

Oligotrophic: A Marine Microbiology Board Game for Science Classrooms

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Oregon State
University

Expected Learning Outcomes

- **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.**

Outline of Lesson

- Marine Microbiology and Carbon Cycle introduction presentation
- Expert Groups
- Modeling presentation
- Explain *Oligotrophic* Simulation
- *Oligotrophic* Simulation 1, 2, and 3
- Conclusions





Is the Earth **BLUE** or **GREEN**?



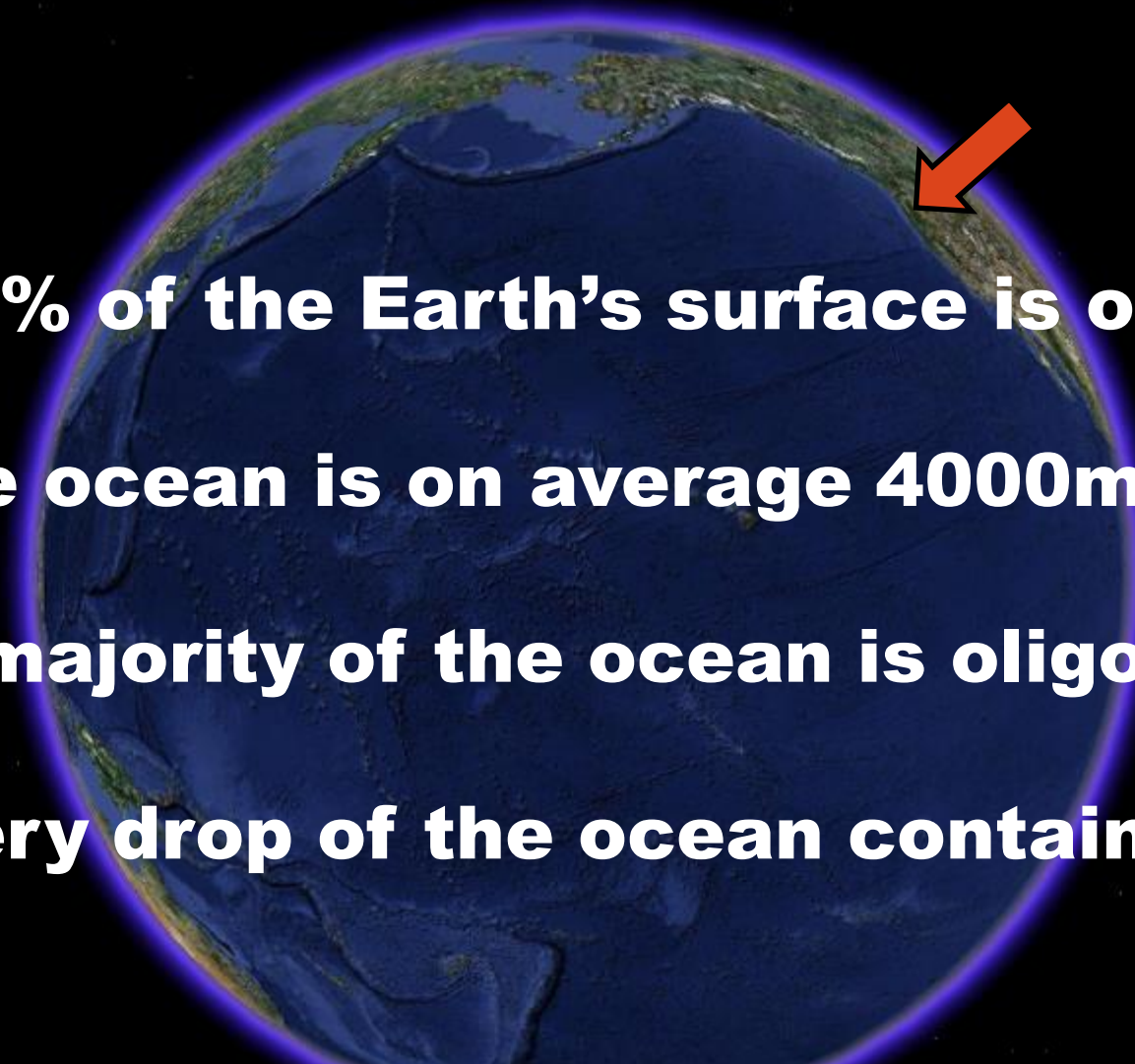
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO
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70% of the Earth's surface is ocean

The ocean is on average 4000m deep

The majority of the ocean is oligotrophic

Every drop of the ocean contains life!

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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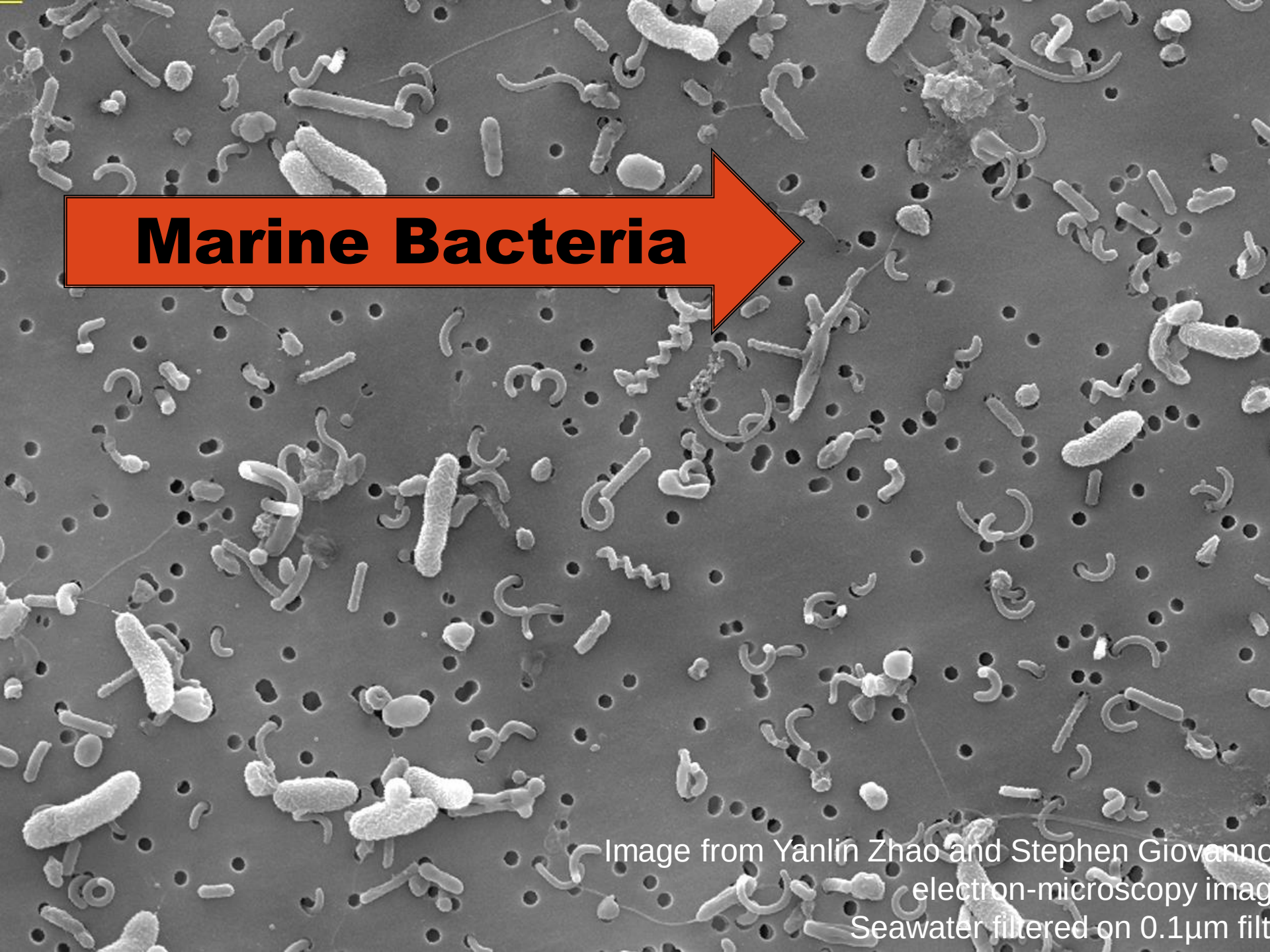
What types of organisms live in the ocean?

**Which types are most important
to our planet?**

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO

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A scanning electron micrograph (SEM) showing a dense population of marine bacteria. The bacteria exhibit various morphologies, including rod-shaped, curved, and spiral forms. They are distributed across a surface that appears to be a filter, with many small, circular pores visible. An orange arrow points from the text 'Marine Bacteria' towards the right side of the image.

Marine Bacteria

Image from Yanlin Zhao and Stephen Giovannoni
electron-microscopy image
Seawater filtered on 0.1 μ m filter

Fun Fact:
In 1 drop of
seawater there
are
1 million
bacteria!

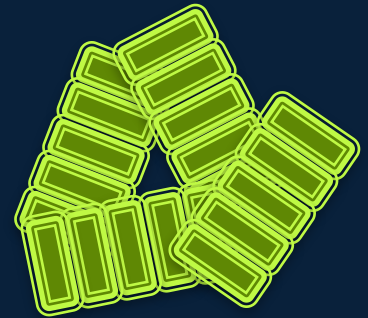
Marine Microbial Vocab!

Oligotrophic: an area of the ocean with low nutrient concentrations

Phytoplankton:

**-Create biomass from the sun
(like plants)**

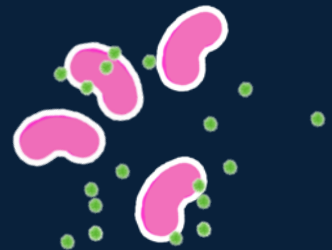
-example: *Prochlorococcus*



Bacterioplankton:

