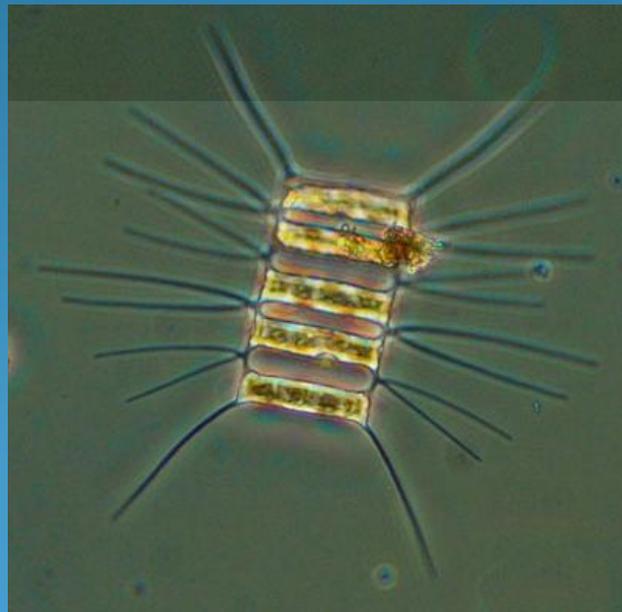


Phytoplankton Growth and Primary Production



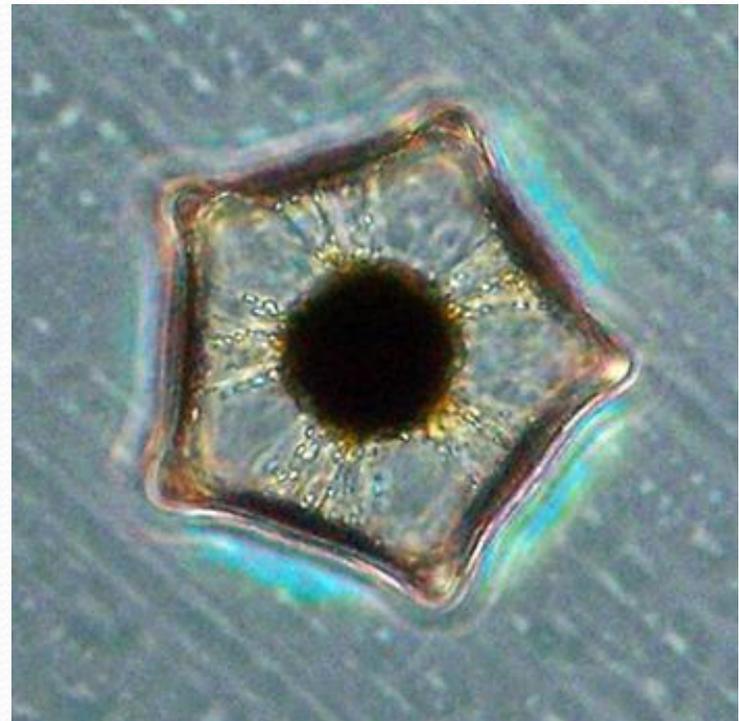
What are phytoplankton?

- Phytoplankton and small “plants” in the ocean
- Single celled, but can live in colonies or chains



Why should you care about phytoplankton?

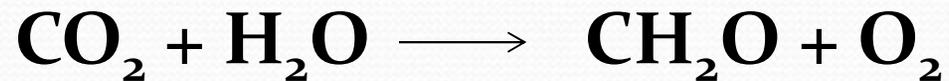
- If you've been in the ocean, you have swallowed **thousands** of phytoplankton.
- Much of the oxygen that keeps you alive was produced by phytoplankton
- They form the base of the food web in the ocean



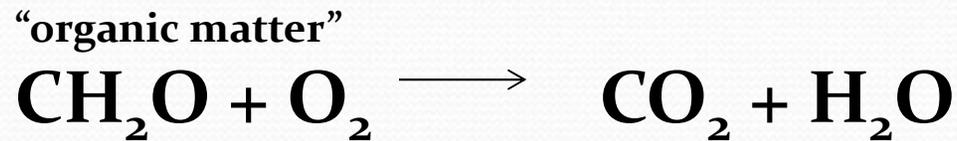
Phytoplankton in the ocean

- Just like plants, they **photosynthesize**

Photosynthesis:



Reverse of photosynthesis:

