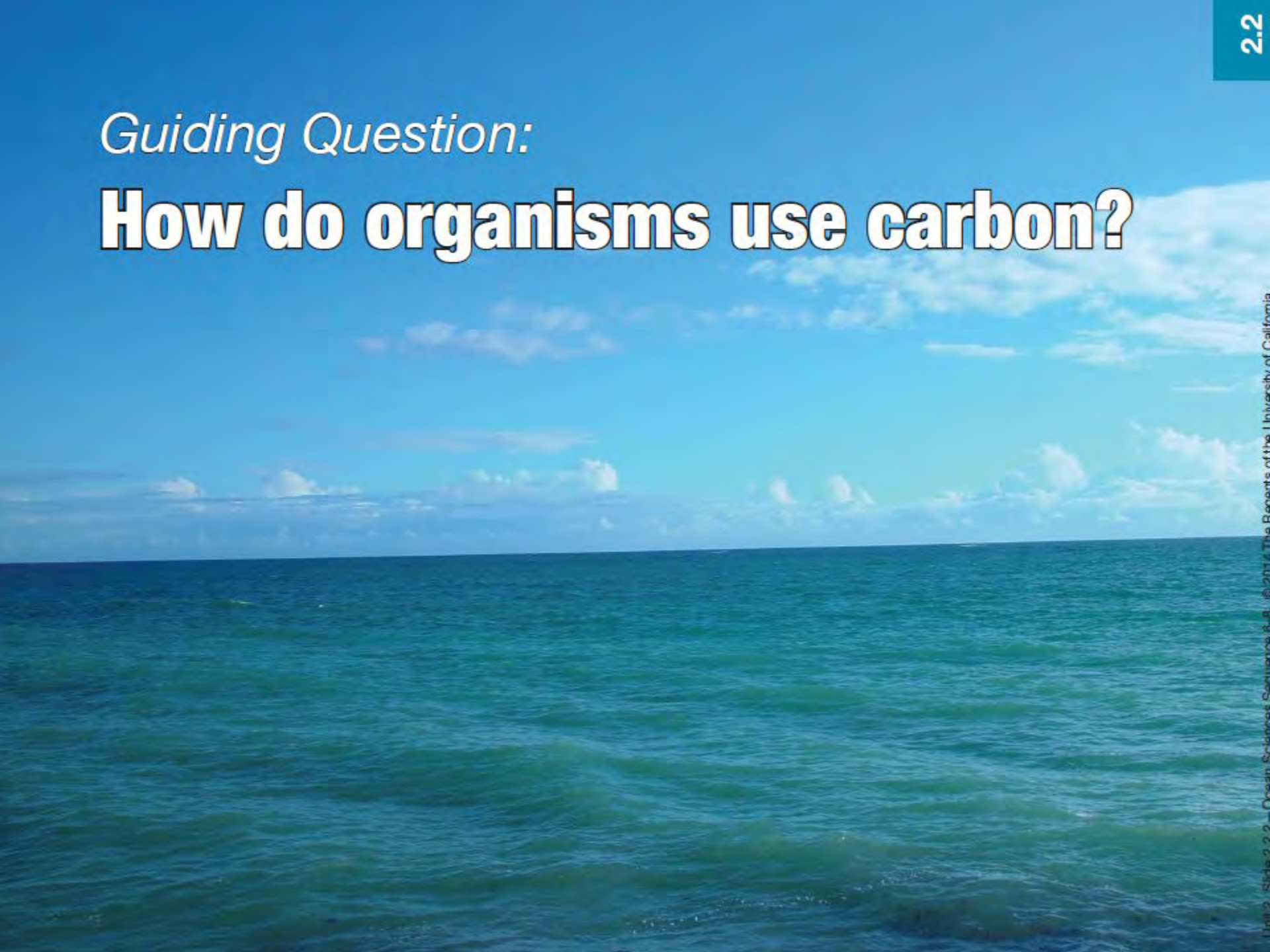
Session 2.2

Tracking Carbon…
through Respiration

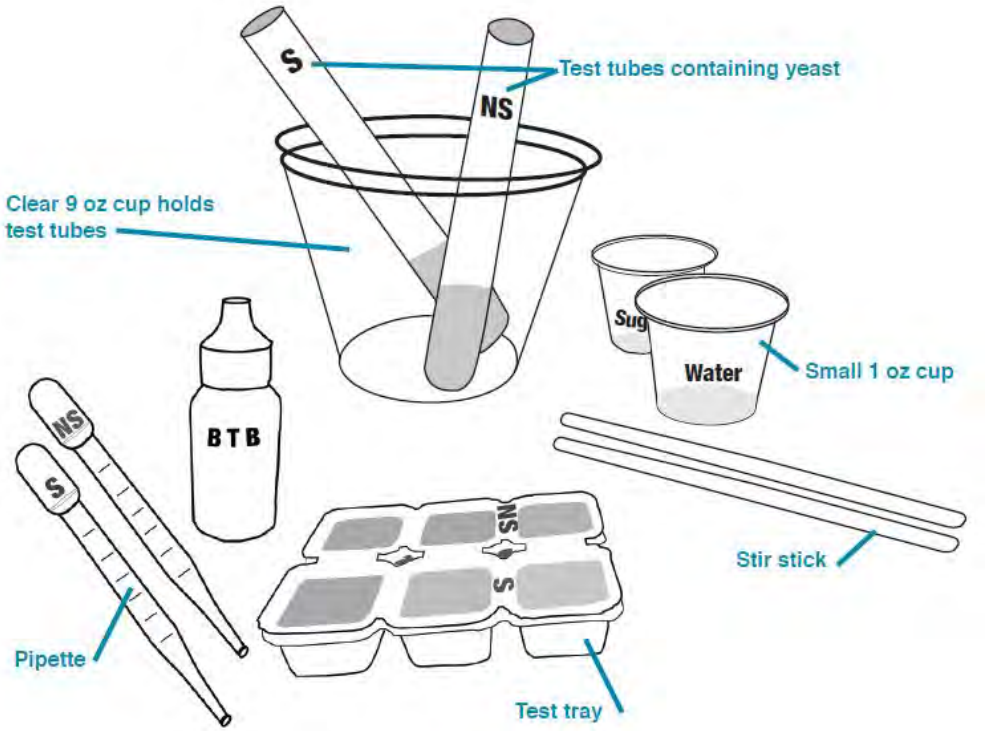
Guiding Question:

How do organisms use carbon?



What does eating have to do with producing carbon dioxide?

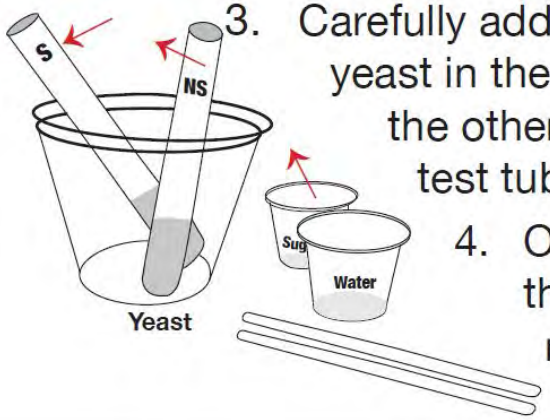
Yeast and pH Investigation



Yeast Investigation, Part 1

2.2

1. Get a tray that holds materials for two pairs. Share the materials.