**-Use biomass produced by
phytoplankton to survive**

-example: SAR11



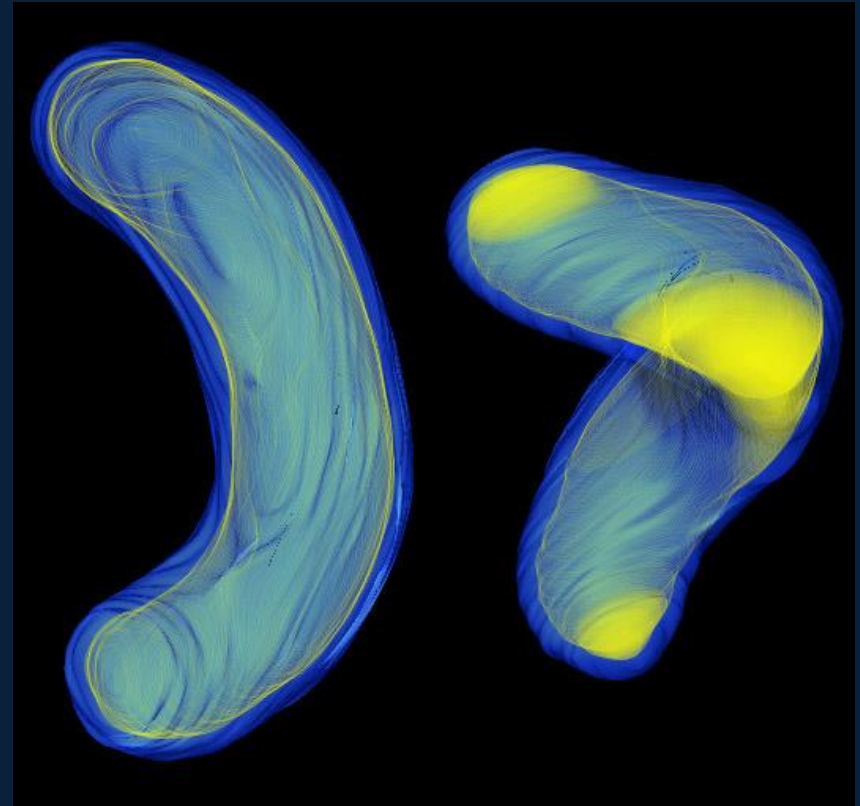
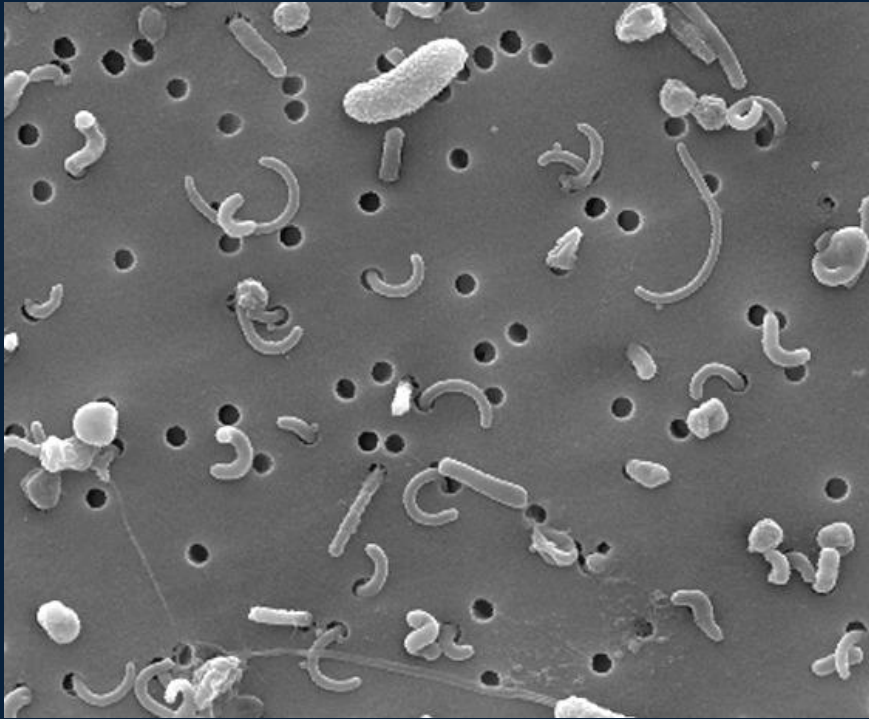
Zooplankton:

**-Consume both phytoplankton and
bacterioplankton**

-example: copepod

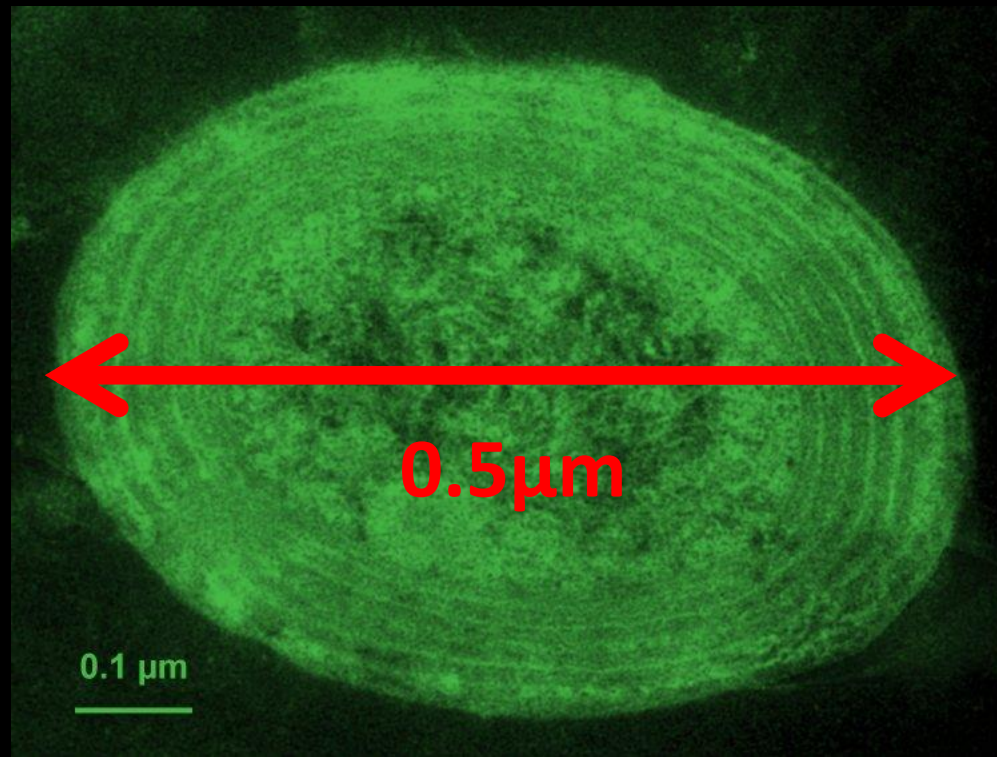


SAR11 is the most abundant bacterioplankton



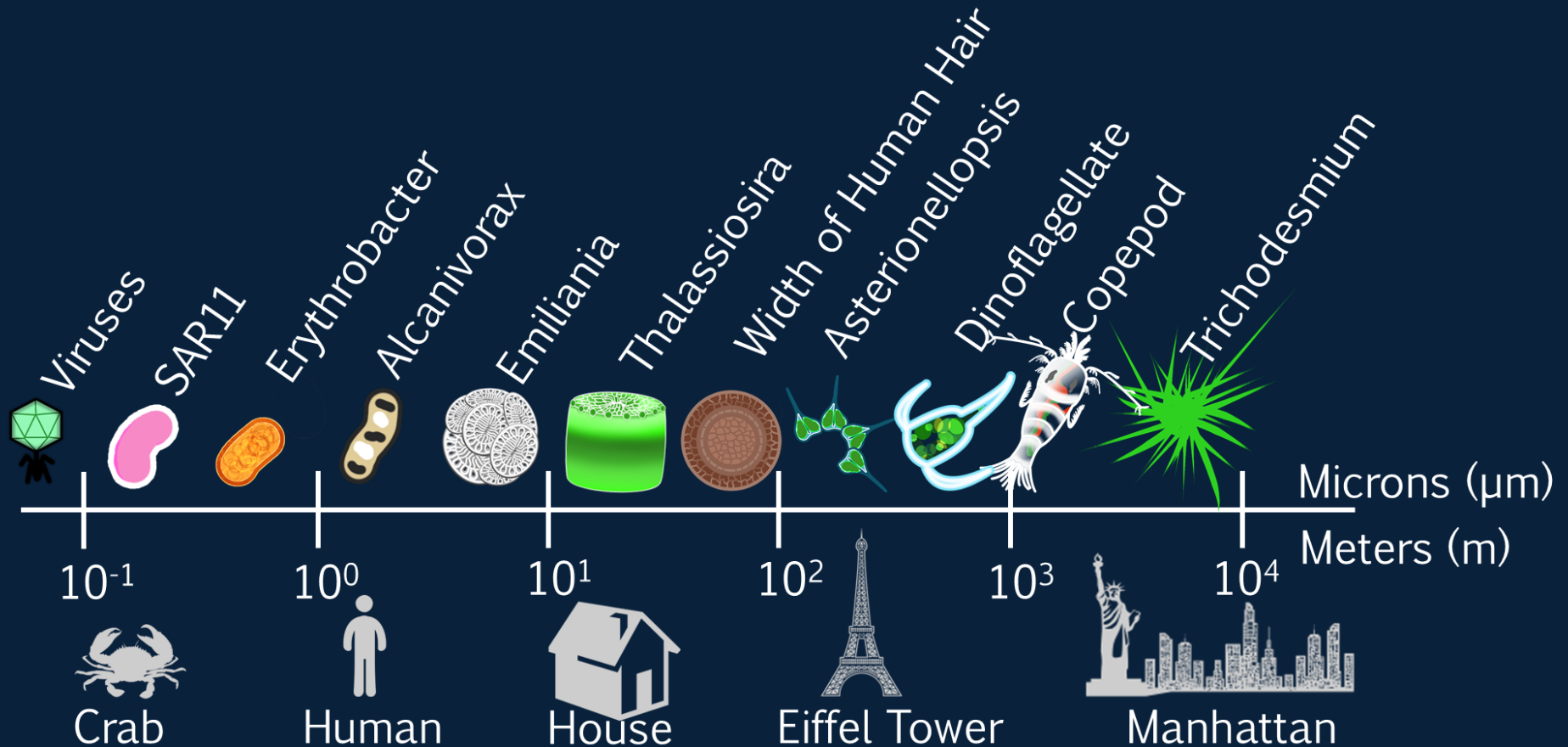
Discovered in the Giovannoni Lab at OSU

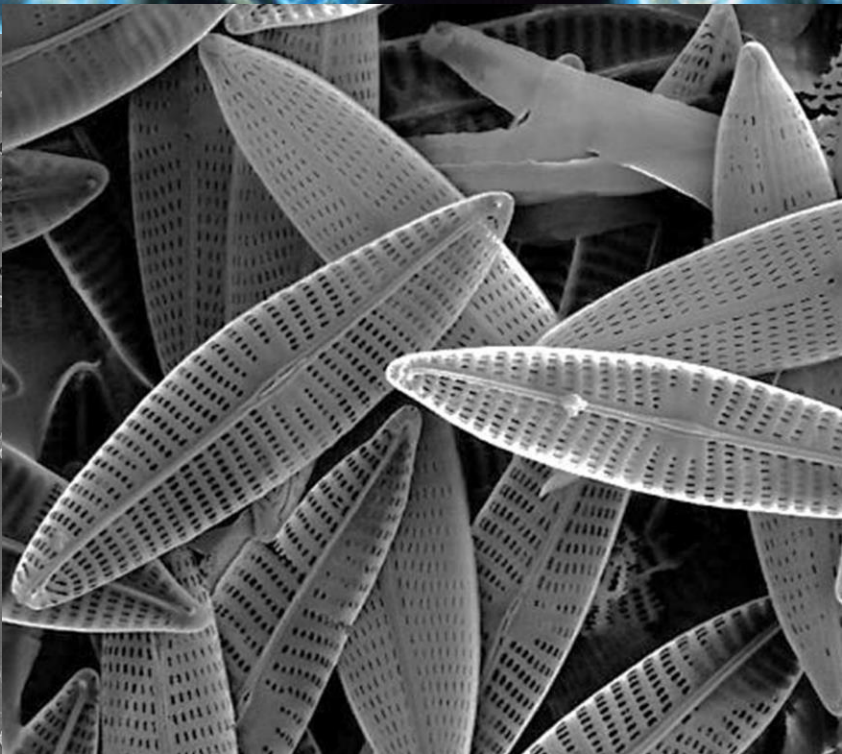
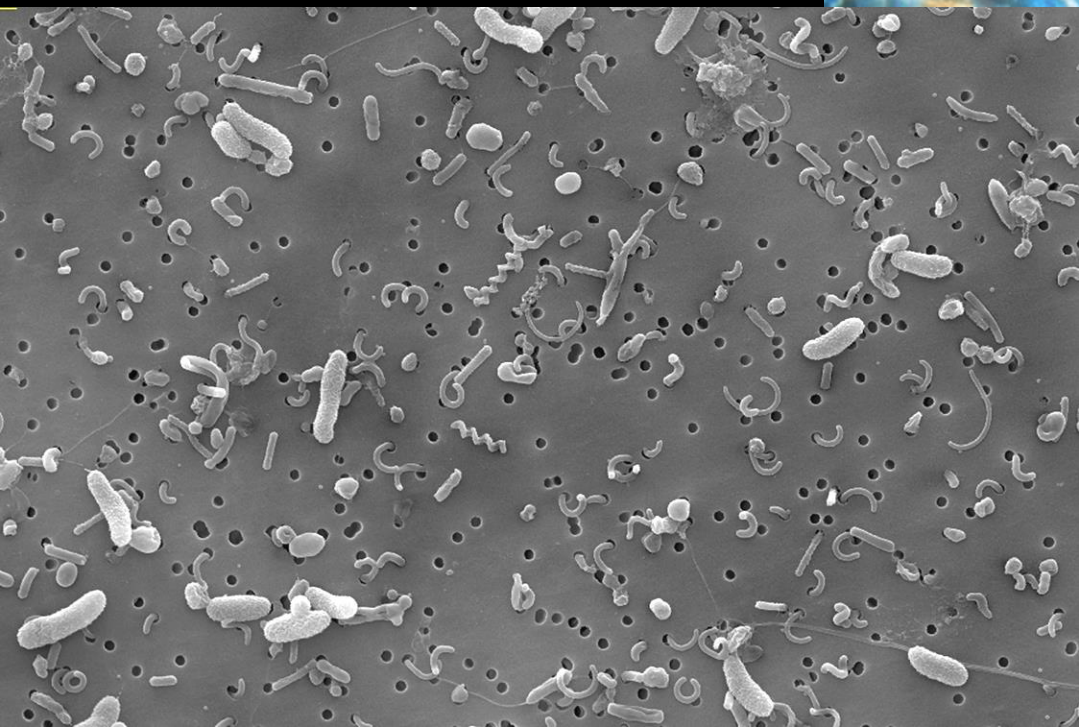
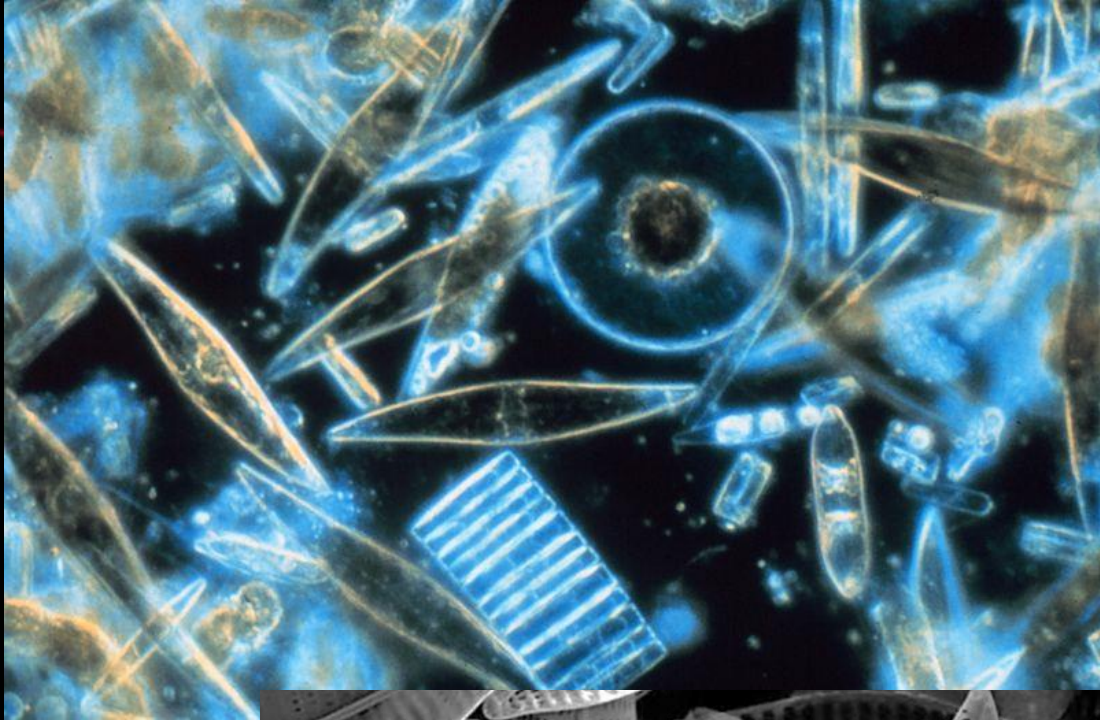
Prochlorococcus is an important phytoplankton

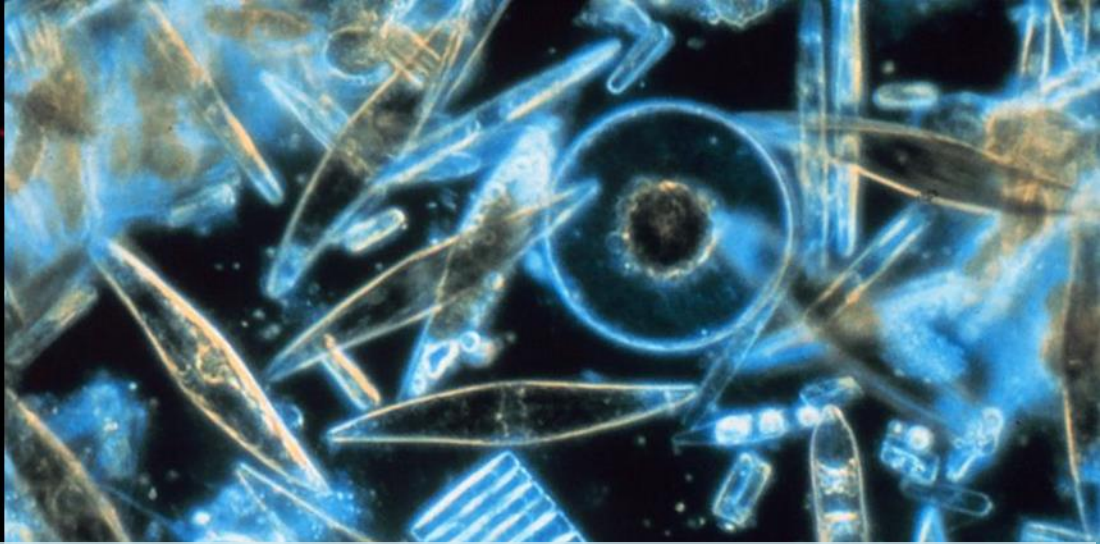


200 in a row = 1 human hair!

Marine microbes are small and diverse

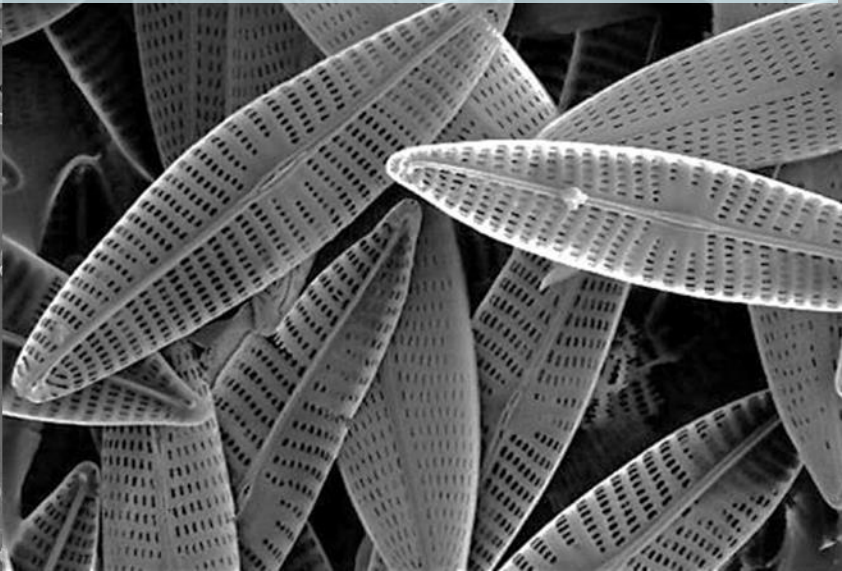
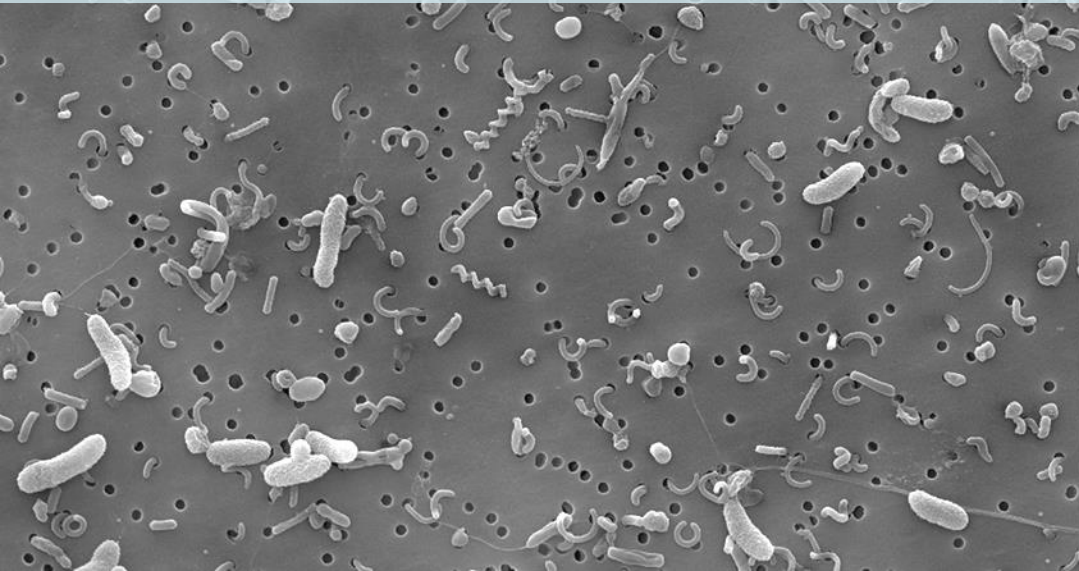




