



Microbe Madness

Overview

Type about three sentences that briefly describe the lesson. The overview may include, but is not limited to, the creator's name, what expedition they are connected with, what inspired them to create the lesson, the main objective, information about the science the lesson is based on, what is most fun about it, a fun fact, a quote, etc.

In a “March Madness” game of survival of the fittest, will your microbe and its genes survive the test of changing conditions on Planet Earth and beyond? Students choose genes from a “toolbox” and pit their microbe against their classmates’, using critical thinking and argument writing to determine the microbe with the best chance of success. Based on PolarTREC expedition “Microbialites in Lake Joyce, Antarctica.”

Objectives

By the completion of this lesson, students will:

- demonstrate that environmental pressures drive evolution
- form compelling arguments predicting what kinds of genes would be useful, given the environment
- theorize the genetic resources necessary to survive in an extraterrestrial environment, thus gaining understanding of the work of astrobiologists

Lesson Preparation

Students can/should read the article from the Antarctic Sun about the Microbialites in Lake Joyce expedition to gain background about using the Dry Valley lakes as an analog for understanding ancient microbial environments. It would be helpful for students to have a basic understanding of evolution and/or cell biology prior to completing this lesson.

Procedure

Describe the steps needed to complete the lesson.

1. A Warm Up: Discuss or do a quickwrite: How can we learn about the possibility of life on another planet without actually going to there ourselves? Answer: Study similar places on Earth and what lives there. The TED-Ed video- “Why Extremeophiles Bode Well for Life Beyond Earth” may also be a good introduction.
2. Explain that microbes dominate our planet. For a long time, single-celled organisms were the only living thing here. We estimate that life on other planets is likely to be single celled as well. How did these life forms survive for billions of years?
3. Theorize what genes would be needed to survive the test of time and changing conditions. Students will select traits from a list and write their choices in LARGE print on the “Gene Choices” page so it can easily be seen from the back of the class. Make sure that students realize that... • No ONE gene will eliminate them from a round – their microbe just has to be the Best Fit. For example, if the environment is cold, and they have no genes for tolerating that, but they have everything else to suit that environment, then maybe they will still be better

Details

- 📌 Lesson
- 🌐 Antarctic
- 🕒 Less than a week
- 📄 Download, Share, and Remix
- ✍ Middle School and Up

Materials

- Microbe Madness- student pages (a class set, not for writing on)
- Microbe Madness Gene Choices- one for each student
- Microbe Madness- Explain Your Thinking Argument Writing Chart- one for each student
- Microbe Madness- Environmental conditions
- A large whiteboard for recording environmental conditions and illustrating brackets

off than their competitors. • Many genes are needed for photosynthesis – if they choose to photosynthesize, they also need to be able to take in carbon dioxide AND iron – it’s a big commitment. • They are limited to 15 points for their microbe in order to simulate that the size of the genome is a limiting factor. • One microbe CAN potentially “breathe” more than one gas. It happens in real life, and therefore it can happen in this game too, but it will cost points.

4. Randomly select environmental qualities for the first round using the Environmental Conditions, best printed on different colors of paper to correspond to each dimension. Post these conditions on the board for all to see and refer back to. Then, each pair of students will decide which of their two microbes are best suited to survive. Remind them that their genes don’t have to be a perfect match, they just have to be more competitive in that particular environment. The winner will advance on to the next round.
5. Repeat step 4 but only change one of the environmental conditions (indicating slow changes over a long period of time), this time with a group of 4 students choosing which of their two remaining microbes will advance on to the next round.
6. Pause the rounds here so that students can complete the first table on the Argument Writing Chart, outlining why their chosen microbe is the best fit for its environment. Give students time to discuss their claims, evidence and reasoning before each student writes their ideas on the page. The teacher can model an example of a trait (that would be evidence), and the reasons for it.
7. Continue the rounds with increasingly larger groups of students deciding on which of their microbes advances on to the next round, until the last environmental change occurs and the last microbe (winner) is voted on.
8. Instruct students to turn back to their Argument Writing Chart, discuss and write about why the winner is best suited for the environment it is found in.

Extension

One could extend this lesson to include pressures in terms of cellular metabolic functions – that in extreme conditions, microbes with large genomes lose the ability to simultaneously carry on complex processes AND still have enough energy for the reproductive process.