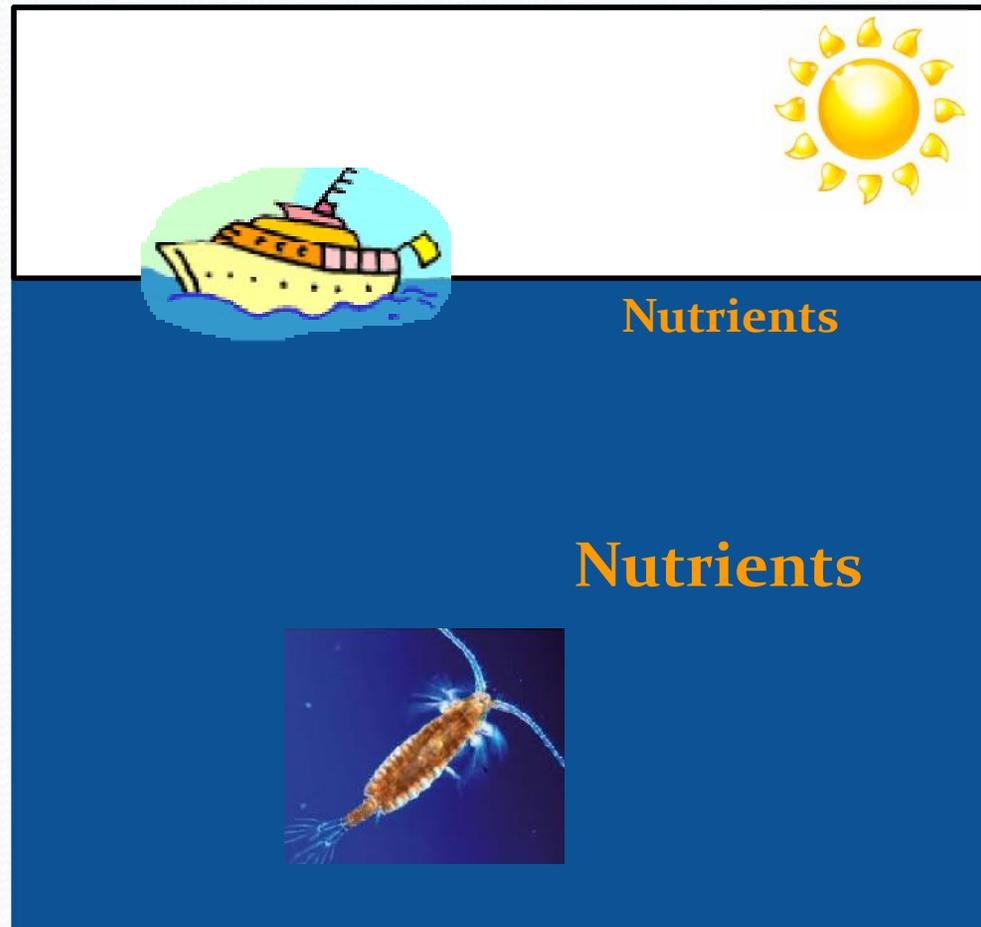




What do plants need to
grow?

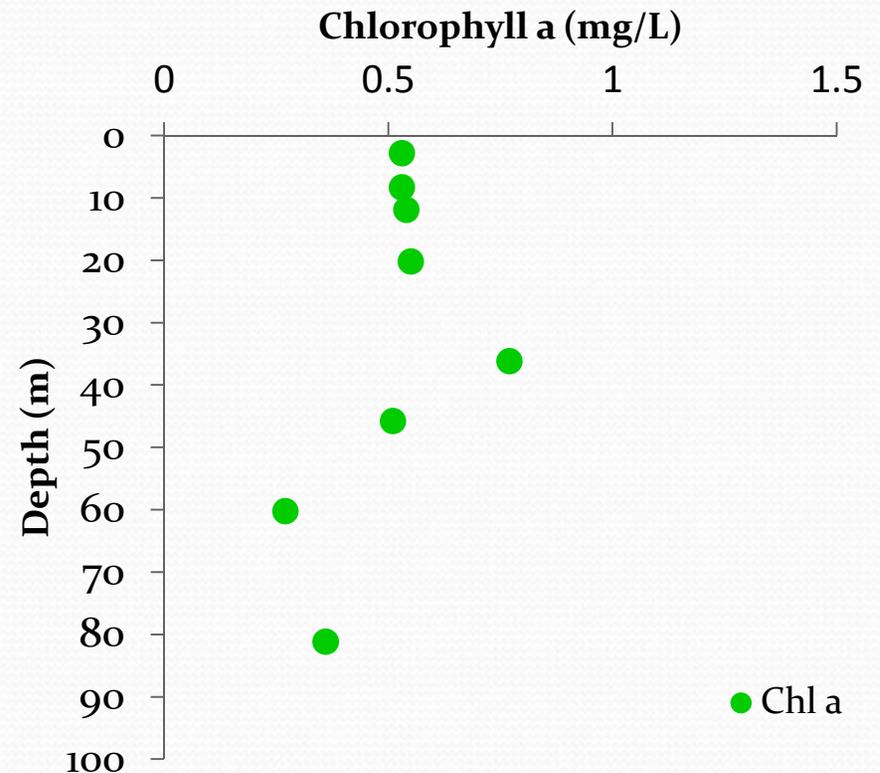
Primary Production in the ocean: a delicate balance

