

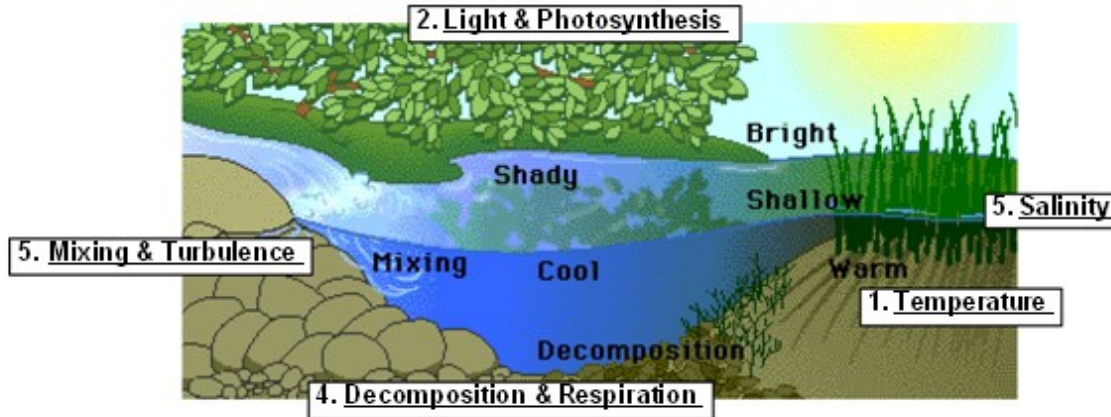
**DISSOLVED OXYGEN & AQUATIC PRIMARY PRODUCTIVITY (LabBench)**

Web address: [http://www.phschool.com/science/biology\\_place/labbench](http://www.phschool.com/science/biology_place/labbench)

Click on **Lab 12: Dissolved Oxygen & Aquatic Primary Productivity**

**A. KEY CONCEPTS:**

1. **Dissolved Oxygen Availability** in ponds and lakes. Using the following diagram, describe the effect that each of the factors has on availability of oxygen and explain why.



a. Temperature: \_\_\_\_\_

b. Light & Photosynthesis: \_\_\_\_\_

c. Decomposition & Respiration: \_\_\_\_\_

d. Mixing & Turbulence \_\_\_\_\_

e. Salinity \_\_\_\_\_

2. **Productivity:** Define each of these terms in **your own words.**

a. Primary productivity: \_\_\_\_\_

b. Gross productivity: \_\_\_\_\_

c. Net productivity: \_\_\_\_\_

3. Why do we use dissolved oxygen as a measure of productivity? Does productivity include more than oxygen?

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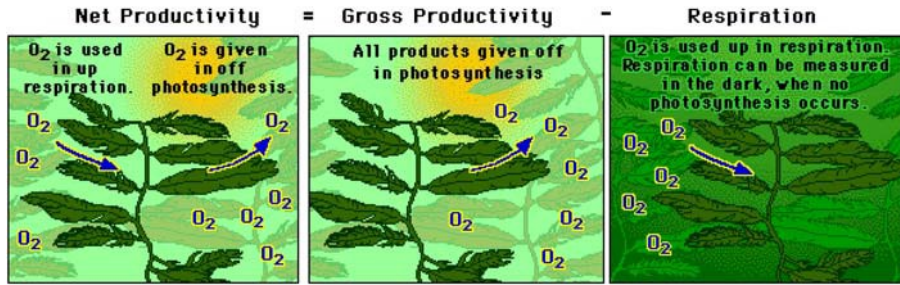
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4. Using the diagrams below explain:



- a. How does putting a sample of pond water and algae/freshwater plants in the light enable us to measure **gross primary productivity**? \_\_\_\_\_
- b. How does putting a sample of pond water and algae/freshwater plants in the dark enable us to measure **respiration**? \_\_\_\_\_
- c. How does subtracting the two enable us to indirectly measure **net primary productivity**? \_\_\_\_\_

5. What are the three ways that primary productivity can be measured? Highlight the way will be used in this lab?.
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_

**B. LAB PART 1: EFFECT OF TEMPERATURE ON DISSOLVED OXYGEN**

We are investigating the effect of the physical factor of temperature on the percent dissolved oxygen in a body of water.

6. What is the relationship between water temperature and dissolved oxygen?  
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7. Explain **why** this relationship exists.  
 \_\_\_\_\_  
 \_\_\_\_\_
8. So, now explain why the fish in the aquarium (on the LabBench Web site) above the radiator died? **What happens to an aquatic ecosystem if the water warms too much?**  
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### C. A MODEL OF PRODUCTIVITY AS A FUNCTION OF DEPTH IN A LAKE

Now we are going to look at the biological factors that affect dissolved oxygen in a body of water. Look at the experimental design on the LabBench Web site ([http://www.phschool.com/science/biology\\_place/labbench/lab12/model.html](http://www.phschool.com/science/biology_place/labbench/lab12/model.html)). We are taking a sample of pond water (with algae) and then modeling different depths in the pond by using screening to block out successive amounts of light. One hundred percent light for shallow depth, all the way to 0% light for deep ponds because the amount of light that penetrates varies with depth.

9. Why do we take an initial reading of dissolved oxygen? What purpose does this serve in the experiment? (**hint: use vocabulary words**)

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10. Click on the “closer look” magnifying glass on the “initial bottle”. Why does the animation show oxygen being diffusing out of the freshwater plants? **What does this signify?**

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11. Click on the “closer look” magnifying glass on the foil- covered bottle. Why does the animation show oxygen diffusing into the freshwater plants? **What does this signify?**

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12. Click on the “closer look” magnifying glass on the 100% bottle under the light. Why does the animation show oxygen diffusing both into and out of the freshwater plants? What does this signify?