Evaluation

Students can be evaluated based on the strength of their Argument Writing Charts.

Resources

List relevant books, maps, posters, websites, videos, etc. that serve as additional resources for the lesson. If known, include resource authorship, dates, publishers, ISBN number, website URL, and any other information necessary for finding the additional resources.

TED-Ed video: <http://ed.ted.com/lessons/why-extremophiles-bode-well-for-life-beyond-earth-louisa-preston> (<http://ed.ted.com/lessons/why-extremophiles-bode-well-for-life-beyond-earth-louisa-preston>)

Assessment

Describe how student understanding, learning, and achievement are evaluated for this lesson. List any related documents (e.g. surveys, rubrics) when submitting the lesson and send them separately.

Author/Credits

Standards

Next Generation Science Standards

MS-LS4 - Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.
MS-LS4-4 - Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment

Common Core Standards

CCSS.ELA-LITERACY.W.7.1

Write arguments to support claims with clear reasons and relevant evidence.

CCSS.ELA-LITERACY.W.7.1.A

Introduce claim(s), acknowledge alternate or opposing claims, and organize the reasons and evidence logically.

CCSS.ELA-LITERACY.W.7.1.B

Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.

Lesson by PolarTREC teacher Lucy Coleman (lucycoleman@gmail.com (<mailto:lucycoleman@gmail.com>)) collaborating with researcher Megan Krusor and fellow teacher Sang Bae.

Microbe Madness—

CLASS SET for students- DO NOT WRITE ON THIS!

You've learned about what cells do, and you've learned about how evolution works. It's time to put the two together! You are tasked to *think like a scientist* and anticipate the set of genes for a microbe that will allow you to stand the test of time and changes in the environment! This kind of predictive thinking allows scientists to hypothesize about the requirements life forms might need in order to survive in places we can't necessarily see for ourselves, like ancient earth, or on other planets.

Be prepared! The environment could be...

- a. hot, OR cold
- b. wet OR dry
- c. salty or unsalty
- d. acidic or neutral
- e. have an atmosphere of oxygen, carbon dioxide or sulfur (we'll have 2 gases at a time)

Steps to follow:

1. Build your microbe! You will do this by selecting the genes you think will give you the best advantage in an ever-changing world, and it will require you to think strategically. Some things to keep in mind are...
 - A cell's genome is only SO BIG, so there are only so many genes it can hold. Therefore, **your total budget for genes is 15 points.**
 - Some genes will make you better suited to an environment, and some won't. No genes are deal-breakers though: **you just have to be competitive enough to survive better than the other microbes and pass on your genes.**
 - Some genes are package deals: you'll notice that if you choose to photosynthesize, you also must be able to take in carbon dioxide AND iron! That's a lot of your gene points, but it may be worth it...?
 - Write your gene choices in BIG PRINT on your MICROBE page.

Gene Name		Function	Size of Gene
Must have	Glycoside Hydrolase	Digest sugar	1
	ATP Synthase	ATP is a molecule used to shuttle energy around a cell in order for it to function	2
	Amino Acid Polymerase	Make protein <u>-</u> something all cells must do in order to survive	2
	Oxidase	Breathe oxygen	2
	Sulfurase	Breathe sulfate	2
	Monooxygenase	Breathe carbon dioxide	1
	Cholesterol Decarboxylase	Inflexible membranes <u>-</u> counteracts effects of higher temperatures	1
	Lipid Cyclase	Fluid membranes <u>-</u> flexible to counteract effects of	2

	cold temperatures	
Sodium Transporter	Export salts <u>_</u> helpful so cell doesn't get overwhelmed with salt inside it	1
Flagellar Motor	Motility <u>_</u> able to move towards a resource Great for accessing light or sugar resources	3
Photosystem 2 Reaction Center AND Siderophily genes	Photosynthesis <u>_</u> only beneficial in an environment with carbon dioxide Siderophily <u>_</u> to get iron, required for photosynthesis	5
Activator	Sporulate <u>_</u> hibernate during poor conditions	3
Plasmid	Two extra genes <u>_</u> gives you flexibility to withstand changing environmental conditions	2
Photolyase	Repairs cells <u>_g</u> good for recovering from ultraviolet ray damage or very dry environments	2

Steps, continued:

2. We'll randomly select environmental qualities for the first round. Then, you and your first partner will decide which of your two microbes are best suited to survive. Remember, ***your genes don't have to be a perfect match, they just have to be more competitive in that particular environment.*** The winner will advance on to the next round.
3. We will repeat step 2 as each group decides which of their remaining microbes is likely to survive each new change in the environment, resulting two finalists, and lastly, one winner who survived the test of time.
4. Demonstrate your thinking: after both the quarterfinal vote and the final vote, you must explain the reasons for your choice. Think like a scientist and explain which microbe advanced in the game, and why. This critical thinking and writing will be turned in as a large part of your grade for this assignment.