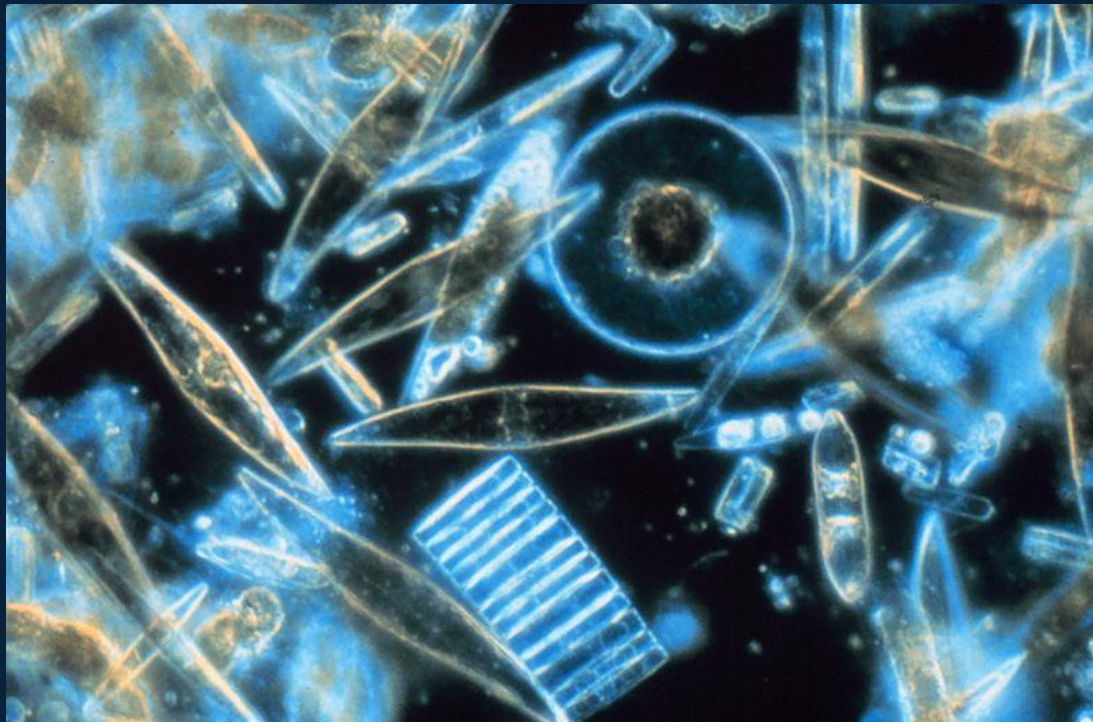


What are these marine microbes doing?

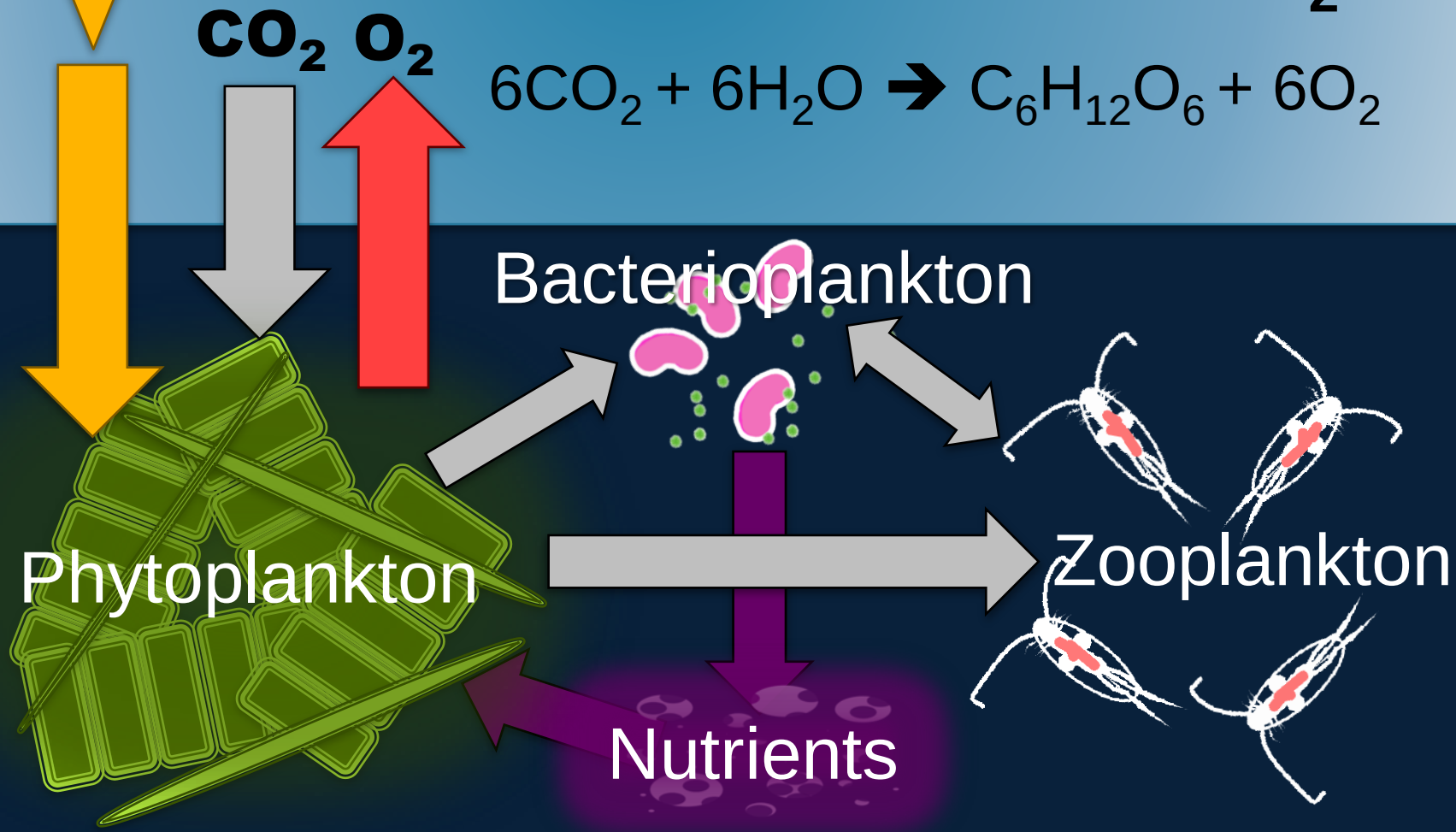
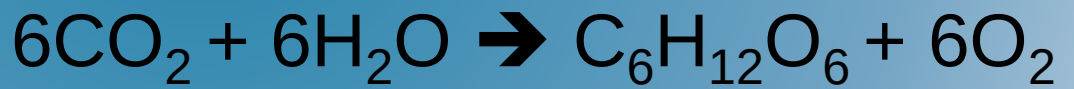
Why should we care about them?



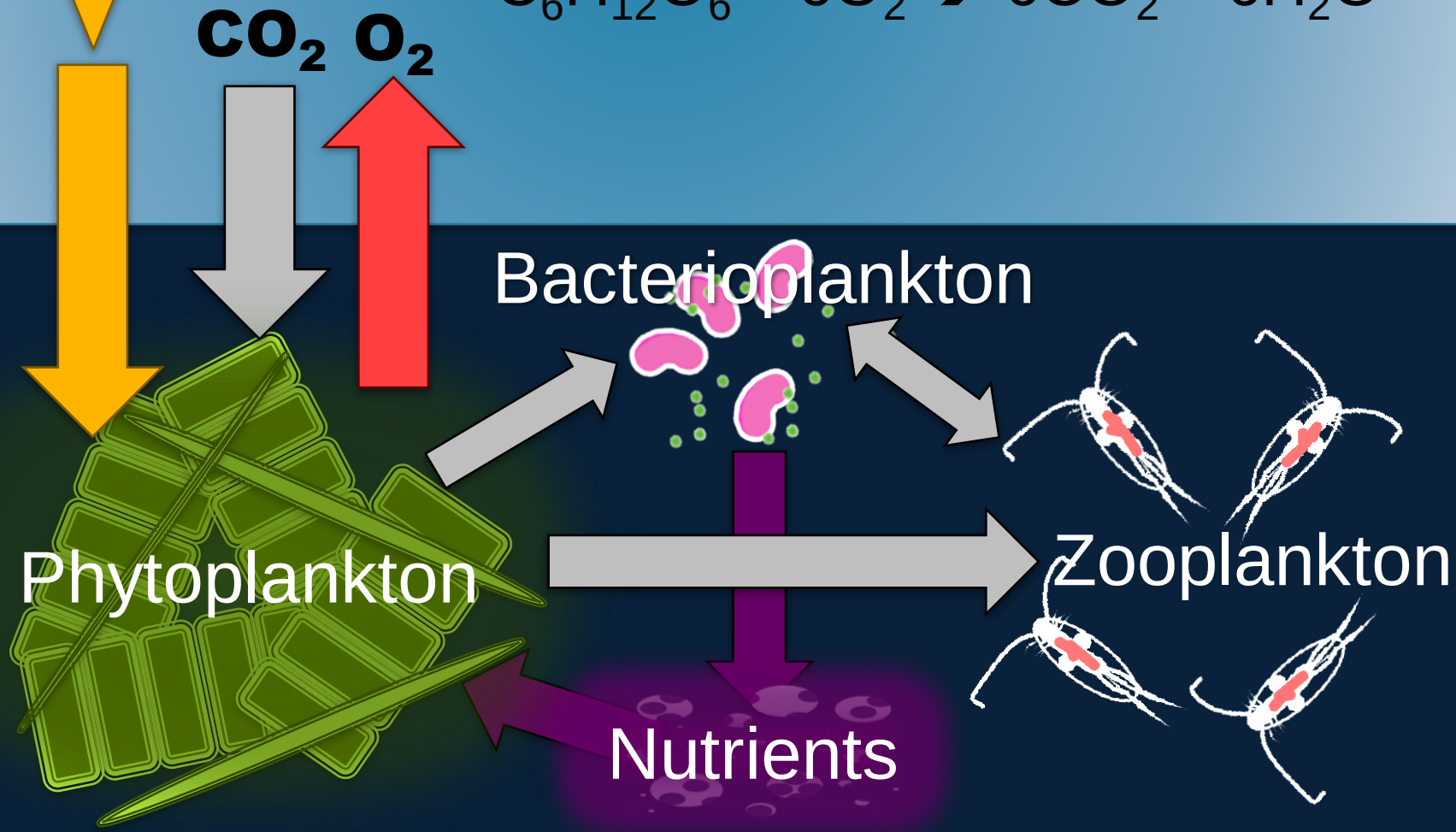
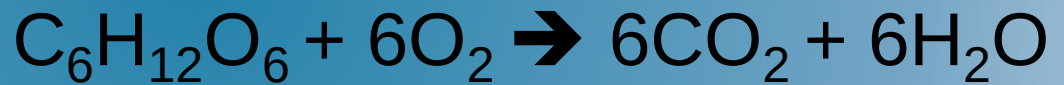
**50% of all oxygen we
breathe is produced by
microbes in the ocean!!**



