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Tools of The Trade: Story of Discovery

Apply to solve a problem

Post Assessment - There are several options to assess your learning from this lesson. Check in with your teacher to see WHICH parts of this activity you should do. You and your teacher will use your responses to assess if you are understanding how scientists gather and think about the data they are collecting. Before handing this in, look back to see if you demonstrate your understanding that similarities in different cells collected in the ocean can provide insight into populations. And more importantly HOW does that comparison apply to wider populations and communities?

Review and *apply to solve a problem.*

1. Read Penny Chisholm's story below.
2. Match your knowledge of the tools to the following story. Fill in the blanks in the story with your responses.
3. Then in the space below the story answer the following questions:
    a. What tools did these scientists use to discover Synechococcus? Write down the list of tools that were "bundled" and used to make these discoveries about *Synechococcus* (a single-cell cyanobacteria).
    b. What part of the scientific question did each tool help to answer? Include information about any of the many expeditions that occurred over the many years.
    c. What were the big questions this series of investigations helped to answer?

Story of Penny Chisholm's Science Discovery:

In 1979, a group of oceanographers were collecting seawater samples and _____ to collect and sort out the cells of phytoplankton to see what lived at the surface and also deeper. The filters' sizes were too big for the kind of phytoplankton they were looking for. The researchers at Woods Hole Oceanographic Institution decided they needed to use a (1 um) filter size. One cell they found in their mesh was 20 um and that is how they captured and discovered *Synechococcus*. When they went to an even finer filter of 0.2 um they were able to isolate the *Synechococcus* from all the other cells. To learn more they stained and counted the cells of *Synechococcus* as they used a _____ to view them under blue light. Another scientist saw that some of the cells were_____ by themselves, without the dye. Some of the photosynthetic pigments in photoautotrophs will also _____ like this (the pigment was chlorophyll). Because they were tiny he suspected they were bacteria -- so he named them *Synechococcus* -- About the same time that the *Synechococcus* was identified, another organism was observed -- with a different internal structure and different chlorophyll. By then, Penny Chisholm was using a new tool that enabled her to distinguish the differences in size among many of these very small phytoplankton. Whole populations of ocean photosynthesizers could be counted and sorted by size and fluoresence, using the _____. From these samples, new kind of cell was distinguished and named *Prochlorococcus*. Ultimately she was able to observe the quantity and size of a wide range of cells and identify 50% of these kinds of ocean

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dwellers. The ancestors of these cells started a chain reaction that produced the oxygen for the atmosphere as we know it today.

These scientists started collecting water samples deeper in the ocean layers, at 100m and 200m. The _____ is a way to collect samples of the cells, as well as understanding more about the environment in which they live, including the nutrient content, pressure and temperature. They use this tool to find out where these photosynthetic dwellers live and to learn what they need to get and use energy.

Later the scientists furthered their understanding of who lived in different layers of the ocean using the cell's rRNA. Sorting the rRNA using _____helped them to see in more detail how the phytoplankton genes were similar and where exactly they were different. By identifying their genes it became clear there were many groups of cells that could be cataloged. They could learn what environment they lived in, and how changes in the environment could limit where they lived and how much oxygen would be produced.

This passage is a summary produced by B Steffens from pgs 49-55 of:
Canfield, Donald E. *"Oxygen: A Four Billion Year History,"* Science Essentials, Dec 1, 2015.

Use this space below or your lab notebook for answering the prompts in Question #3:

To close out this assessment your class will come back together to watch this video to experience scientist Penny Chisholm in her lab talking about *Prochlorococcus:*
Annenberg Learning: Video Unit 3: Oceans // Section 1: Introduction (start at 13 min.)

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Below is an alternative to the above Assessment for students who are completing the Project-Based Learning (PBL) version of this unit. Ask your teacher before completing this next section.

***Planning an Investigation for PBL (*Summative Assessment**)

Apply your new knowledge of tools by designing an investigation to take on an ocean research expedition.

Design a bundle of tools that will help answer the question(s) - How much oxygen is produced in the ocean? (or *use focused questions from the PBL project*).

a) Use at least 3 of the tools (or more) you have been learning about.
b) Justify how the tool will help answer the question. (What data do you hope to obtain? And how will it help answer the question?)
c) Where will you collect the samples?

Remember: The tools are the same, but how and where the samples are taken is what is important to designing a research question and data collection plan.