- Light
- Nutrients
- Absence of predators (grazers)



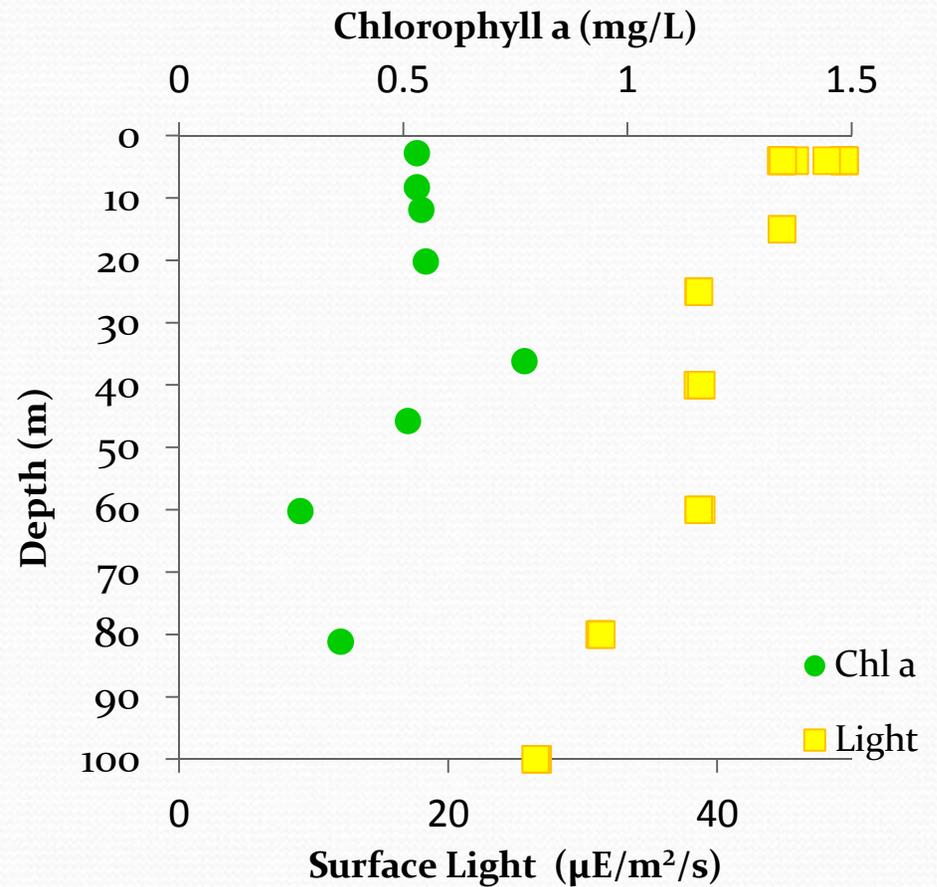
Primary Production in the ocean: a delicate balance

- Light
- Nutrients



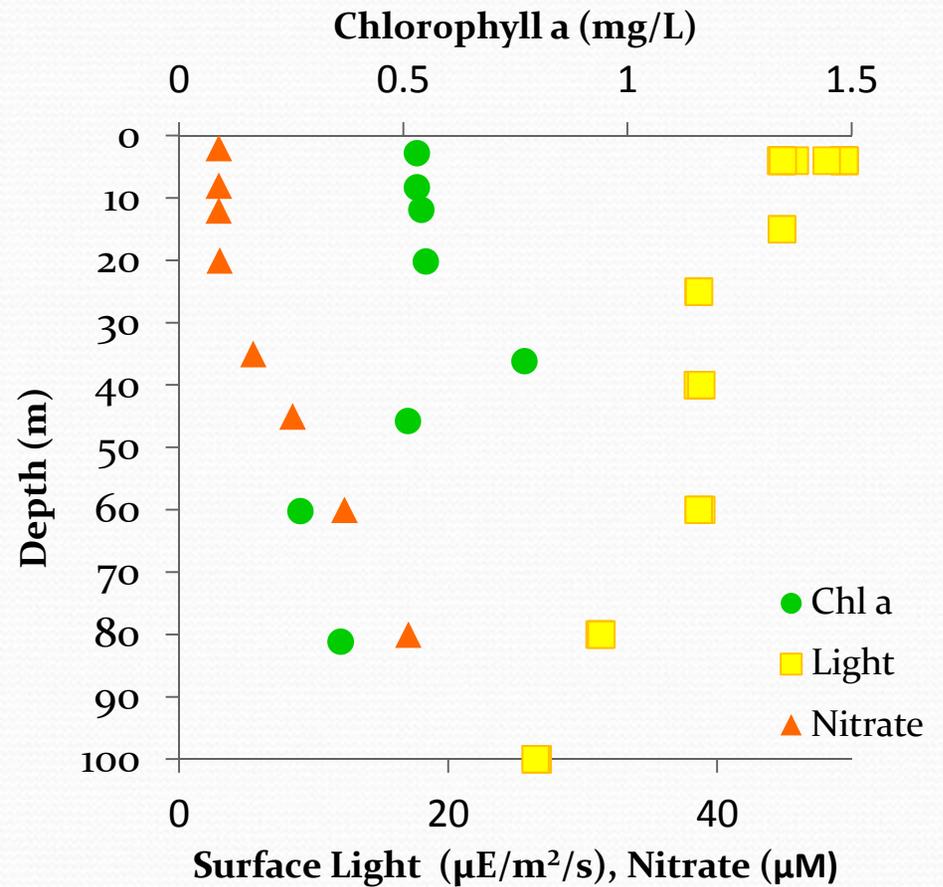
Primary Production in the ocean: a delicate balance