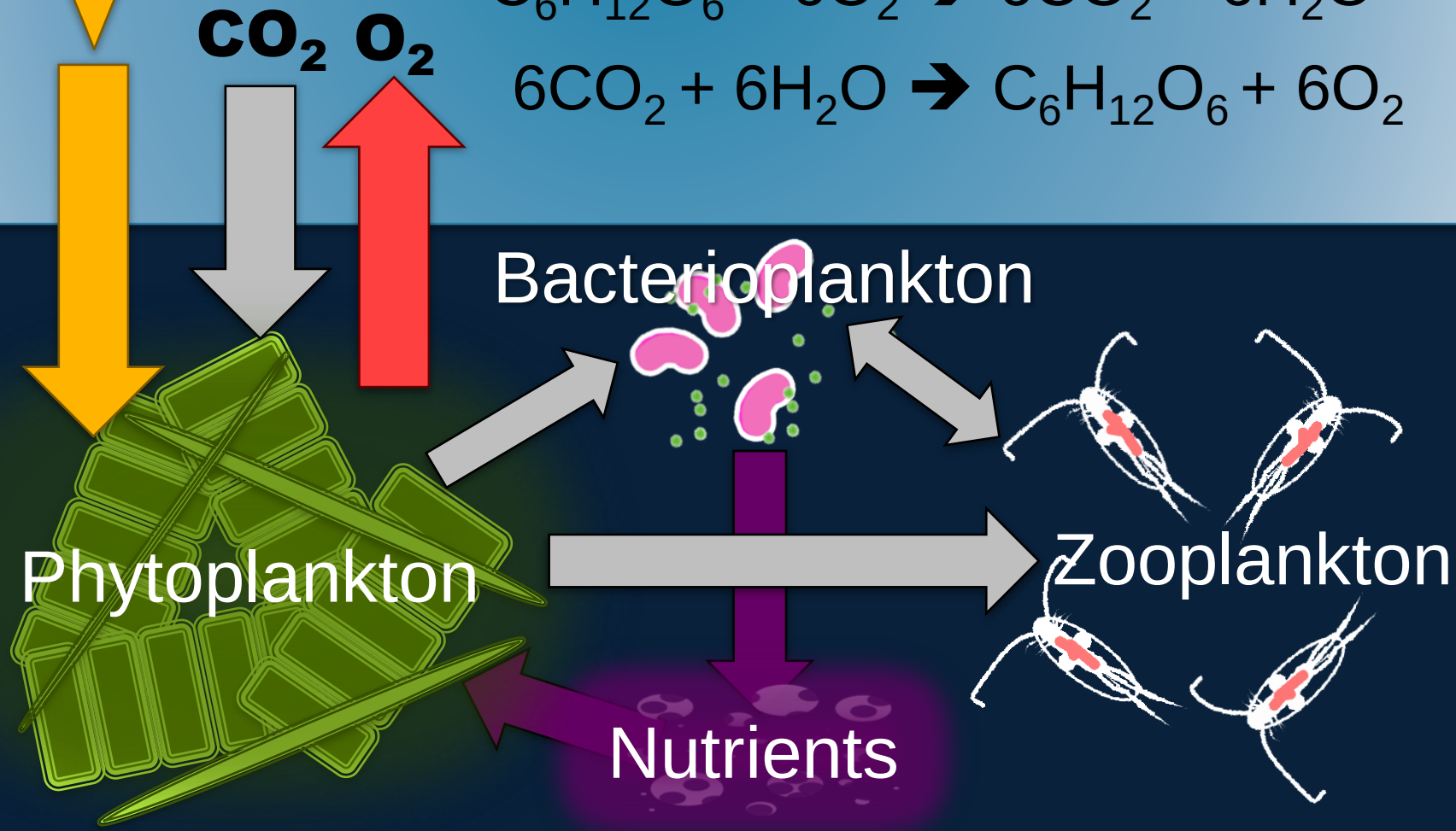
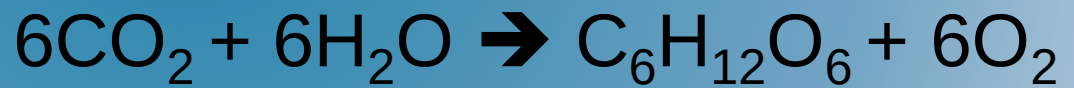
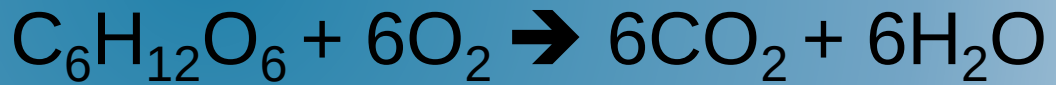
Photosynthesis by phytoplankton removes CO₂ from the atmosphere, and forms biomass and O₂



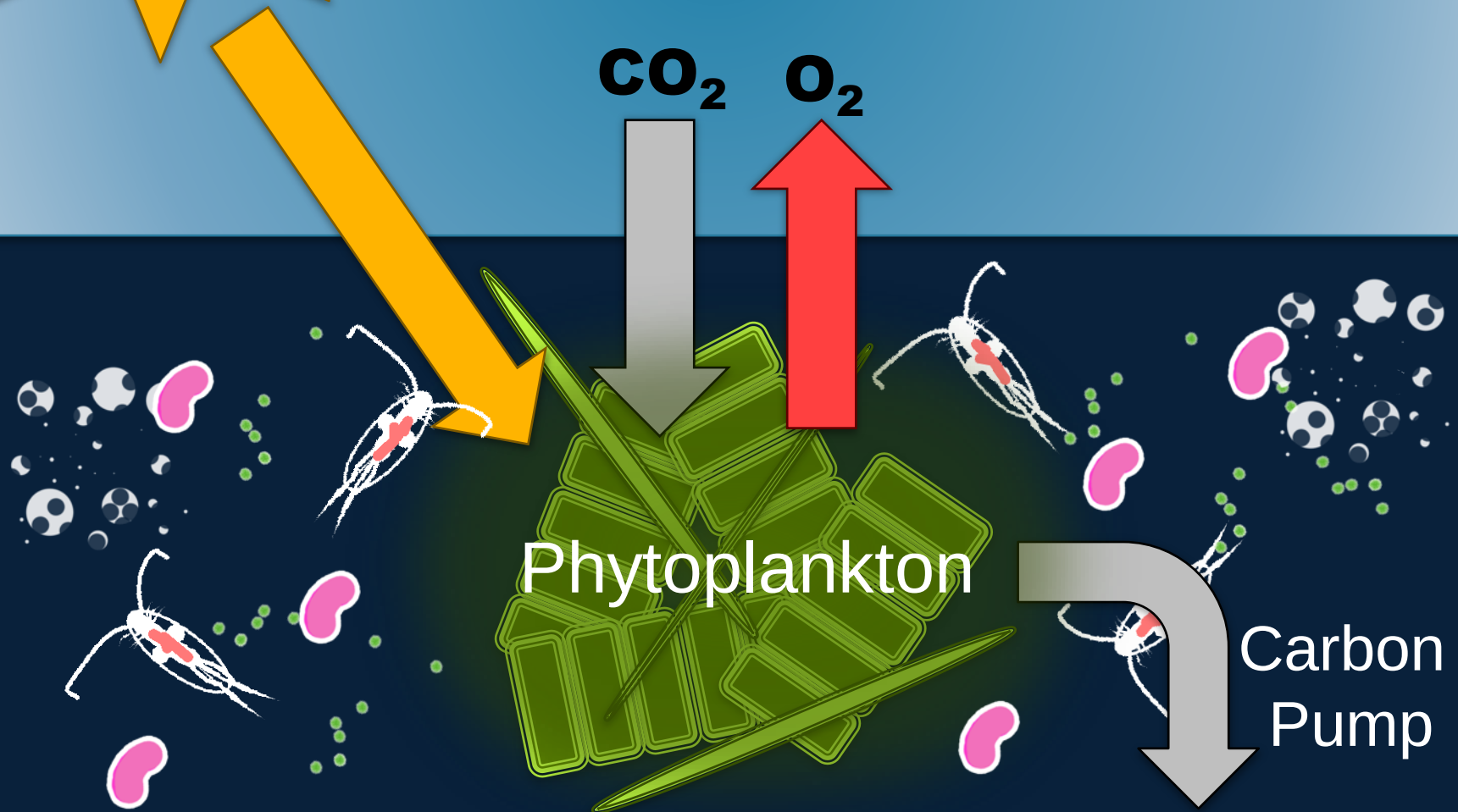
Respiration by heterotrophs
uses biomass and O_2 ,
producing CO_2



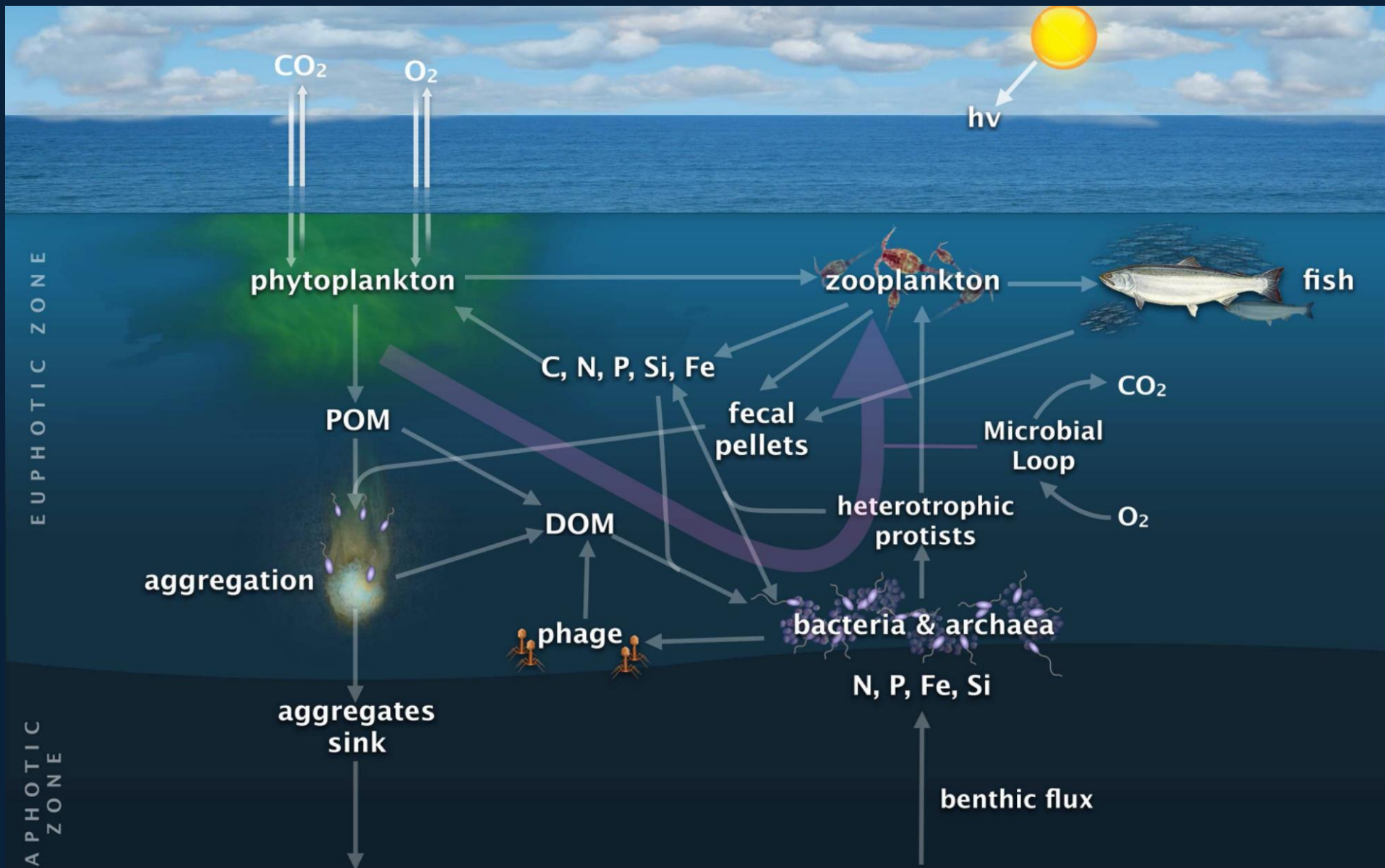
How is Oxygen produced if photosynthesis and respiration are balanced?