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### D. ANALYSIS OF RESULTS

Let’s look at the results that will allow you to calculate the different types of productivity.

13. **Measuring Respiration:** Remember that plants (primary producers) perform both photosynthesis and respiration. To measure the amount of respiration that is happening in the bottle, we measure the amount of dissolved oxygen in the initial sample and then the amount of oxygen in the bottle kept in the dark. As shown in the illustration below, you then subtract the amount of dissolved oxygen in the “dark bottle” from the amount of dissolved oxygen in the “initial bottle” to calculate the amount of oxygen **consumed in respiration**. I have added some possible measurements to help. Explain why this calculation works.

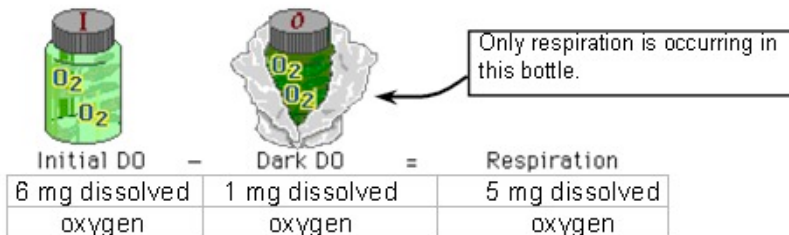
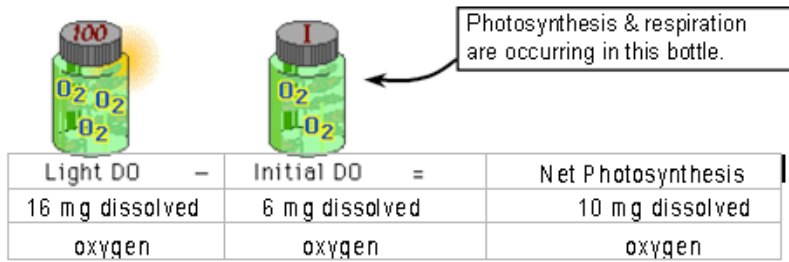


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14. **Measuring Gross Productivity:** Remember **gross productivity is the total amount of sugars and oxygen produced by the plants in an ecosystem**. I don't like how this Web site shows you how to calculate gross productivity. The equation is correct, but it is a short cut, so it makes it more difficult to understand. *So follow me with the illustrations and the possible measurements below.*



So the illustration shows us there was 10mg increase in dissolved oxygen in the jar as a result of photosynthesis in the last 24 hours and there was 5mg decrease in dissolved oxygen in the jar as a result of respiration in the last 24 hours. So the gross productivity (the full photosynthetic production in this ecosystem) of the algae in the bottle is the 5mg dissolved oxygen lost to respiration added back to the 10 mg dissolved oxygen accumulated in the bottle kept in the light. So what the algae really produced in the bottle was a total of 15mg of dissolved oxygen, it just lost 5mg to respiration. And remember, the **oxygen is an indirect measurement of the sugars produced in photosynthesis and lost in respiration.**

10 mg oxygen gained from photosynthesis	+	5 mg oxygen lost to respiration	=	15 mg oxygen as gross productivity
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Now, in your own words, explain why this calculation works.

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15. **Measuring Net Productivity:** Remember **net productivity is the amount of sugars and dissolved oxygen produced by the plants in an ecosystem once you subtract out what the producers have consumed in respiration**. So we actually already calculated that in the last example; I just called it “net photosynthesis.” Explain why this calculation works.




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**SUMMARY QUESTIONS**

16. Would you expect the dissolved oxygen levels in water sampled from a stream entering a lake to be higher or lower than the dissolved oxygen levels in water sampled from the lake itself? **Explain why.**

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17. Would you expect the dissolved oxygen levels in water sampled from a lake at 7AM to be higher or lower than the dissolved oxygen levels in water sampled at 5PM? **Explain.**

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18. One of the major sources of water pollution is the runoff from fertilizer used in agriculture and on suburban lawns as well as golf courses. In particular, the nitrogen and phosphorus nutrients in the fertilizer creates problems in the streams and ponds it flows into. They cause **algal blooms** and **eutrophication** in lakes.

a. Why do nitrogen and phosphorus promote a lot of plant/algal growth?

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b. What is meant by algal bloom? Remember: Algal blooms and Eutrophication are NOT the same thing.

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c. What problems do algal blooms cause in ponds & lakes? Why isn't a lot more producers a good thing?

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d. What is meant by eutrophication?

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19. At what depth—shallow or deep—will there be more primary productivity in a pond or a lake? Explain why.

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20. In an experiment, why do we use the mean of class data to make conclusions rather than individual student group data?

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21. AP Biology exam FRQ (2008). Consumers in aquatic ecosystems depend on producers for nutrition.

a. **Explain** the difference between gross and net primary productivity.

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b. **Describe** a method to determine net and gross primary productivity in a freshwater pond over a 24-hour period.

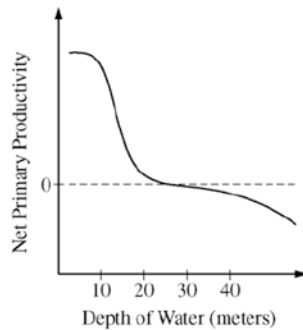
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c. In an experiment, net primary productivity was measured, in the early spring, for water samples taken from different depths of a freshwater pond in a temperate deciduous forest.

NET PRIMARY PRODUCTIVITY IN A FRESHWATER POND ECOSYSTEM DURING SPRING



**Explain** the data presented by the graph, including a description of the relative rates of metabolic processes occurring at different depths of the pond.

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d. **Describe** how the relationship between net primary productivity and depth would be expected to differ if new data were collected in mid-summer from the same pond. **Explain** your prediction.

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