2. Carefully add the sugar water to the yeast in the "S" test tube. Stir with one stir stick, and place the test tube back into the cup.
3. Carefully add the plain water to the yeast in the "NS" test tube. Stir with the other stir stick, and place the test tube back into the cup.
4. Observe the test tubes for the next 10 minutes and record your observations.



Investigation, Part 2

2.2

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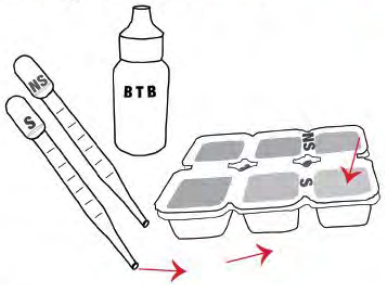
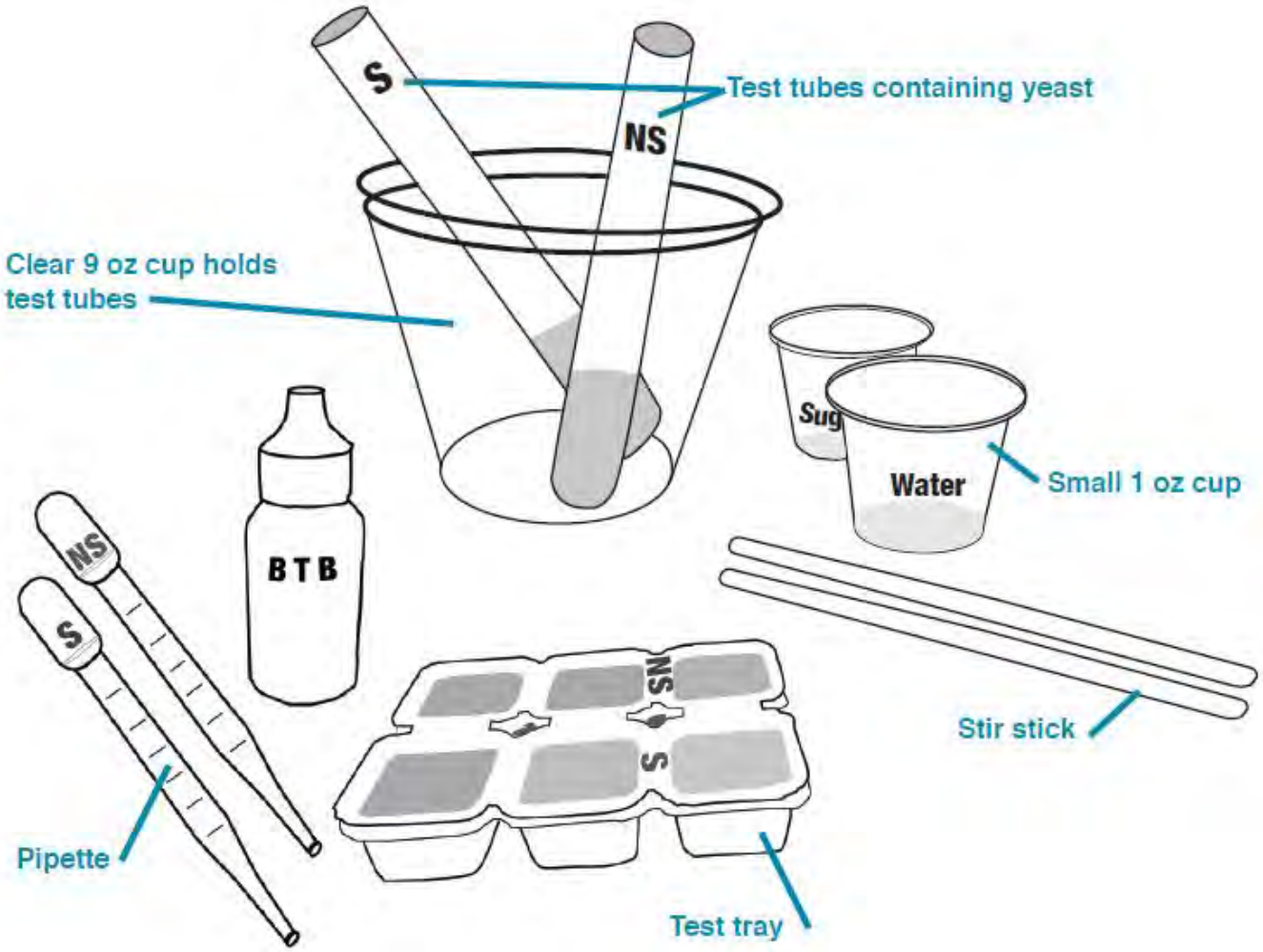
sugar and three