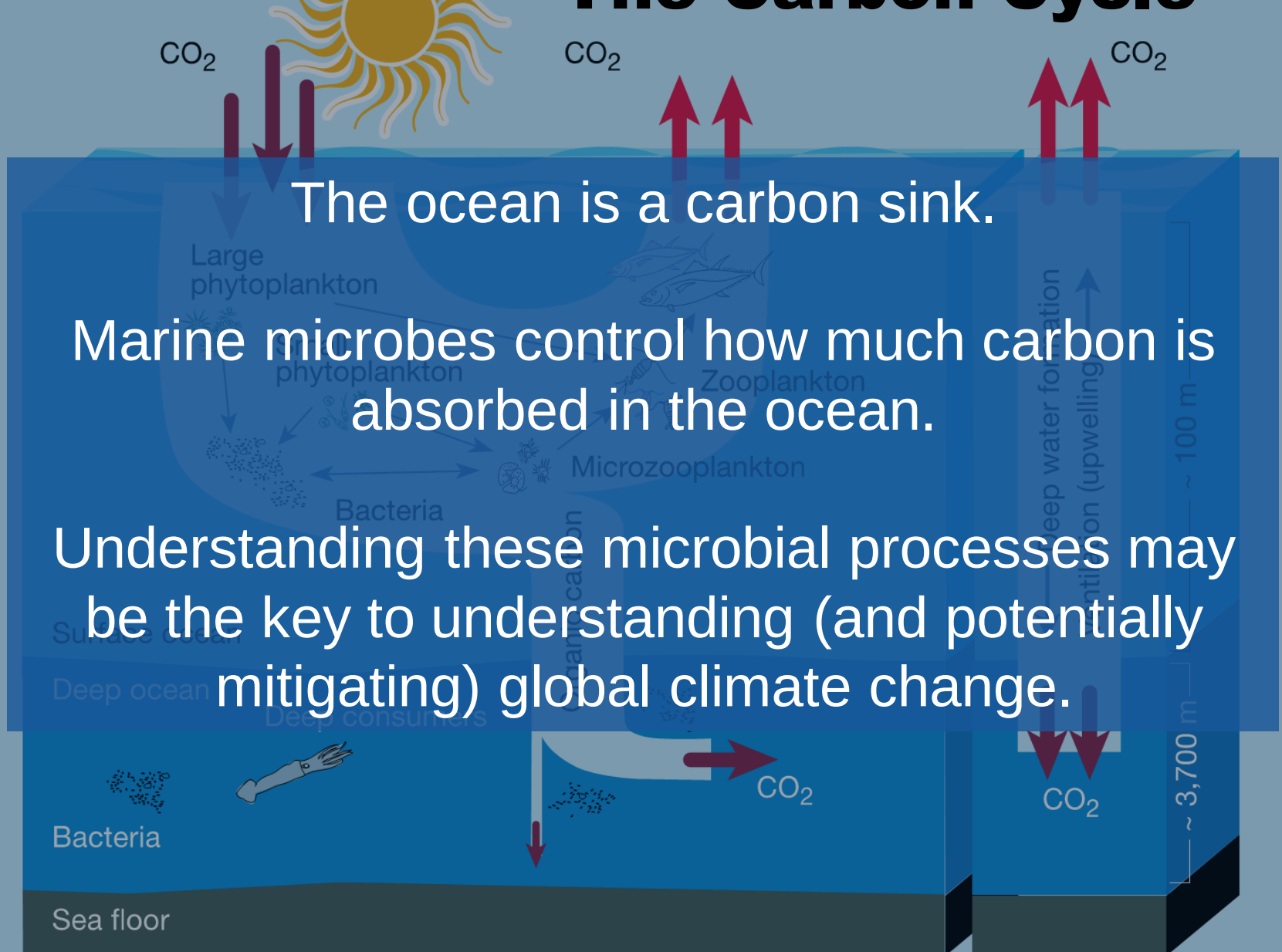
**The Carbon Pump sequesters
some fixed carbon, allowing
net O_2 production and CO_2
removal**



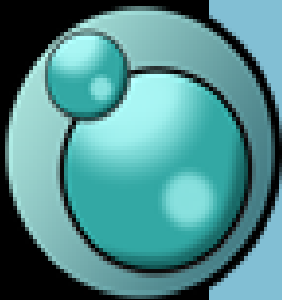
Marine Microbial Interactions Control the Strength of the Carbon Pump



The Carbon Cycle



Marine Microbe and Carbon Cycle Expert Groups



Abiotic

These are chemicals and processed that can be turned into biomass.



Phototrophs

These are organisms that use photosynthesis to turn atmospheric carbon into their biomass.



Heterotrophs

These are organisms that get energy by consuming biomass, it can be from debris or other organisms.



Viruses

These are non-living entities that use living organisms to make more copies of themselves!

**How can we experiment
with marine microbial
ecology and the carbon
cycle in the classroom?**



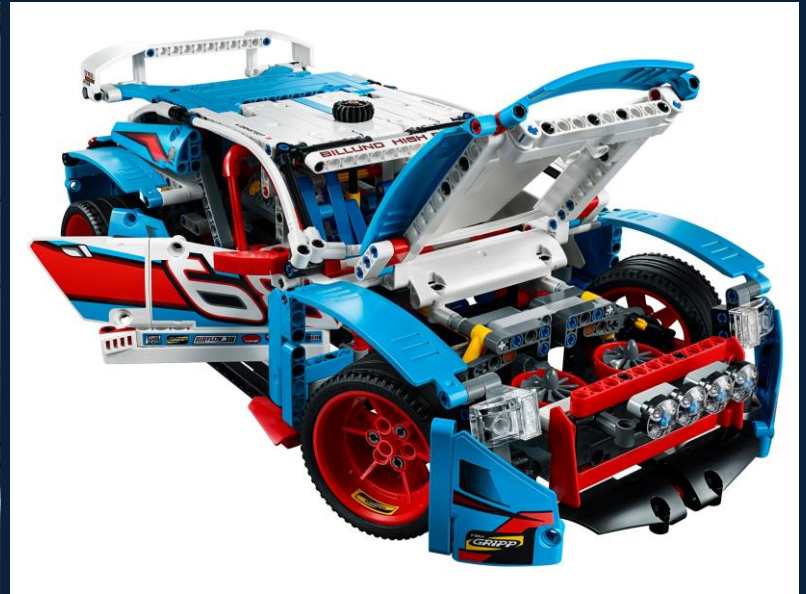
How can we study racecars in the classroom?

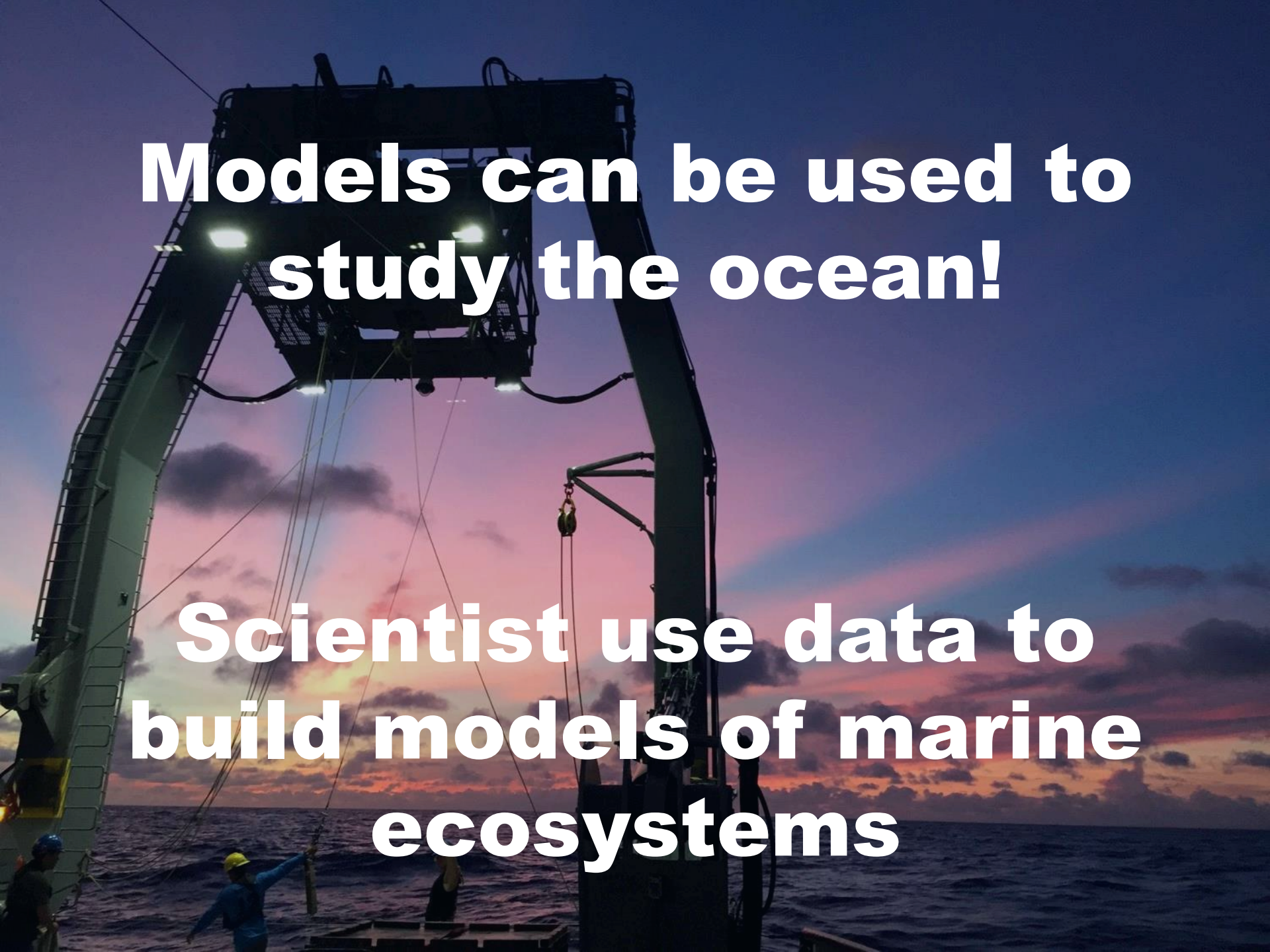


Models can be used to study systems



Models use data to recreate actual systems



A large research vessel's crane is lifting a platform over the ocean at sunset. The sky is a mix of orange, pink, and blue. The crane is a large, dark structure with a platform suspended from it. The platform has several lights on it. The ocean is dark blue with some whitecaps. Two people are visible on the deck of the vessel, one in a blue shirt and yellow helmet, and another in a dark shirt. The text "Models can be used to study the ocean!" is overlaid on the image in white, bold, sans-serif font.

