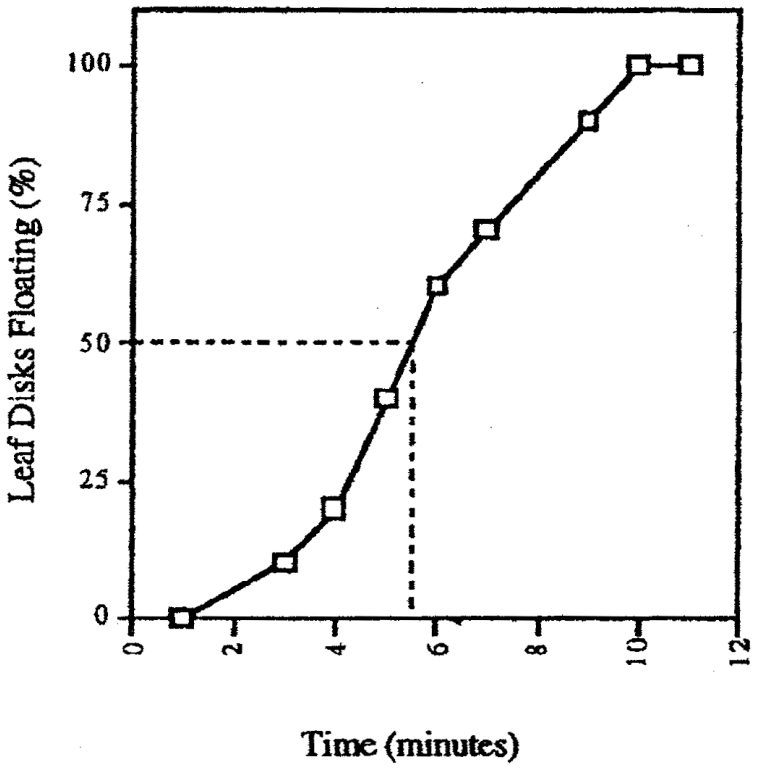
BIOLOGY 100
SOLUTIONS TO PROBLEMS

PHOTOSYNTHESIS AND RESPIRATION IN LEAF TISSUE

1. A student just completed an assay of photosynthesis using the floating leaf disk method with 10 leaf disks in a test tube. After 1, 3, 4, 5, 6, 7, 9, 10, and 11 minutes the number of leaf disks floating were 0, 1, 2, 4, 6, 7, 9, 10, and 10 respectively. What was the ET 50_{light} for this trial?

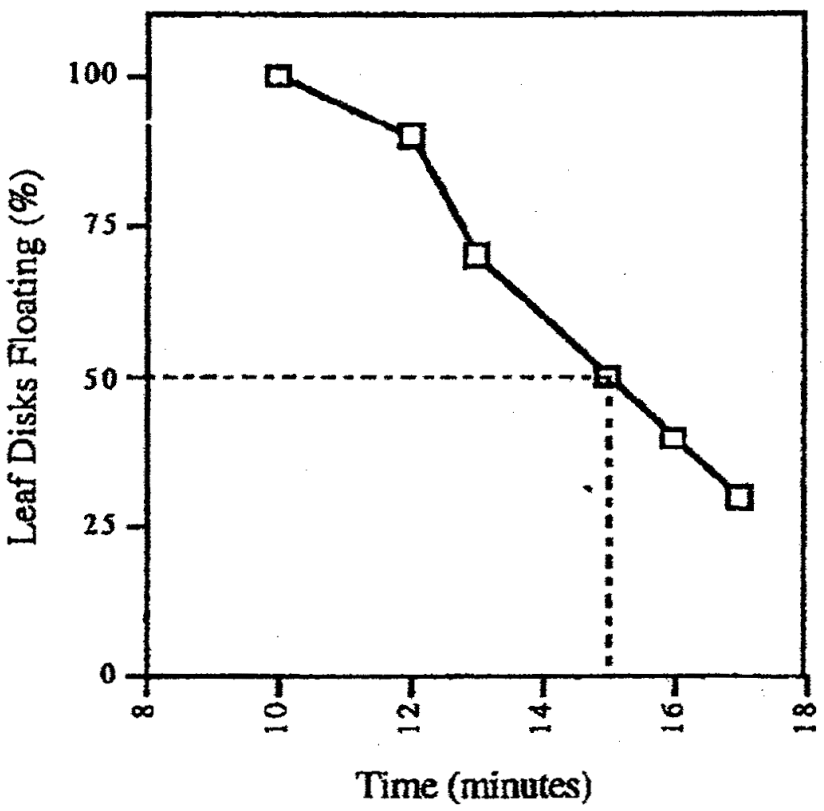
To determine the $ET_{50\text{-}light}$ for this trial, plot the percent leaf disk floating as a function of time:



From the above graph, we can interpolate that 50% of the leaf disks floated at 5.5 minutes. Therefore, the $ET_{50\text{-}light}$ is 5.5 minutes.

2. Having just observed net photosynthesis with floating leaf disks, the leaf disks from the trial presented in problem 1 were placed in the dark to determine the rate of respiration for the leaf disks. After 10, 12, 13, 15, 16, and 17 minutes in the dark, the number of leaf disks floating were 10, 9, 7, 5, 4, and 3, respectively. What was the ET 50_{dark} for this trial?

To determine the $ET_{50\text{-}dark}$ for this trial, plot the percent leaf disk floating in the dark as a function of time:



From the above graph, we can interpolate that 50% of the disks sank at 15.0 minutes, this is the $ET_{50\text{-}dark}$.

3. Using information provided in problems 1 and 2, calculate the relative rates of photosynthesis and respiration. In addition, determine the ratio of photosynthesis/respiration for this tissue.

The relative rate of respiration = $\frac{1}{ET_{50\text{-dark}}} = \frac{1}{15 \text{ min}} = 0.067 = 0.067 \text{ min}^{-1}$

The relative gross rate of photosynthesis =
$\frac{1}{ET_{50\text{-light}}} + \frac{1}{ET_{50\text{-dark}}} = \frac{1}{5.5 \text{ min}} + \frac{1}{15 \text{ min}} = 0.182 \text{ min}^{-1} + 0.067 \text{ min}^{-1} = 0.249 \text{ min}^{-1}$

The ratio of gross photosynthesis:respiration = $\frac{0.249 \text{ min}^{-1}}{0.067 \text{ min}^{-1}} = 3.72$

The gross rate of photosynthesis was 3.72 times as great as that for respiration, meaning that the plant was producing carbohydrates well over three and a half times faster than it was using carbohydrates in respiration. The surplus of carbohydrates can be stored for respiration later and used for building plant structures.

4. If leaf disks from an old leaf had an ET 50_{light} of 8 minutes, and if leaf disks from a young leaf had an ET 50_{light} of 5 minutes, which tissue had the faster net rate of photosynthesis? Would it be possible for the old tissue to have a faster gross rate of photosynthesis? If so explain your logic.

Net rate of photosynthesis for young leaf = $\frac{1}{ET_{50\text{-light}}} = \frac{1}{5 \text{ min}} = 0.20 \text{ min}^{-1}$

Net rate of photosynthesis for old leaf = $\frac{1}{ET_{50\text{-light}}} = \frac{1}{8 \text{ min}} = 0.125 \text{ min}^{-1}$

Therefore, the old leaf has a net rate of photosynthesis that is lower than the young leaf.

It would be possible for the old leaf to have a gross rate of photosynthesis that was faster than the young leaf since the gross rate of photosynthesis takes into consideration the rate of respiration. If the old leaf had a rate of respiration that was much larger than that of the young leaf, then the gross rate of photosynthesis would be greatest for the old leaf.