- Light
- Nutrients



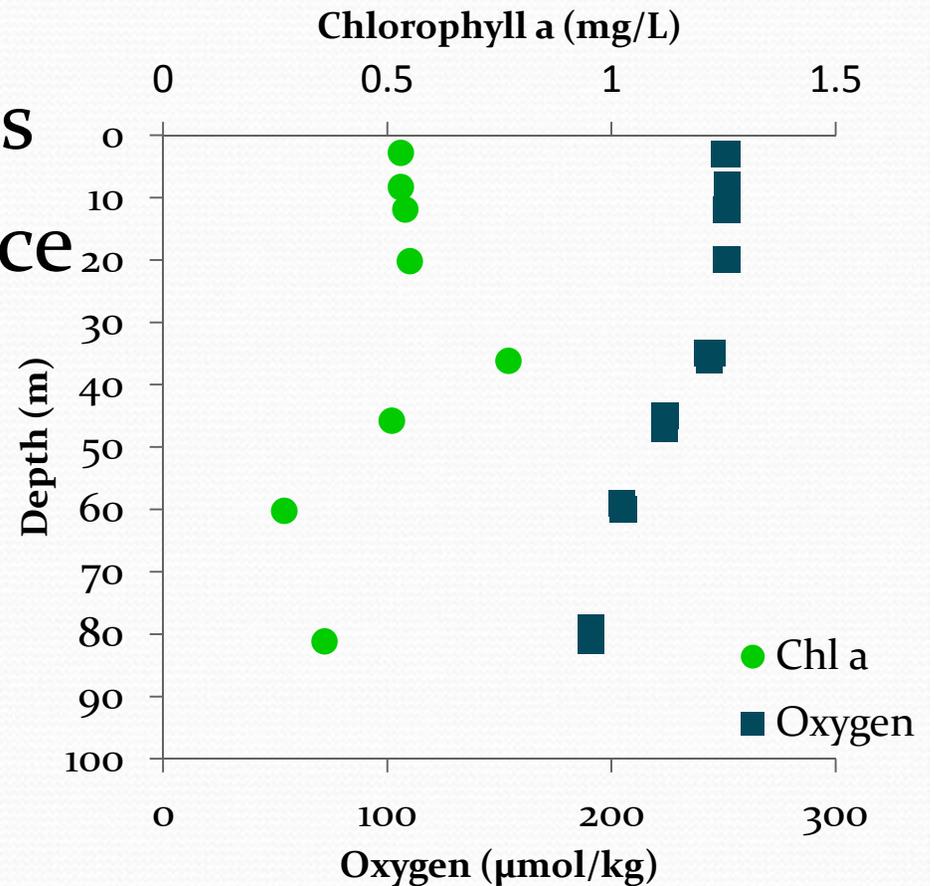
Primary Production in the ocean: a delicate balance

- Light
- Nutrients



Primary Production in the ocean: oxygen production

- Oxygen concentrations are higher in the surface waters where the phytoplankton live





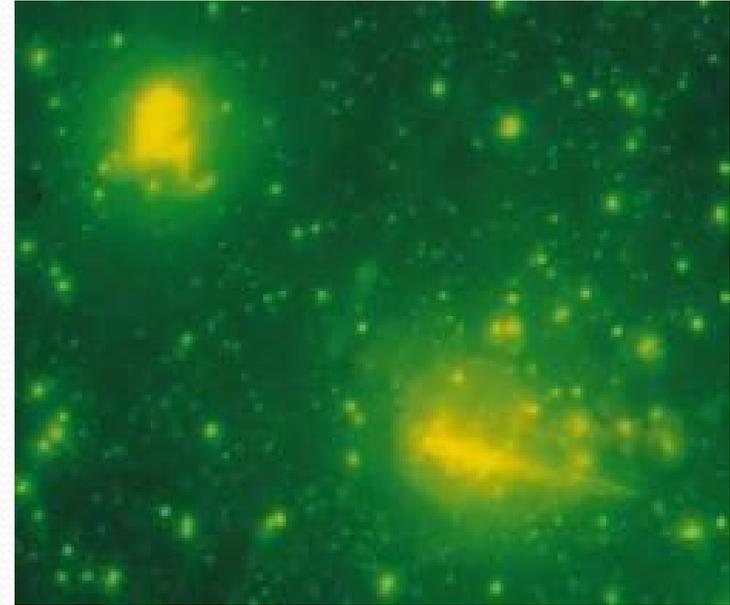
How do we measure
phytoplankton?