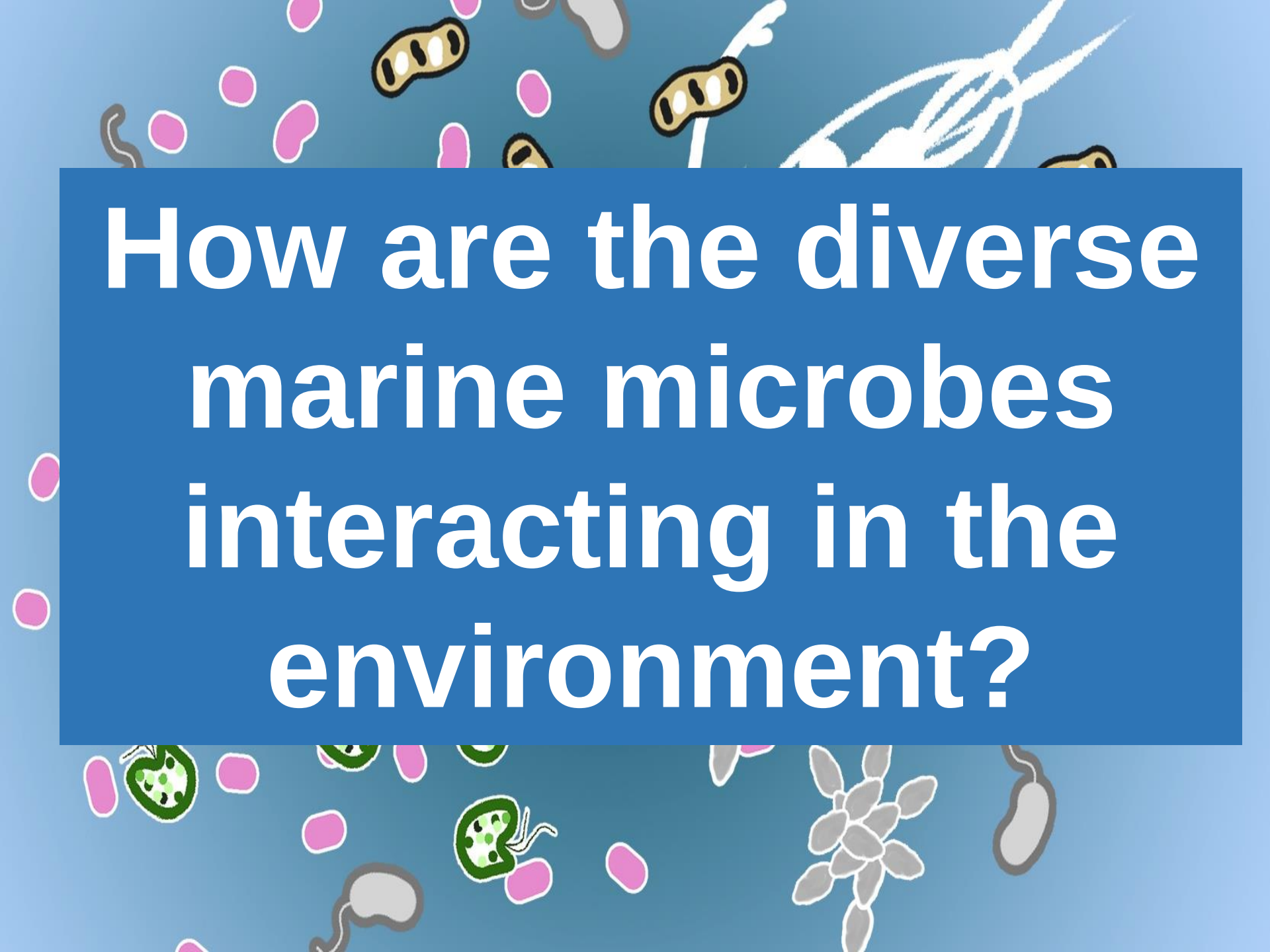
**Models can be used to
study the ocean!**

**Scientists use data to
build models of marine
ecosystems**

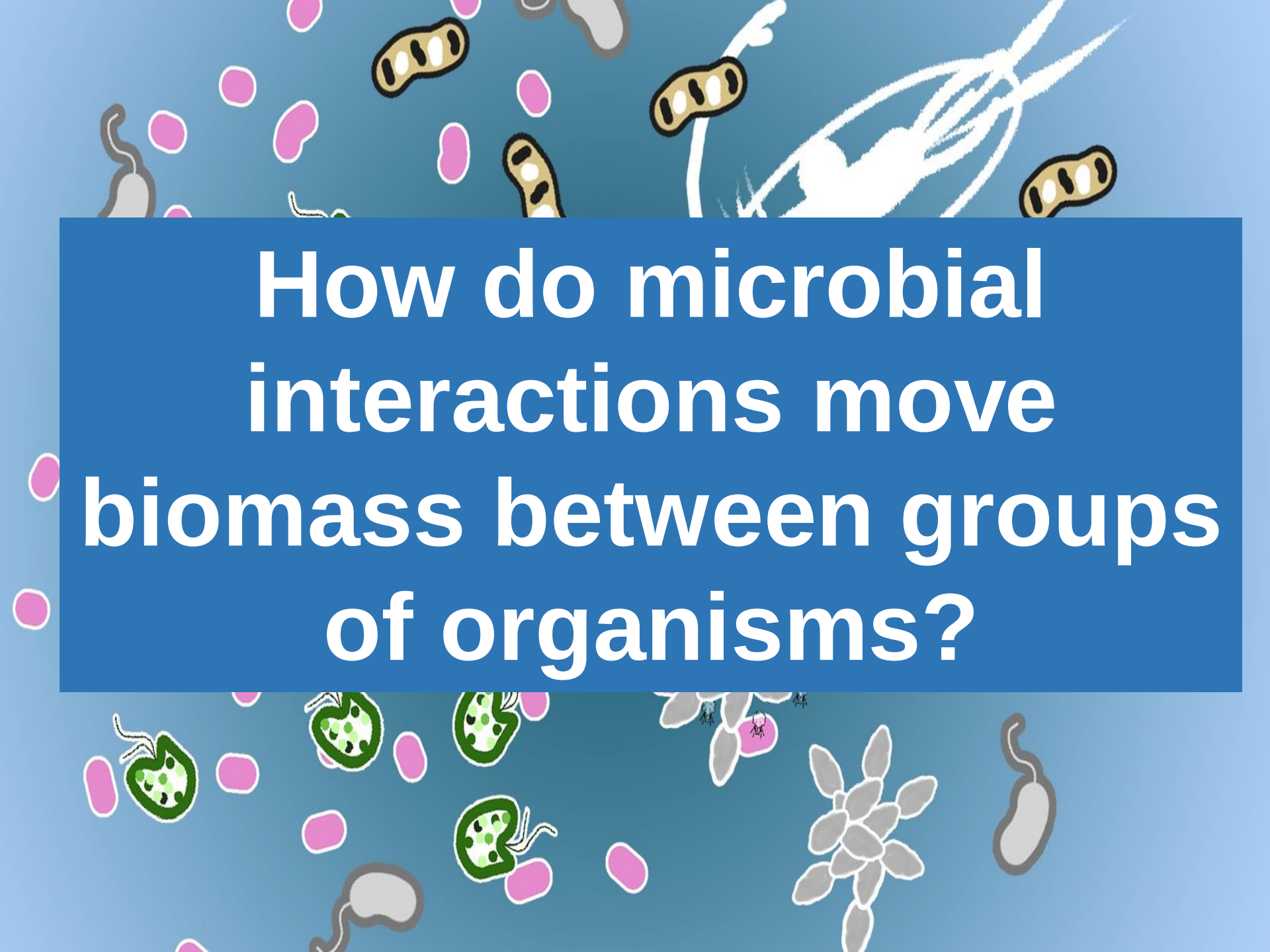
Microbial Ecology Model

Oligotrophic



The background of the slide is a light blue gradient. It is decorated with various stylized, cartoonish illustrations of marine microbes. These include pink oval shapes, yellow bean-shaped organisms with black internal details, green circular organisms with internal patterns, and greyish, more complex structures. Some organisms have long, thin appendages or flagella. The illustrations are scattered across the top and bottom edges of the slide, framing the central text box.

**How are the diverse
marine microbes
interacting in the
environment?**

The background of the slide is a light blue gradient. It is decorated with various stylized, hand-drawn illustrations of microorganisms. In the top half, there are several pink oval shapes, some yellow bean-shaped organisms with black internal details, and a white, branching, root-like structure. In the bottom half, there are green heart-shaped organisms with black dots inside, more pink ovals, grey bean-shaped organisms, and a cluster of grey, multi-lobed structures. The central text is white and set against a solid blue rectangular background.

**How do microbial
interactions move
biomass between groups
of organisms?**

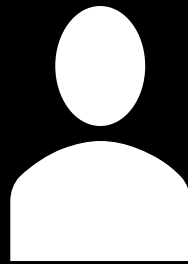
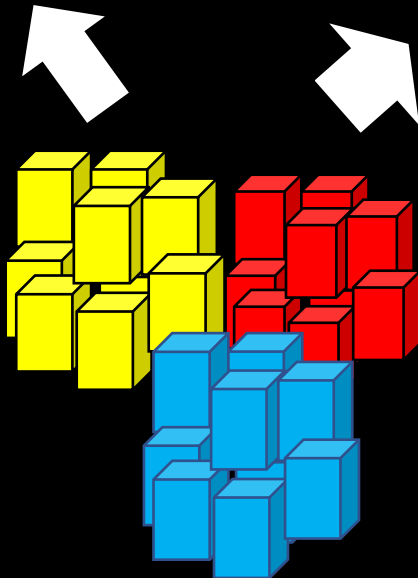
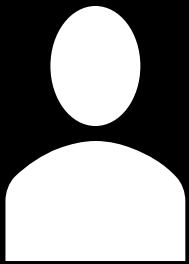
How to play:

Oligotrophic

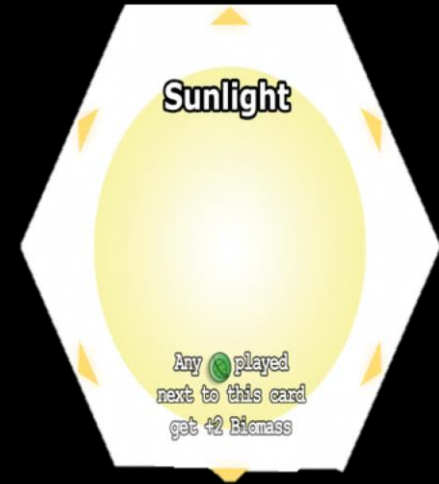


Set up

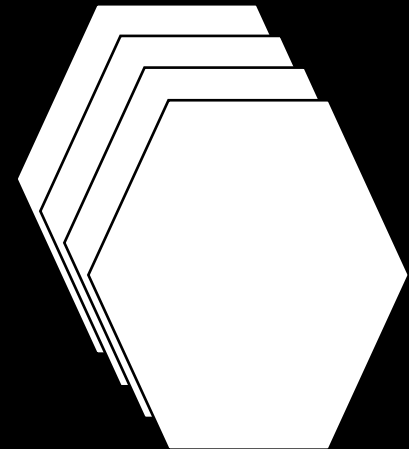
Give 20 cubes to
each player of a
single color