2. Fill the "S" pipette from the "S" test tube. Deposit the sugar–yeast mixture into one of the cups on the "S" side of the test tray. Repeat twice to put yeast into the other two "S" cups.
3. Fill the "NS" pipette from the "NS" test tube. Deposit the yeast mixture into one of the cups on the "NS" side of the test tray. Repeat twice.
4. Squeeze 8 drops of BTB into each test-tray cup.
5. Observe any color changes; match to color key.

A few things before starting the investigation...

- What is BTB?
  - Bromothymol blue
  - a chemical that turns green or yellow when it's mixed with an acid.
  - In water, CO_2 makes an acid called carbonic acid, so if the BTB turns color, that is evidence there may be CO_2 present.
- Why do we need to use a **proxy**?
  - a proxy is a measured parameter used to estimate or predict another parameter that cannot be measured or quantified directly
  - We can't accurately measure the *amount* of CO_2 in the water, but BTB can be used as a proxy to indicate the presence or absence of CO_2.



Yeast Investigation

Part 1:

1. Get a tray that holds materials for two pairs. Share the materials.
2. Carefully add the sugar water to the yeast in the "S" test tube. Stir with one stir stick, and place the test tube back into the cup.
3. Carefully add the plain water to the yeast in the "NS" test tube. Stir with the other stir stick, and place the test tube back into the cup.
4. Observe the test tubes for the next 10 minutes and record your observations.

A. Describe how each test tube looks at the beginning.

B. What is the first change you notice?

C. What is the next change? Draw what you see.

D. Describe what you notice when the 10 minutes is almost up.

Yeast Investigation (continued)

Part 2:

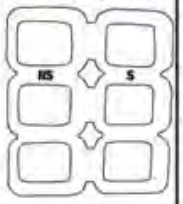
1. Notice that the test tray has three cups for sugar and three for no sugar.
2. Fill the "S" pipette from the "S" test tube. Deposit the sugar-yeast mixture into *one* of the cups on the "S" side of the test tray. Repeat twice to put yeast into the other two "S" cups.
3. Fill the "NS" pipette from the "NS" test tube. Deposit the yeast mixture into one of the cups on the "NS" side of the test tray. Repeat twice.
4. Squeeze 4 drops of BTB into each test-tray cup.
5. Observe any color changes; match to color key.

Color Key: Testing for Carbon Dioxide with BTB:

Blue =	Green =	Yellow =
no carbon dioxide	some carbon dioxide	lots of carbon dioxide

Describe your results:

Draw and label your results.



What evidence did you gather to help answer the question, What does eating have to do with producing CO_2?