How do we measure something we can't see?

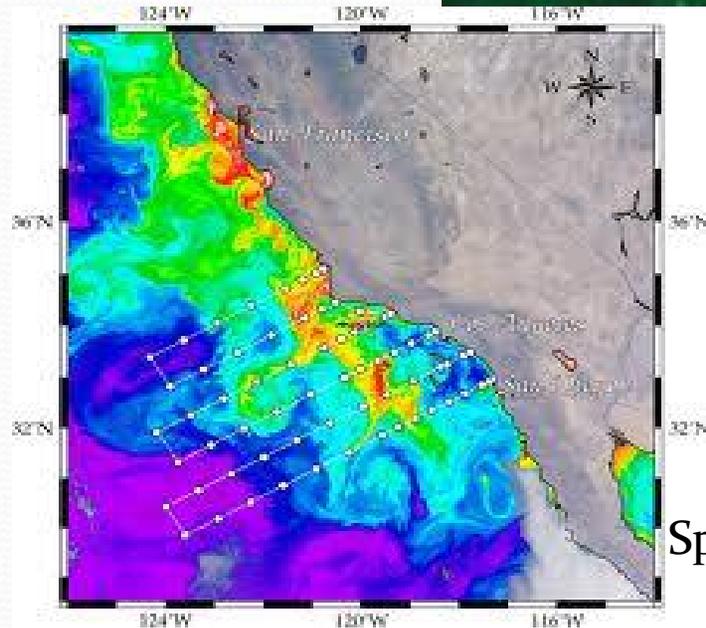
- Microscope
 - Counting the number of phytoplankton
- Fluorometry
 - Measures the “fluorescence” of the phytoplankton
- Spectrophotometry
 - Measures the amount of light that can pass through the phytoplankton