Pull out the sunlight

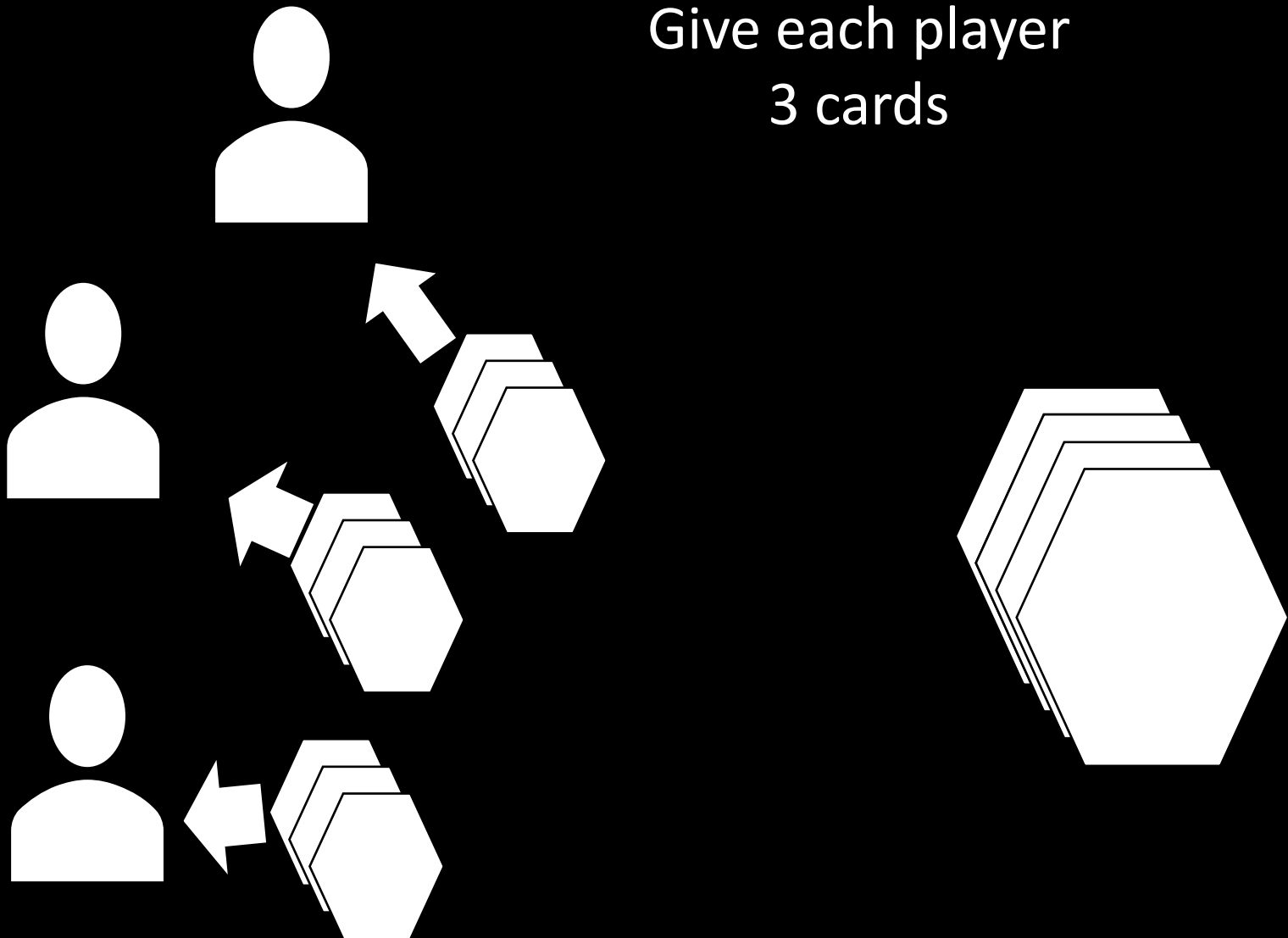


Shuffle all of the
other cards
together

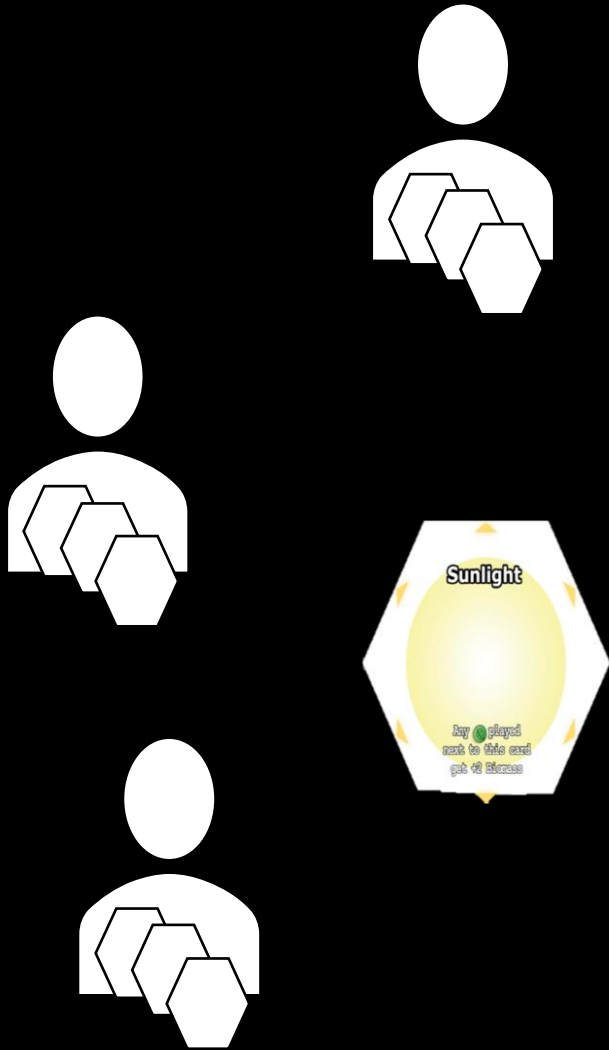


Set up

Give each player
3 cards



Set up



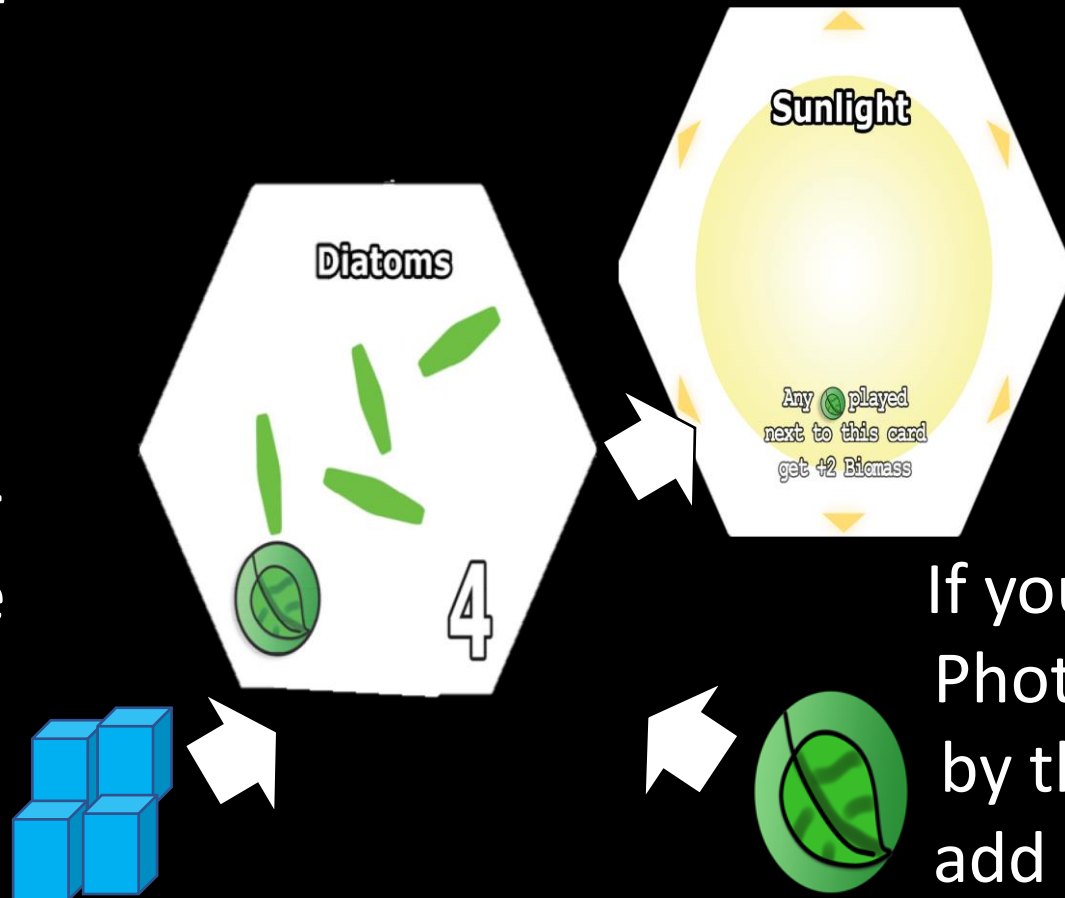
Put the sunlight card in the center of the play area



You are now ready to play!

How to play:

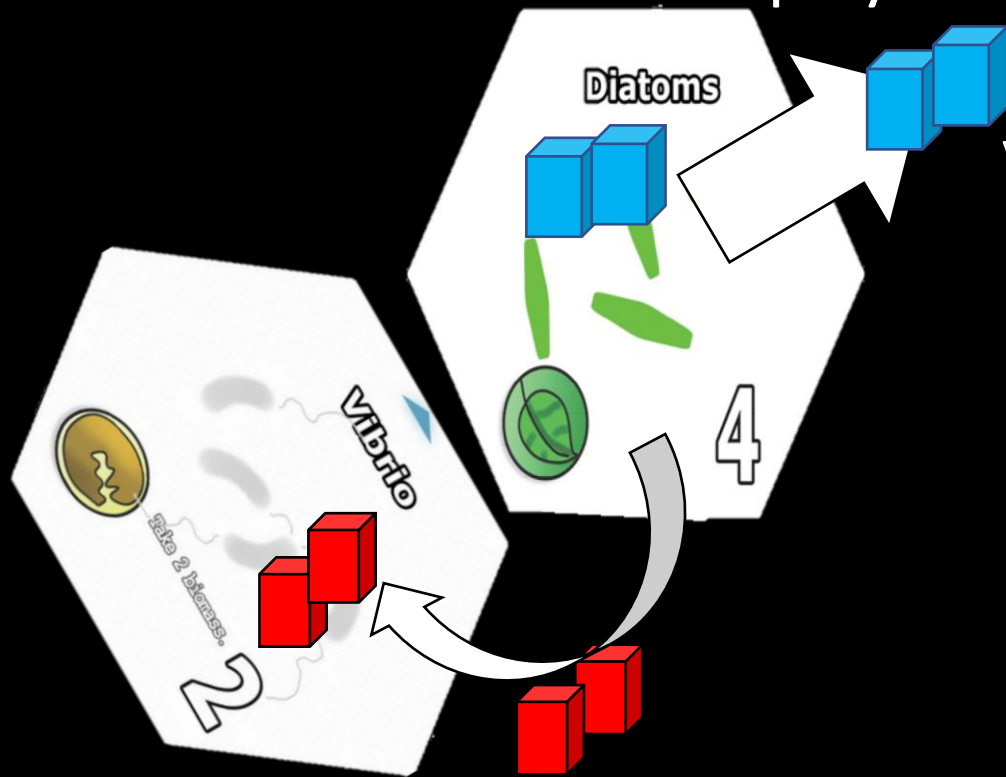
Each turn, play 1 card from your hand so it connects to at least one other card.
Put cubes of your color equal to the number on the card



If you play a Phototroph by the sun, add 2 more cubes



When you play a card:



Return to
player.

The arrow points to the
cards that it effects.

Take: Switch the cubes to
you color and move it to you
card.

(Remember some can only
take from certain others!)

Return: Give the cubes on
the indicated card back to
their player.

To win, start your
turn with 5 or less
biomass (cubes).

