Biology 1305
Modern Concepts in Bioscience (ICB Textbook)

Hello and welcome to the weekly resources for BIO-1305 - Biology 1

This week is Week 13 of class, and typically in this week of the semester, your professors are covering the topics below. If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout the semester.

We also invite you **to look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester.**

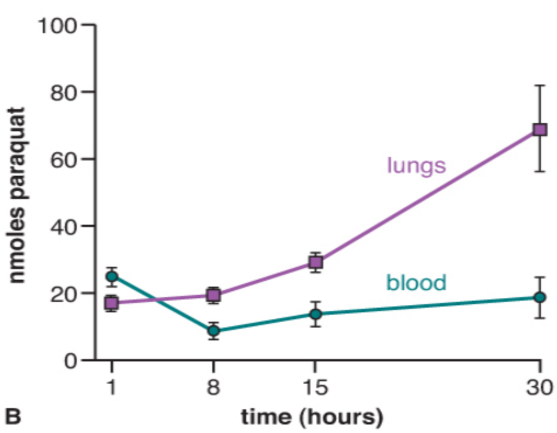
If you have any questions about these study guides, group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel, or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours (M-Th 9am8pm on class days at 254-710-4135).

KEYWORDS: Photosynthesis, Paraquat, Oxygen Production, Carbon Fixation, Light

TOPIC OF THE WEEK:

Photosynthesis

Our book introduces the process of photosynthesis by describing Paraquat, which is a herbicide that is banned in Europe but still used in the American continent. Scientists wanted to learn more about the hazards of this pesticide. They did this by quantifying the level of paraquat in lab rats that had consumed potentially lethal doses of the herbicide.

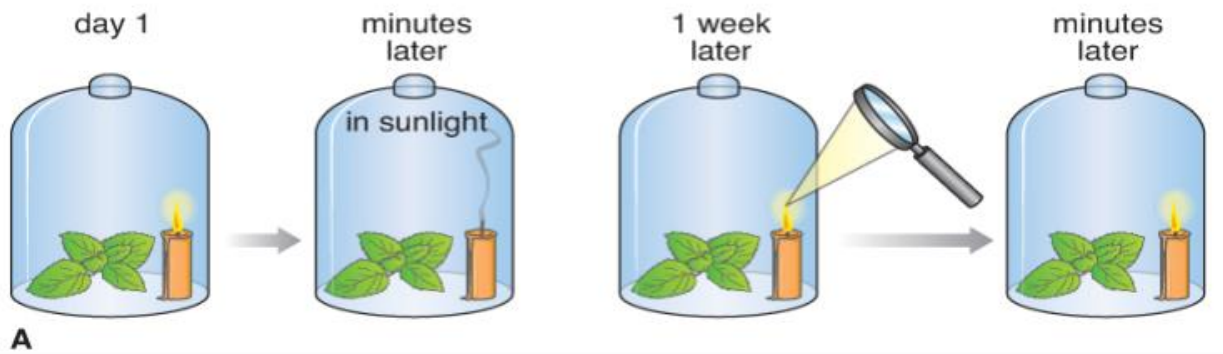


This figure shows the results of the experiment described above. The graph shows the paraquat levels in the blood (per mL) and lungs (per gram) of rats fed paraquat. As we can see, over time, t**he paraquat levels in the lungs increase at a much more rapid rate than those in the blood.**

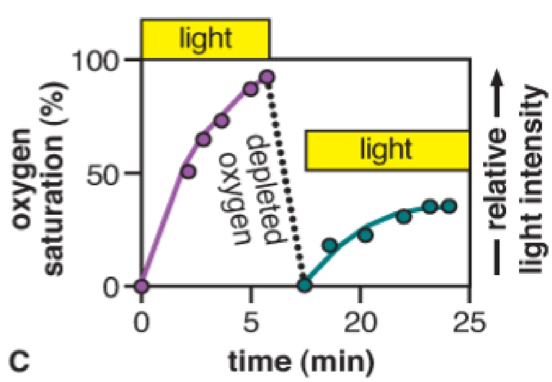
In order to understand how this herbicide works in plants and how it might affect animals, we need to understand photosynthesis. Before we dive into the details of this process, it may help if you watch this overview video.

Photosynthesis: https://youtu.be/sQK3Yr4Sc_k

Let's begin by looking at an experiment conducted by Joseph Priestley. Priestly was trying to understand what was in the composition of air which allowed the flame of a candle to burn. In order to study this, he placed an airtight glass dome over a burning candle and a sprig of mint. After a few minutes, the flame went out because it had consumed something in the air. The apparatus was placed in the sunlight for many days before Priestley used a magnifying glass to relight the candle. *If the equipment was kept in the dark or lacked a mint leaf, the candle could not be lit again.* The figure below summarizes Priestly's procedure.



The results of this experiment showed that **in order for a flame to burn, both sunlight and the mint leaves were needed**. If either of these two things were missing, the flame was not supported. Today, we know that the mint plant was releasing oxygen, which is needed for a fire to burn. In order for this to happen, sunlight was required.