Microscope



Fluorometry



Spectrophotometry- satellites

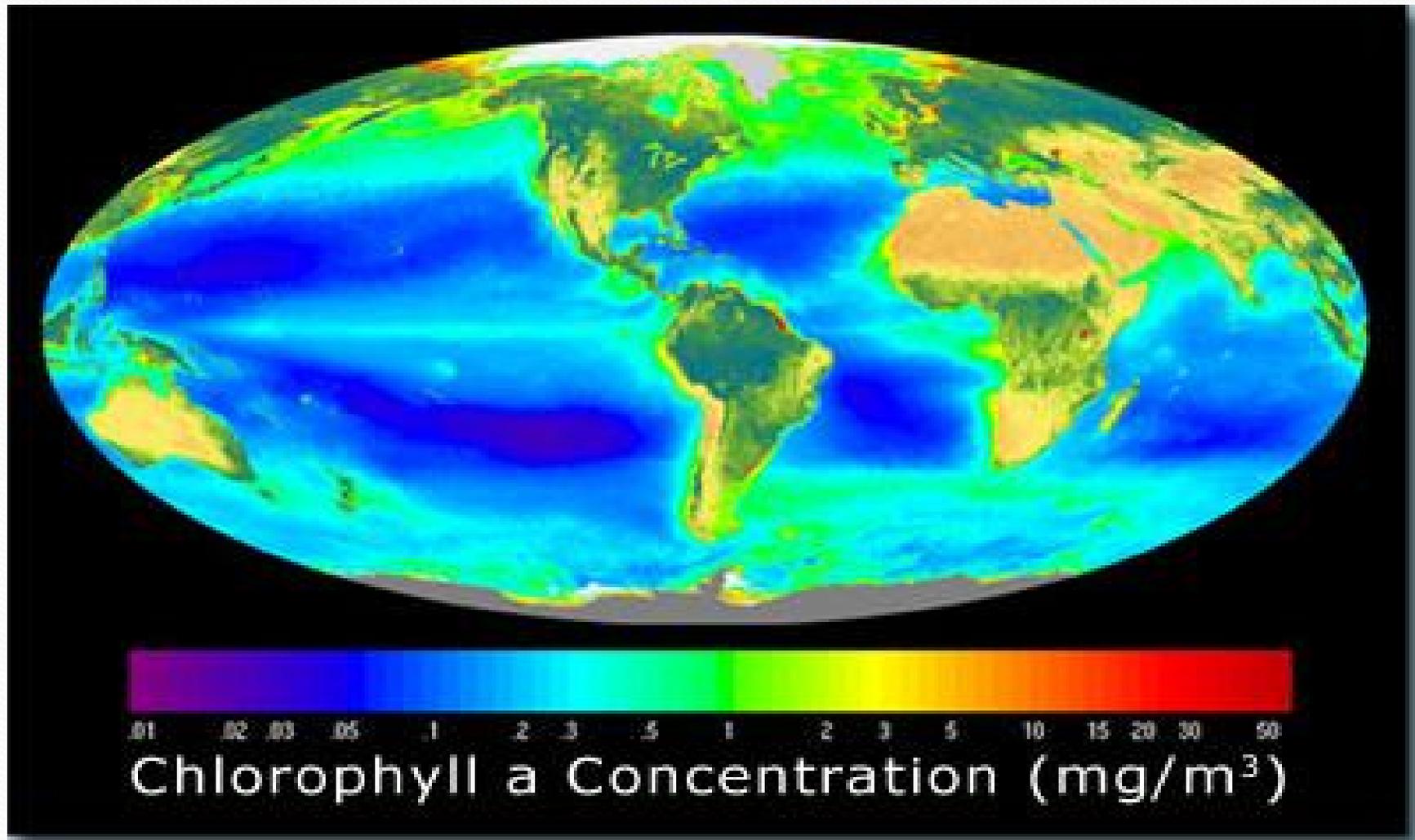


What gives phytoplankton a color?

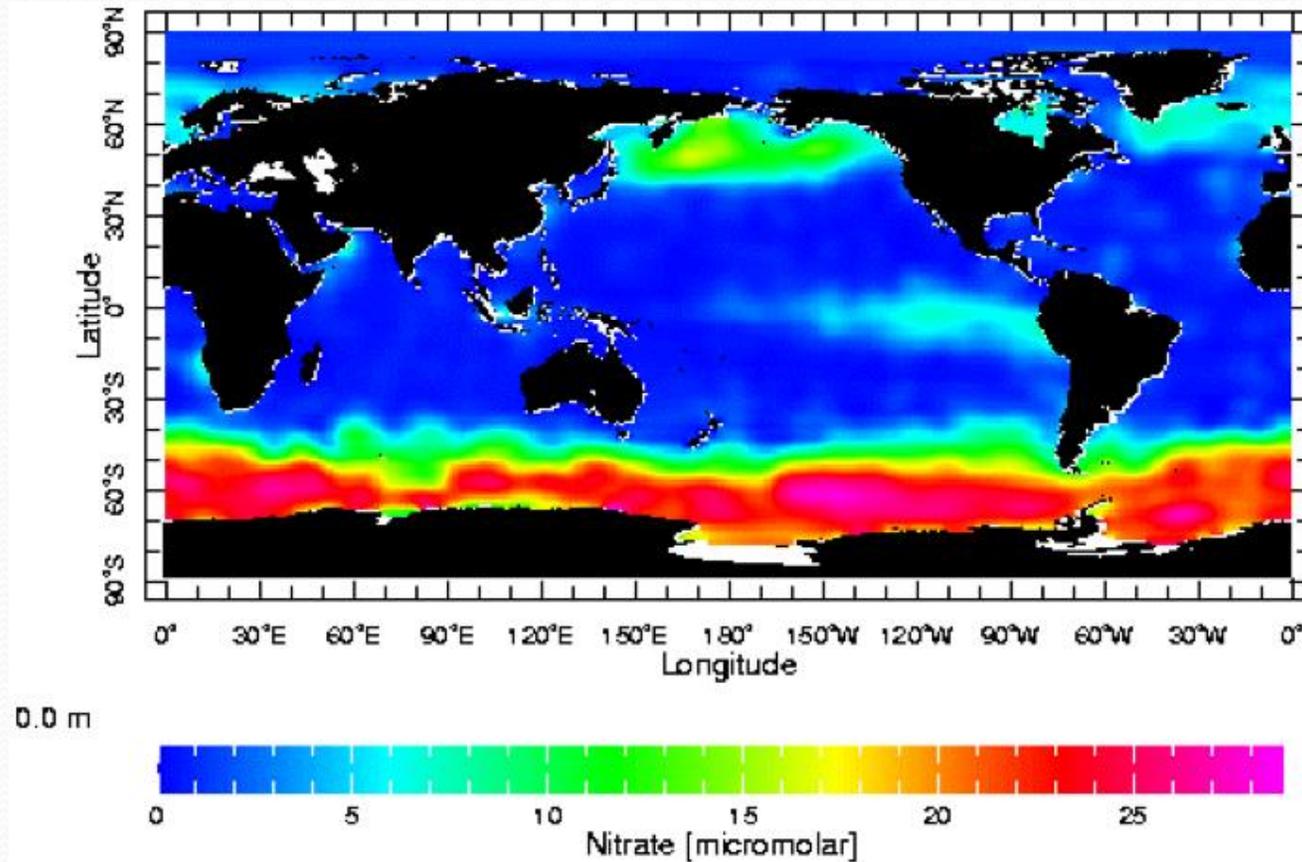
Chlorophyll *a*

- Chlorophyll *a* is a pigment that gives phytoplankton a green color
 - Land plants also have this pigment
- Necessary in photosynthesis
 - Reflects green light

