕒 2 lessons**

**Key words:**  
**Astrobiology**  
**Ocean**  
**Life**  
**Solar system**  
**Planetology**

**Subjects:**  
**Physics**  
**Biology**

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## LESSONS IDEA

The main goal of the lessons is to provide access to knowledge and source materials in the field of the modern science frontiers, to present questions and hypotheses of real astronomy and biology research, and by the fact that so far there are no unambiguous answers here (questions about the presence of microbiological life beyond the Earth is still open) an indication of unusual directions and opportunities for future professional career would be presented.

The lessons intends to familiarize students with the concept of ocean worlds, display their important role in astrobiology, and help define Earth as one of them. During the lessons students:

- will read „Colorful extremophiles” presentation,
- will check the understanding the presentation through a quiz,
- will discover water color dependence on the presence of microorganisms using satellite data,
- will discuss and vote on the choice of the life discovery space mission target,
- will present information about selected target useful for potential life discovery using remote sensing methods.

The lesson consists of two parts. The first part is dedicated to the issue of how we can find evidence of microscopic life's existence on Earth in satellite images. In this part, a student will get introduced with a presentation about extremophiles, then learn to use the Sentinel EO-Hub tool and use it to see the difference between water with a low and high concentration of microorganisms in satellite images. In the second part, the student will try to choose the target of the mission to detect microbial life on one of the ocean worlds. For this purpose, (s)he will get acquainted with the database of images of ocean worlds taken by already completed space missions. Then the student will make a mini-presentation in which he will describe the conditions in the world of his choice and try to predict what microorganisms could live there.

 **Presentation - colorful extremophiles** [⇒link](#)

The student will learn about selected concepts related to astrobiology and will be able to recognize the activity of extremophiles in aerial or satellite images (please note, the user should only use the GUEST account). After reading the presentation, the student should know the answers to such questions as:

- What are extremophiles?
- What are ocean worlds?
- Name a few examples of ocean worlds.
- What pigments do you know and what is their role in the life of microorganisms?

While reading the presentation, the student selects 2-3 ocean worlds and, based on Internet sources, tries to determine the environmental conditions to which microorganisms living in such a world would have to adapt. The choice and justification are included in the work sheet by the student.

After studying the presentation, the student solves a simple test that checks the basic elements of knowledge in the field of astrobiology [⇒link](#) PIN: 0528577. The student writes the number of earned points and the nickname on the Kahoot platform in the work sheet.

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Then, students get familiar with the images taken of the selected astronomical object. For this purpose, she/he searches the database for images in various optical channels and browses them. A lot of time should be spent on this task, because when viewing the more successful and worse images, the student tries to answer the following questions:

- *Would it be easy to find microorganisms in my ocean world?*
- *What optical channels would I need to use?*
- *Does the surface of this world make this task difficult?*

While viewing images, students can share their discoveries.

Detailed instruction for the students:

- *You have already met some ocean worlds in the Solar System. You also know some of the microorganisms that might live in such worlds. What's more, you can answer the question: what kind of images do I need to use to discover the presence of extremophiles in the photographed place.*
- *The last task will allow you to see what source material astrobiologists working on the ocean worlds work with. Look for them and try to answer the question: would it be easy to find colorful extremophiles in the ocean world of your choice? What does the surface of this moon or planet look like? Is it homogeneous? Diverse? Which of the microorganisms would be easy to spot there?*
- Detailed steps:
  - 🔗 *Open the website with Cassini images in a browser [⇒link](#)*
  - 🔗 *Enter the name of the ocean world of your choice in the "Filter targets" field.*
  - 🔗 *In the "Color Filters" field, select the color of light in which you would like to see the selected ocean world from the drop-down menu. The abbreviations visible there mean:*
    - \* *BL - blue color*
    - \* *MT, HAL, CB, RED - red color*
    - \* *GRN - green color*
  - 🔗 *On the left side you will see thumbnails of images of the selected object in the selected color. By clicking on the most interesting, review them carefully. Try to answer the questions asked. Remember, there are no right or wrong answers here. These are the questions that scientists struggle with all the time.*
  - 🔗 *Choose 2-3 most interesting photos of the selected ocean world.*
  - 🔗 *Complete task 4 in the work sheet.*
  - 🔗 **Link to instructions for students** [⇒link](#)

Classes introduce new elements extending the core curriculum to include remote sensing tools: a) multispectral images, b) remote sensing indicators, c) spectral channels, and biology: d) model organisms. Especially in the case of a-c points, make sure that the students have acquired the concepts, and in Action 3 (analysis of Salt Lake photos) correctly selected a remote sensing indicator allowing the identification of the area with a high concentration of microorganisms.

The set of spectral signatures is worth printing because it facilitates work under Action 3: the student can more easily choose the correct spectral channels in the Sentinel Hub tool by being able to "look" at the printed charts.

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The result of the lessons should be a presentation prepared by students. The aim of the exercise is for the student to summarize the acquired knowledge and his own thoughts. Using the on-line tool [⇒link](#), students present on one page the selected world, its conditions and extremophiles that can live there.



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## ADDITIONAL MATERIALS:

*✍ the SeeSaw application - registration and creating an account is required*

- Presentation *Colorful extremophiles*
- Presentation *The halophile seeker*
- Moodle platform with the presentations and tasks for students [⇒link](#)
  
- Sentinel Hub Earth Observation Browser [⇒link](#)
- Cassini RAW Images explorer [⇒link](#)
  
- Quiz Kahoot [⇒link](#) PIN: 05285777



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