Marine Microbiology in the Oligotrophic Ocean
STUDENT WORKSHEET
SMILE Workshop August 2019
Giovannoni Lab, Oregon State University

Oligotrophic Simulation developed by Quinn Washburn
Lesson and materials developed by Chris Suffridge, Chih-Ping Lee, Stephen Noell, Quinn Washburn, and Sarah Wolf

Learning Objectives:
- The ocean is the largest biome on Earth and it is full of life.
- Microorganisms are the most abundant and important inhabitants of the ocean.
- Microbes are diverse (size, shape, and function)
- Microbes form ecosystems where their interactions impact global processes including the carbon cycle.
- We can use models to study and conduct experiments on global processes such as the carbon cycle.

1. **Simulation 1**
   1.1. Predict which class of organisms will accumulate the most biomass. Record your prediction in the datasheet below.
   1.2. Run the simulation.
   1.3. After the simulation has completed, record the number of biomass cubes on each type of card in the datasheet below. The color of the cubes doesn't matter.

Oligotrophic Marine Microbial Ecology Simulation Datasheet			
Name:			
Team Members:			
Simulation #1 Where does the biomass accumulate at the end of the simulation?			
Prediction:			
Directions: Record the total number of biomass cubes on each type of card at the end of the simulation			
Abiotic	**Phototrophs**	**Heterotrophs**	**Viruses**

   1.4. Use the data recorded above to make a bar graph to show the distribution of Biomass Cubes
   1.5. Did your results match your prediction?
   1.6. How did your results match those of your classmates?
   1.7. Why do you think the biomass ended up distributed this way?
2. **Simulation 2**
   2.1. Based on your results from Simulation 1, predict which class of organisms will accumulate the most biomass. Also, predict how the abundance of biomass on

each class or cards will change over the course of the simulation. Record your predictions in the datasheet below.

2.2. Run the simulation.

2.3. At the end of each round (after each player has played one card), record the number of biomass cubes on each type of card in the datasheet below. The color of the cubes doesn't matter.

Oligotrophic Marine Microbial Ecology Simulation Datasheet				
Name:				
Team Members:				
Simulation #2 How does biomass move during the game?				
Prediction:				
Directions: Record the total number of biomass cubes on each type of card at the end of each round (after each player has played 1 card)				
Round #	**Abiotic**	**Phototrophs**	**Heterotrophs**	**Viruses**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

2.4. Use the data recorded above to make a line graph to show the distribution of biomass cubes changes after each round (x-axis: round number, y-axis: biomass number; each card type should have its own line)

2.5. How did each type of organism's biomass change over time?

2.6. Did your results match your prediction?

2.7. How did your results match those of your classmates?

2.8. Why do you think the biomass distribution changes in this way?

2.9. Describe several specific interactions between organisms that you observed.

3. **Simulation 3**
   3.1. Interactions between organisms are the basis of a stable ecosystem. What would happen if one class of cards was removed from the simulation? Make a prediction and write it on the datasheet below.
   3.2. Run the simulation.
   3.3. At the end of each round (after each player has played one card), record the number of biomass cubes on each type of card in the datasheet below. The color of the cubes doesn't matter.

Oligotrophic Marine Microbial Ecology Simulation Datasheet				
Name:				
Team Members:				
Simulation #3 How do the microbial interactions change when one group of organisms is removed from the simulation?				
Prediction:				
Directions: Cross out the column for the group of cards you've removed. Record the total number of biomass cubes on each type of card at the end of each round (after each player has played 1 card)				
Round #	**Abiotic**	**Phototrophs**	**Heterotrophs**	**Viruses**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

   3.4. Use the data recorded above to make a line graph to show the distribution of biomass cubes changes after each round (x-axis: round number, y-axis: biomass number; each card type should have its own line)

3.5. Did your simulated ecosystem function the same in simulation 3 as in simulation 2? Describe the differences. What might have caused those differences?
3.6. How did each type of organism's biomass change over time?
3.7. Did your results match your prediction?
3.8. How did your results match those of your classmates?
3.9. Why do you think the biomass distribution changes in this way?

4. **Conclusions:** Scientists often make educated predictions that they can test to determine if they are correct or not. Even with lots of background research their predictions are often incorrect. Being able to predict how microorganisms interact and respond to different environmental conditions is something marine microbiologists are keen on understanding, especially due to global climate change.
   4.1. State an example of a time your prediction was correct, and what events transpired that made it correct.
   4.2. State an example of a time your prediction was incorrect, and what events transpired that made it incorrect.
   4.3. Draw a picture or diagram of an interaction that you saw in the simulation and indicate how biomass flowed through the interaction.
   4.4. Research one of the organisms from the game online. Draw a picture of it and state three traits of the organism (what they consume, etc).
   4.5. What is at least one reason that marine microorganisms are globally important? Do they impact you directly? Do microbial interactions affect their global impact?
   4.6. Why is it important for scientists to understand how microorganisms contribute to the cycling of nutrients in the oceans? How can this information be used to inform change beyond the scientific community?