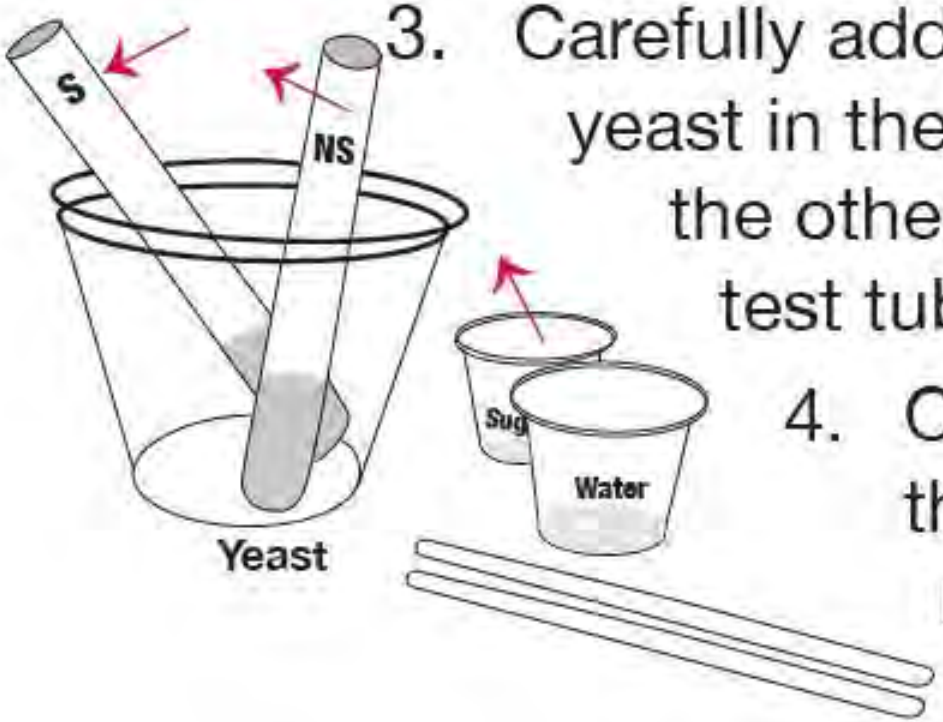
A few more things before starting the investigation

- What about a control?
  - How does BTB react in *water without yeast*? (control)
  - Comparing the difference in BTB reactions (color) between the treatment and controls shows the effect of increasing the amount of carbonic acid in the water, due to CO_2 being released by the yeast

- What are the independent and dependent variables?
  - The variables are: Yeast and the amount of CO_2 in the water
  - The independent variable is the yeast and the dependent variable is the amount of CO_2 in the water. Why?

Yeast Investigation, Part 1

1. Get a tray that holds materials for two pairs. Share the materials.
2. Carefully add the sugar water to the yeast in the "S" test tube. Stir with one stir stick, and place the test tube back into the cup.
3. Carefully add the plain water to the yeast in the "NS" test tube. Stir with the other stir stick, and place the test tube back into the cup.
4. Observe the test tubes for the next 10 minutes and record your observations.



Yeast Investigation, Part 2

1. Notice that the test tray has three cups for sugar and three for no sugar.
2. Fill the "S" pipette from the "S" test tube. Deposit the sugar–yeast mixture into one of the cups on the "S" side of the test tray. Repeat twice to put yeast into the other two "S" cups.
3. Fill the "NS" pipette from the "NS" test tube. Deposit the yeast mixture into one of the cups on the "NS" side of the test tray. Repeat twice.
4. Squeeze 8 drops of BTB into each test-tray cup.
5. Observe any color changes; match to color key.

Making sense of yeast investigations

- Sharing observations
- What is your evidence that the tube with sugar was producing CO_2?
- Did you find similar results each time you tested the yeast?
- Where do you think the CO_2 came from? What is your evidence?

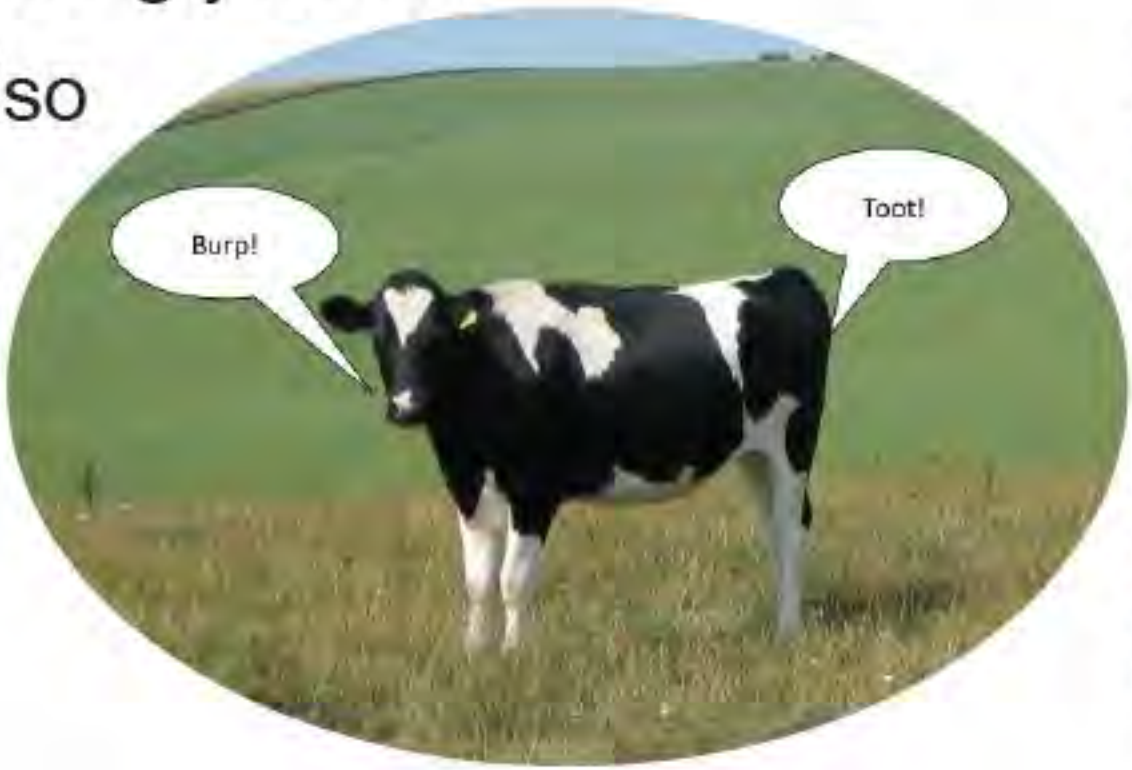
What does eating have to do with producing (breathing out) CO_2?