Primary Production

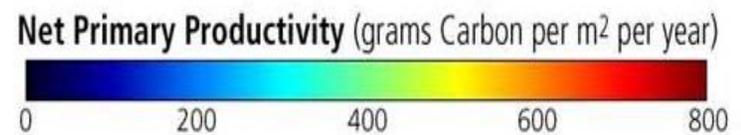
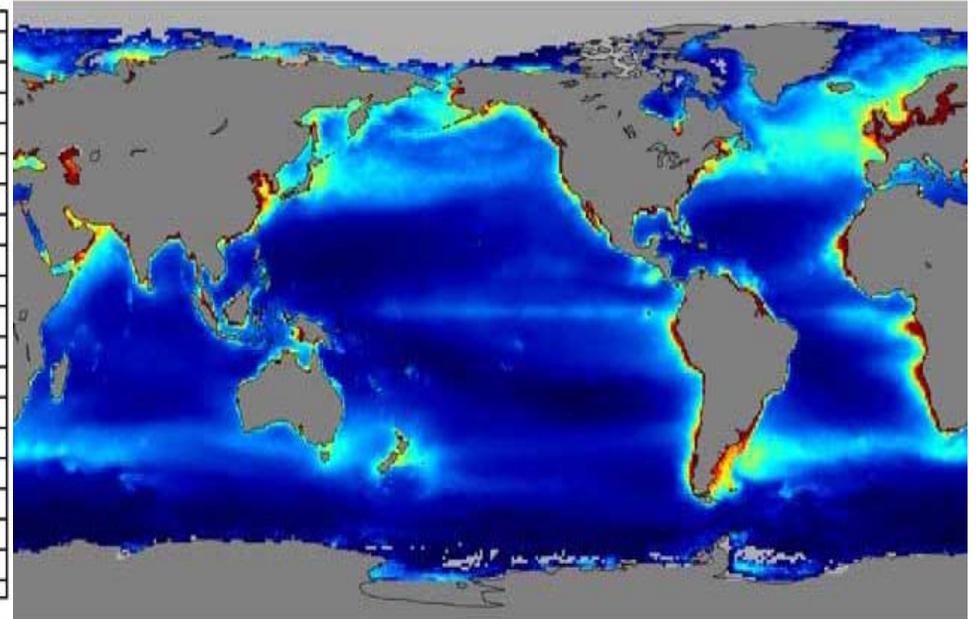
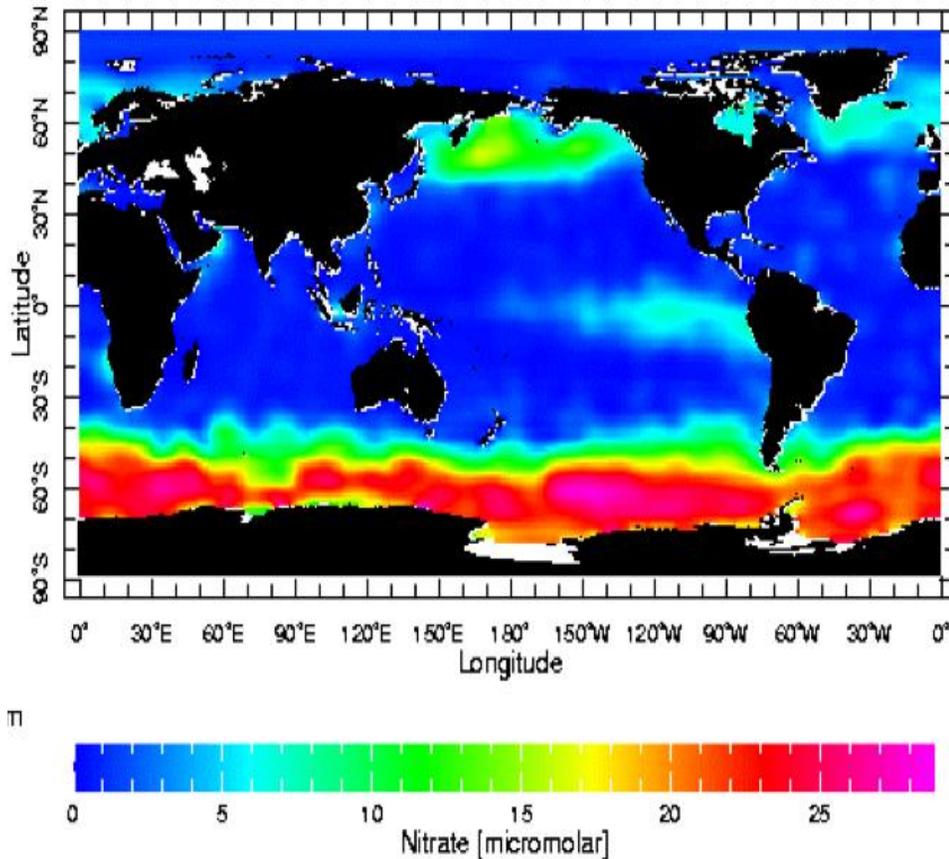


Phytoplankton need their nutrients too!



