

Marine pathology: revealing the ocean's etiology to earthbound students

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Students, especially those from the inland parts of a country, tend to have a “terrestrial-centric” view of Earth. For some, exploration of marine ecosystems may occur only during holidays or while watching the Discovery channel. The idea that oceans have pathogens that cause devastating diseases in a variety of organisms is less familiar to students than human diseases and medical treatments.

Harvell *et al.* (see pages 375–382) provide an excellent resource to help students bridge familiar topics in science with the unfamiliar. This review points out how little we know about diseases in the ocean and exemplifies the nature of science by discussing the process of investigating complex questions and showing that a lot of information is uncertain and awaits further exploration. Here we present a way to use this reading for a single class meeting, but this segment of instruction does not stand alone. It would fit well after a section on disease, viruses, immunology, or biogeochemical cycles.

■ Learning goals

In this example, teams of students will:

- Demonstrate understanding of the scientific process by constructing hypotheses and a means of testing them.
- Compare and contrast diseases in marine and terrestrial ecosystems.
- Illustrate why knowledge of ocean diseases is incomplete and uncertain.

Instructional strategy (50 minute period): We again use the learning cycle to provide students with opportunities to interactively engage with the material to construct better understanding (BSCS 1993; Bransford *et al.* 1999; Ebert-May *et al.* 2004).

Engagement (last ten minutes of prior class): At the end of class, introduce the Harvell *et al.* paper as homework. To provide context, show figures from the paper with brief explanations about hosts and their pathogens, as well as how transmission occurs. Use the graphs in Figure 4 to show disease increases in recent times. Challenge the class by asking them to predict why diseases in the oceans are increasing. Ask students to think individually for 30 seconds, and then turn to their neighbor to discuss for 2 minutes. Select 2–3 pairs to report orally, record their predictions on an overhead, and provide feedback.

To learn about your students' prior knowledge ask them to answer this question:

How is testing and determining treatment for a serious viral infection like Severe Acute Respiratory Syndrome (SARS) carried out within the human population? Students write their responses on carbonless paper¹, turn in their answers and pick up their homework assignment (Panel 1) on the way out of class, or access it on the class website.

Next class period

After students have submitted their homework, ask them to form groups of four by disease topic. This process can be facilitated in larger classes by providing a list of all the diseases mentioned in the paper and assigning sections of the classroom for each disease topic on an overhead prepared beforehand. When the groups have formed, ask students to form two pairs within each group to compare findings for 2 minutes; with pairs, everyone has a chance to talk.

Panel 1. Homework

Read the Harvell *et al.* paper “The rising tide of ocean diseases...”

- Choose one marine disease discussed and use information from the paper, library resources, the Internet, and textbooks to briefly explain the following:
 - a. Symptoms of the disease
 - b. Pathogens causing the illness, including how they are transmitted
 - c. Anthropogenic factors influencing the disease
 - d. Known or potential treatments
 - e. Three ways this marine disease is similar to human disease caused by a similar pathogen

- Take notes, to be used in class, on your findings. Use your carbonless paper notebook so you can turn in one copy while keeping another for yourself.

Grading ideas: assign one point per correct item or grade quickly with + or -. Notes: no need to make comments because students have a copy and will work with the material in class.

¹Carbonless paper is a laboratory research pad in 8.5" x 11" format, quad or line ruled, available at campus bookstores. It provides students with a record of what they do in class and eliminates the need to return papers to large numbers of students. For writing that is graded, individual student's points are posted on the web, and the next day in class, faculty show anonymous examples of “exemplary” and “needs improvement” that students can compare to their answer and discuss if appropriate.

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Courtesy of E. Weil

Porites sp from Palau is affected by an unidentified disease syndrome causing blue spots surrounded by darker halos.

Exploration (25 minutes): The entire team of four begins the exploration by designing a research study to investigate “their” disease. Instruct each group to create a draft plan, on their carbonless paper, to treat the disease they are discussing, based on the following points:

- Define the problem: what is known and unknown about the disease?
- Develop one testable hypothesis that would provide information to increase our knowledge about this disease
- Design a method to test the hypothesis.
- Predict results that would support or refute your hypothesis.

Walk around and listen to student discussions; respond to questions by offering suggestions without giving solutions. After 10 minutes, give them a 5-minute warning to finish the assignment. At that time, select 2–3 groups to report out and provide them with a transparency and pen to show their draft plan to the class. After each report, ask the group to respond to one or two questions from the class or yourself. Ask groups to submit a copy of their draft plans (you collect the original, they keep the copy of the carbonless paper).

Explanation (25 minutes): Explain the biological concepts students need to know to reinforce their understanding of the Harvell *et al.* paper. Focus on comparing and contrasting the major qualitative differences between marine and terrestrial environments that can influence the outcome of a disease. Supplement your explanations with information from McCallum *et al.* (2004). As an exercise in the middle of your lecture ask the students to look at the Harvell *et al.* paper again. Assign each fifth of the class one of the five unsolved problems in the paper and ask them to count how many times the section indicates “we don’t know” as an illustration of how much remains to be learnt about the ocean and disease. After students report out and you record

the numbers, ask them to write one plausible reason for this lack of knowledge. Again, select two or three individuals to share their thinking with the class, record their ideas, synthesize and discuss. Then continue to compare marine to terrestrial systems, for example:

- Types of pathogens and their transmission and persistence
- Taxonomic diversity and life history differences of major phyla
- Environmental stressors
- Application of human or terrestrial models in ocean disease situations.

Assessment (10–15 minutes of the next class period): Inform students that at the beginning of the next class you will provide a scenario from the Harvell *et al.* paper from which each individual (or group) will write a second hypothesis and the experimental approach (not to be confused with protocol) they would use to test this. This assessment reminds students that much is still to be learnt about ocean disease and their hypothetical experiment could potentially contribute to that knowledge. An exemplary response would include a relevant reason for the investigation (biological rationale) and a hypothesis with an independent variable (what is manipulated) and a dependent variable (what is measured), the organism or system, and the predicted direction of the results using the appropriate comparison. Alternatively, a multiple choice question presenting possible hypotheses about the scenario (only one of which included all of the above components) or a conceptual multiple choice question that assessed students’ ability to compare diseases in marine and terrestrial environments are useful, depending on the learning goals one wants to emphasize most.

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