Respiration: the whole process of organisms breaking down carbon containing molecules, such as sugar, for energy and for building bodies, and releasing some of the carbon as CO_2 by breathing it out into the atmosphere.

Carbon In/Carbon Out for **Respiration**

Releasing Carbon Dioxide and Methane Gas

- The carbon in the carbon dioxide gas you are breathing out comes from solid carbon, which is found in everything you eat.
- Some animals also release carbon as methane gas (CH_4). Some release a lot more CH_4 than others.



Key Concept

2.2

Most organisms get energy and materials to build their bodies from molecules that contain carbon. They break down these molecules and release carbon dioxide gas. This is respiration.

Session 2.3

Tracking Carbon through Photosynthesis, Part 1

BTB Changes

water + BTB

water + BTB + CO_2

water + BTB + CO_2 + plant + sunlight

1. *Why do you think the BTB changed back to blue after the plant and sunlight were added?*
2. *What have you heard about photosynthesis?*

Plants and other photosynthetic organisms take in CO_2 and give off O_2 during photosynthesis.

Where does most of the matter in plants come from?

Three Common Answers

Most of the matter in plants comes from

- ⊗ a. the soil.
- ⊗ b. the water.
- ⊗ c. the air.

Where does most of the mass (new plant material) of a new plant come from?

Carlos

Its mass comes from the soil.

Its mass comes from the air.

Michael

Its mass comes from the water it takes in through the roots.

Susie

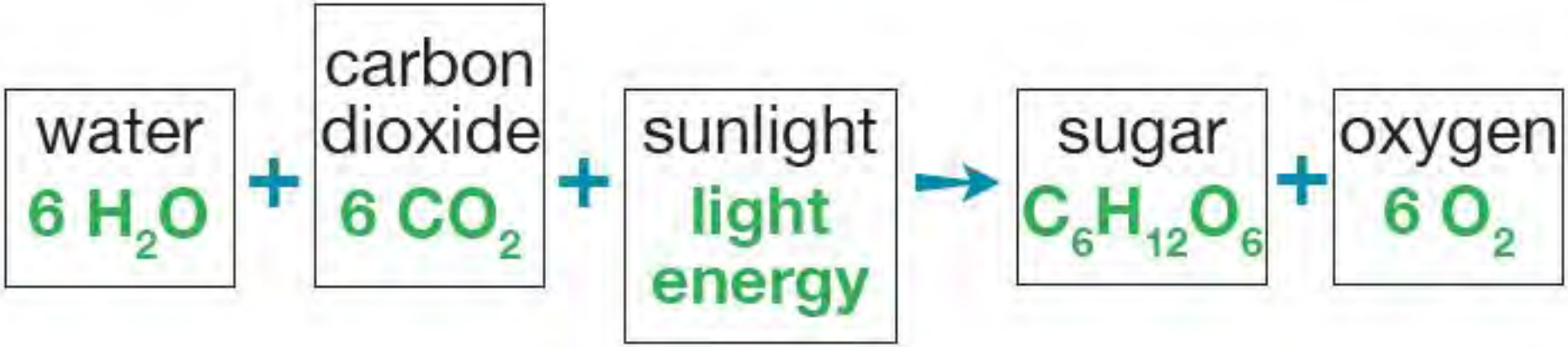
Its mass comes from the sunlight.

Keshawn

Questions to discuss:

1) What would you say to each of these kids about their solution to the problem?
2) Do you agree with any of the kids? If so, who? Why?
3) What question would you ask each student about their answer? Why?

Carbon In/Carbon Out for **Photosynthesis**



Gathering more evidence

•Use the active reading strategy as you read *Researching Photosynthesis*.