Data from the Levitus World Ocean Atlas 1994.

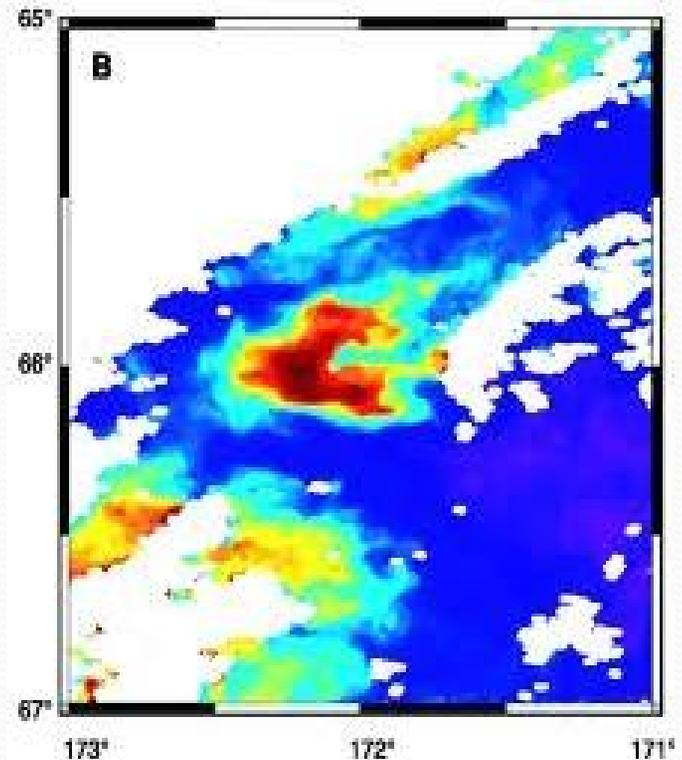
Phytoplankton and Nutrients



Data from the Levitus World Ocean Atlas 1994.

Special Nutrient: Iron (Fe)

- Phytoplankton don't often have enough Fe that they need in order to grow





Experiment: How would you test if
phytoplankton have what they
need to grow?

Conclusions

- Phytoplankton are living “plants” in the ocean
- Phytoplankton are the main photosynthesizers (produce oxygen)
- They can be measured by oceanographers in many different ways
- Phytoplankton grow the best when they have plenty of light and nutrients

50 μm

100 μm



Let's Grow Some Phytoplankton!

- **Lab Overview**

- Growing phytoplankton in different nutrient environments
 - Control- no extra nutrients added
 - + Nutrients- adding the major nutrients nitrate and phosphate
 - + Nutrients and Iron- adding the major nutrients nitrate and phosphate, and also the minor nutrient iron
- Monitor their growth over several days
 - Microscope Counts (“Counts”)
 - Spectrophotometer (“%Transmission”)

Let's Grow Some Phytoplankton!

Lab Set-Up

- First, draw your data table in your notebook

	Day				
	1	2	3	4	5
Phytoplankton Treatment	% T Counts				
Control					
+ Nutrients					
+ Nutrients and Iron					

- 
- Next, each lab pair go get one 250 mL glass flask.
 - Decide in your group which pair will have the **Control**, which will have the + **Nutrients**, and which will have the + **Nutrients and Iron**
 - In your pairs, label your flask with the appropriate treatment (**Control**, + **Nutrients**, +**Nutrients and Iron**)
 - Each pair should now fill their flask with 50 mL of seawater from the large container on the counter
 - Use a graduated cylinder

Calculate How Much of Each Nutrient We Need to Add!

- **Initial Concentrations** of stock solutions (M_i)
 - Nitrate- 0.008 M
 - Phosphate- 0.004 M
 - Iron- 0.00025 M
- **Final Concentrations** (M_f) in 50 mL of seawater (0.050L, V_f)
 - Nitrate- 48 μ M (10^{-6} M)
 - Phosphate- 24 μ M
 - Iron- 1.5 μ M

$$M_i V_i = M_f V_f$$

- 
- Now we will add the necessary nutrients to each flask (if needed)
 - If your pair has the flask labeled “**Control**” no other steps are necessary
 - If you have the flask labeled “+ **Nutrients**” you need to add 300 μl of the Nitrate and Phosphate solutions
 - If you have the flask labeled “+ **Nutrients and Iron**” you need to add 300 μl of the Nitrate and Phosphate and Iron solutions