Name:

Date:

Class:

Microbe Madness: Explain Your Thinking!

First Round

After you and your seatmate have selected the microbe that advances to the next round, support your choice with evidence:

We think that _____'s microbe will be more successful because the environment is _____ and this microbe has _____ gene. This gene will help because.....

Quarterfinals

Environmental Conditions	
Temperature	
Water	
Salinity (salt)	
Acid	
Atmosphere	

After you and your classmates have selected the microbe that advances to the quarterfinals, support your choice with evidence:

Which microbe was best suited to survive in the environmental conditions?	
Evidence (genes that it has)	Reasoning – what makes that gene BEST for this environment?

Finals

Environmental Conditions	
Temperature	
Water	
Salinity (salt)	
Acid	
Atmosphere	

After you and your classmates have selected the microbe that advances to the finals, support your choice with evidence:

Which microbe was best suited to survive in the environmental conditions?	
Evidence (genes that it has)	Reasoning – what makes that gene BEST for this environment?

Now, turn your reasoning into a well-crafted paragraph, with a main idea/topic sentence in which you assert your claim. Follow that with documentation of your evidence and reasoning. This should be done on a separate sheet of paper.

Name:

Date:

Class Period:

Microbe Madness Final Writing Assignment

You've written a paragraph that examines why your chosen microbe is well suited to its environment. Now, we're going to make it even stronger. Your first task is to type it into a google document. Please use the default font and font size.

Next, share your document with your partner, and complete the Peer Review.

Peer review

Name of Reviewer:

Checklist:

Criteria	Yes!	Sort of...	Errr.... Not yet.
Main Idea sentence- answers the question "Which microbe was best suited to survive in the environmental conditions?"			
Evidence- <ul style="list-style-type: none"> 1st piece of evidence is supported with reasoning that goes BEYOND what was stated on the ToolBox chart and <i>makes good sense</i> add a comment in google.docs that shows why the reasoning is good or what needs to be fixed. 			
<ul style="list-style-type: none"> 2nd piece of evidence is supported with reasoning that goes BEYOND what was stated on the ToolBox chart and <i>makes good sense</i> add a comment in google.docs that shows why the reasoning is good or what needs to be fixed. 			
<ul style="list-style-type: none"> 3rd piece of evidence is supported with reasoning that goes BEYOND what was stated on the ToolBox chart and <i>makes good sense</i> add a comment in google.docs that shows why the reasoning is good or what needs to be fixed. 			
Conclusion- a statement that wraps up the paragraph in a way that masterfully sums up the paragraph			
Spelling, grammar and language conventions- these can be pointed out in the document			

Next, fix your own mistakes on your document, and turn it in!

Your Name:

Microbe Madness Rubric

Criteria	Yes!	Sort of...	Errr.... Not yet.
Microbe Madness “Explain Your Thinking” worksheet shows clear thought process and going beyond what was merely stated for you.			
Rough Draft of Paragraph complete and on time.			
Final Paragraph			
Main Idea sentence- answers the question “Which microbe was best suited to survive in the environmental conditions?”			
Evidence- <ul style="list-style-type: none">• 1st piece of evidence is supported with reasoning that goes BEYOND what was stated on the ToolBox chart and <i>makes good sense</i>			
<ul style="list-style-type: none">• Conclusion- a statement that wraps up the paragraph in a way that masterfully sums up the paragraph			
<ul style="list-style-type: none">• Spelling, grammar and language conventions- have minimal mistakes			

Print these sheets double sided, so, for example, one side says "Acidic" and the other "Neutral Acidity"

Acidic

Hot

Neutral Acidity

Cold

Wet

Salty

Dry

Low salt

Oxygen atmosphere

Carbon Dioxide
Atmosphere

Sulfur atmosphere