•After reading, pair up with someone and discuss your questions and the following two prompts focusing in on the equation for photosynthesis as shown in the reading.

•

–Where could the oxygen (O) in the sugar have come from?

–Where could the carbon (C) in the sugar could have come from?

–Is there enough evidence to support one of the answers (water or air) over another? If yes, explain. If no, what more information would you need in order to have enough evidence to support one of the answers?

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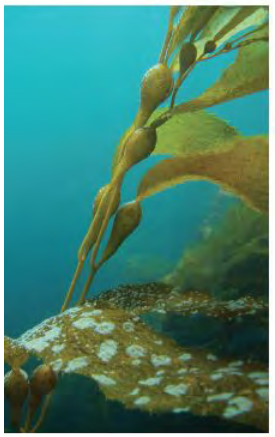
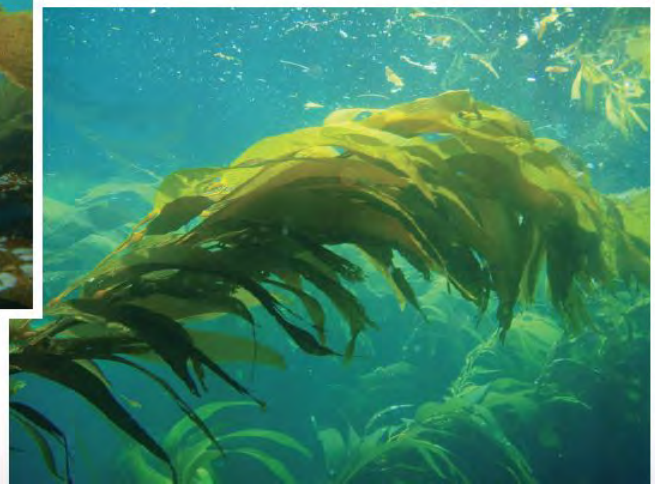
Gathering even more evidence

- Sit with a partner to read and discuss:
  - "*Following the Water in Photosynthesis*"
  -
- What new evidence did you gather?