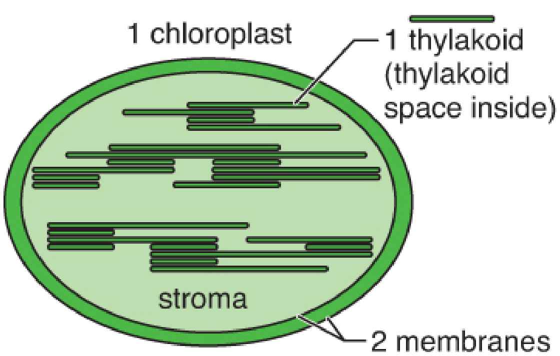


Over a century later, a biochemist conducted an experiment in which he disrupted spinach leaf cells and used centrifugation to isolate the intact **chloroplasts.** Hill exposed the chloroplasts to light and measured the concentration of dissolved oxygen in the buffer containing the chloroplasts.

Between the two light exposures, Hill used a chemical that rapidly consumed all the oxygen. We can see this point between the two curves on the graph. The results of his experiment demonstrated that the rate of oxygen production was influenced by the intensity of light. Oxygen production was higher when the rate of oxygen production was greater.

HIGHLIGHT #1: Chloroplasts

In the above experiment, we saw that the biochemist isolated intact chloroplasts, exposed them to sunlight, and then measured the rate of oxygen production. This is because chloroplasts are the organelle in which photosynthesis takes place. Let's make sure we understand the basic structure of these organelles.



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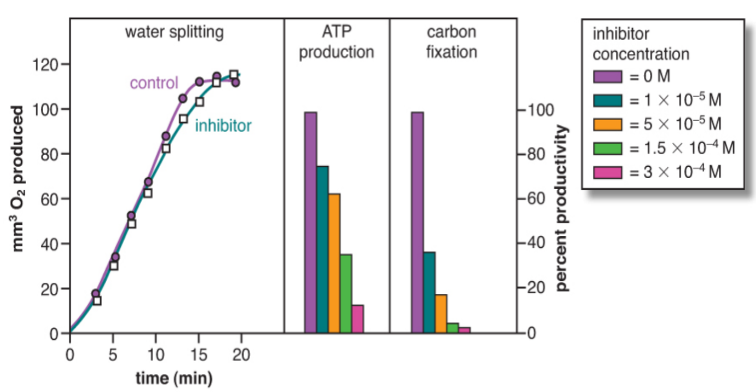
Chloroplasts contain **thylakoids,** which are green internal membranes which float in the liquid **stroma,** the fluid-filled space which is inside the chloroplast and which surrounds the thylakoid membranes. The thylakoids are hollow and flattened membrane vesicles that enclose a liquid-filled lumen that we call the **thylakoid space.**

HIGHLIGHT #2: Three Steps of Photosynthesis

By the mid-1950s, scientists knew that plants could **split (or consume) water,** produce adenosine triphosphate (ATP), and convert CO_2 into multi-carbon sugars **(carbon fixation)**. An investigator measured the rate of all three processes when they were exposed to different concentrations of an enzymatic inhibitor. For the first experiment, he placed chloroplasts in a solution containing a 1.5 × 10-5 M inhibitor and compared the rate of water splitting to chloroplasts without any inhibitor.



As we can see, t**he inhibitor caused a decrease in the rate of oxygen production when compared to the control after approximately 10 minutes**. At this point, the slopes of both lines began to vary.

For the remaining two experiments, Arnon measured the rate of ATP production and the rate of CO2 fixation when exposed to a range of inhibitor concentrations. Each of the bars on the two bar graphs represents the rate of either ATP production or carbon fixation when exposed to a certain concentration of an inhibitor. As we can see, **both processes were inhibited the most when the concentration of the inhibitor was greater**, which is expected.

The importance of this experiment is that the results confirmed that these three processes were inhibited differently from each other. This means that **splitting water, producing ATP, and fixing carbon are performed by three distinct enzymatic pathways.** This discovery helped the scientific community realize that for future experimentation, they could design experiments to test one pathway at a time.

CHECK YOUR LEARNING

(Answers below)

1) You may have learned in previous classes that plants release oxygen through photosynthesis. At what point in photosynthesis is oxygen released?
2) Based on what we have learned in this section, do plants release oxygen at night?
3) What is carbon fixation? Is carbon reduced or oxidized in this process?
4) In general, do plants release only oxygen, or both oxygen and carbon dioxide?

THINGS YOU MAY STRUGGLE WITH

- It is a common misconception that cellular respiration happens in animals, while only photosynthesis happens in plants. Remember that plants carry out both photosynthesis and cellular respiration (think about a plant cell; it has both mitochondria and chloroplasts!)
- Be able to compare photosynthesis and cellular respiration after reading this chapter of the book. Some things to think about are where ATP is used or created, where each process takes place in the cell, when oxidation and reduction steps are happening, the role of electron carriers and coenzymes, and the reactants and products in each process.

ANSWERS

1) During the process of splitting water.
2) Most plants don't release oxygen at night, or they do so in very small amounts.
3) Carbon fixation is the process of covalently linking CO_2 with H^+ and electrons to form 3-carbon sugars. Carbon is reduced in this process.
4) Plants release both oxygen and carbon dioxide.

Thanks for checking out these weekly resources! Don't forget to check out our website for group tutoring times, video tutorials and lots of other resources: www.baylor.edu/tutoring! Answers to Check your Learning questions are below!