Photosynthetic Ocean Organisms

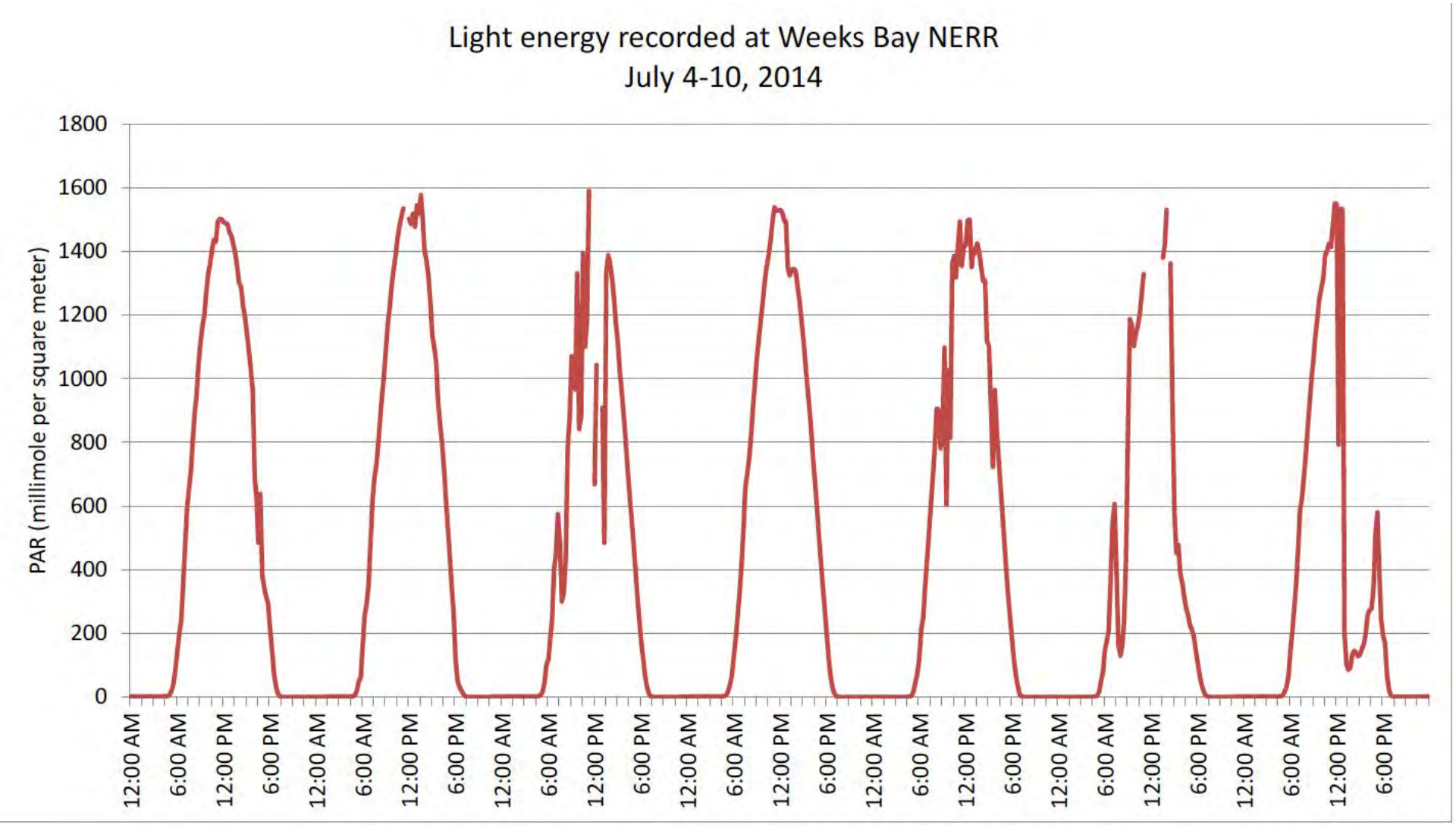


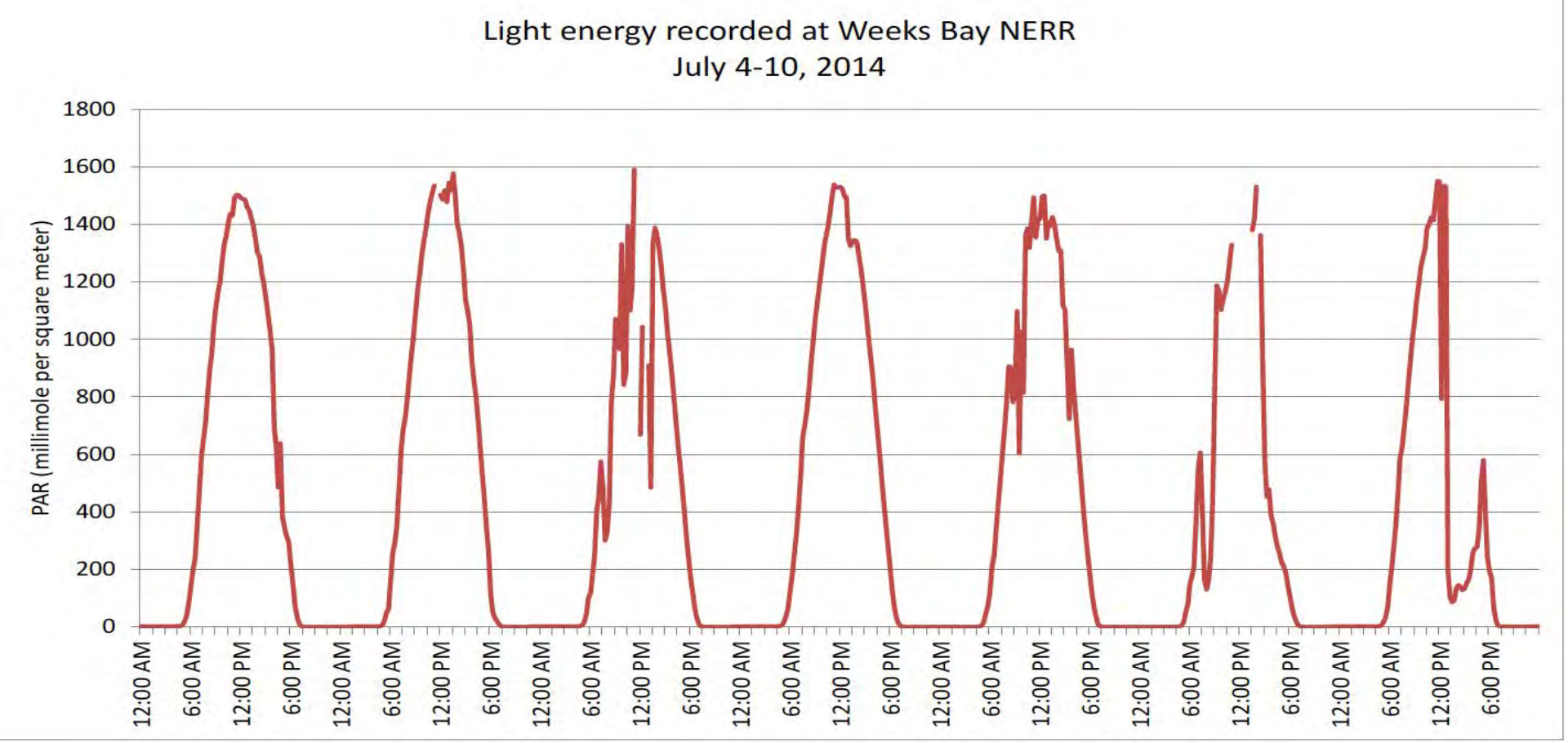


Opposite Processes

Respiration (digestion, growing, moving):

Photosynthesis:


Light energy recorded at Weeks Bay NERR
July 4-10, 2014
PAR (millimole per square meter)
1800
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
6:00 AM
12:00 PM
6:00 PM



1.How many days do these data cover?

2.What time of day do you see the highest light intensity? The lowest?

3.How do you think the weather might have been different on Day 1 vs day 3? What is your evidence for this?

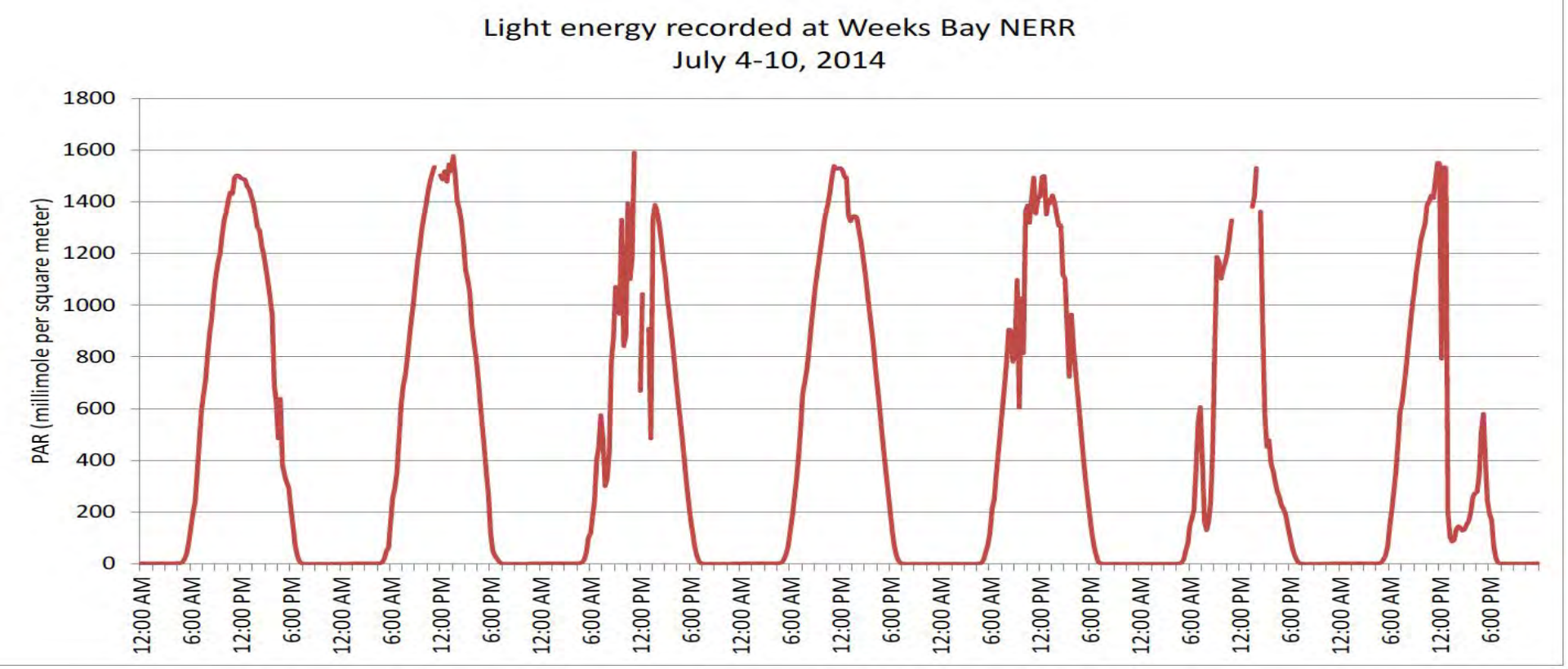
4.What do you notice about the data for Day 6? What do you think happened?

How much photosynthesis & respiration is taking place?

- Difficult to measure the cellular processes of respiration and photosynthesis directly – especially in the field
- Changes in the concentration of oxygen is often used as a proxy for photosynthesis and respiration.
  - Proxy - “A measured parameter used to estimate or predict another parameter that cannot be measured or quantified directly.”

To keep in mind as you make predictions about respiration and photosynthesis

- when the rate of photosynthesis is greater than the rate of respiration, the dissolved oxygen concentration in the water will increase;
- in the absence of light, the rate of respiration will exceed the rate of photosynthesis and dissolved oxygen concentrations will decrease.



1. Thinking about the relationship between light energy, photosynthesis & phytoplankton in the water, what do you predict would happen to dissolved oxygen concentrations as light intensity increases?

2. Assuming plankton respiration is relatively constant throughout a 24 hour period, what would you predict would happen to dissolved oxygen concentrations at night in the water column?

3. What do you predict will happen to CO_2 concentrations between high light (day) and low light (night) periods?

Group discussion

- Given the changes in CO_2 you predicted between high light (day) and low light (night) periods, how would you expect atmospheric CO_2 concentrations to vary throughout the year? What makes you think that?
- If only natural processes were involved, what season would you expect to find the highest concentrations of CO_2 in the atmosphere? What is your evidence for that?
- What season would you find the lowest concentrations of CO_2 in the atmosphere? Why?