Why are plants not always green?

Introduction:
A pigment is a molecule that absorbs light in the visible portion of the electromagnetic spectrum. The leaves of most plants are rich in pigments. These pigments absorb light and convert it to chemical energy to fuel the production of glucose. The primary photosynthetic pigment is chlorophyll a. Other pigments, such as chlorophyll b and carotenoids are referred to as accessory pigments. These absorb light and funnel the energy to chlorophyll a.

Different pigments absorb different wavelengths of light. When light hits a pigment, it is absorbed, reflected or transmitted. Wavelengths of light that are absorbed are not visible to the viewer. Non-absorbed wavelengths are transmitted and reflected. When white light, such as sunlight, hits chlorophylls, the wavelengths at the blue and red ends of the spectrum are absorbed. Green wavelengths are not well absorbed, so they reflect back to our eye, making a leaf appear green to us. Chlorophyll a and b maximally absorb slightly different wavelengths. As a result, chlorophyll a is blue-green in color while chlorophyll b is yellow-green. Their different absorption peaks provide the adaptive advantage of wider energy collection.

A spectrophotometer is a machine used by scientists to measure the absorbance of light by substances. The better a pigment absorbs a wavelength of light, the higher its percent absorbance reading.

Graph 1: *create a graph in your lab book*
Use the data from the table below to make an absorption spectrum graph for chlorophyll a and chlorophyll b. The line for each is an approximation of the absorption spectrum for that molecule.

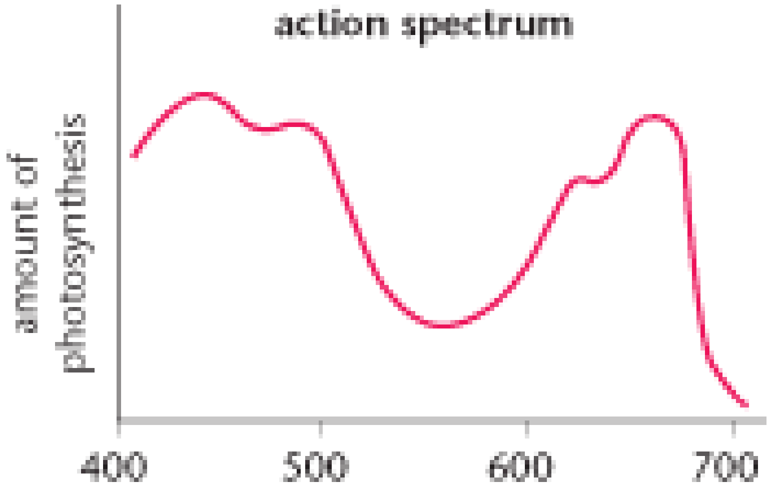
Wavelength (nm)	Chlorophyll a % of Light Absorption	Chlorophyll b % of Light Absorption
400	32	8
425	60	29
450	10	62
475	3	51
500	0	8
525	0	0
550	4	3
575	2	4
600	4	2
625	3	20
650	21	29
675	44	4
700	12	0

Discussion Questions: *answer in complete sentences in your lab book*
1. Based on the data and your graph, what can you conclude about the two chlorophylls and their absorption spectra? In what ways are the two similar? Different?

2. Explan why leaves are green. Begin your explanation with white light coming from the sun and ending in your eye.

3. Based on the data and your graph, which type of light (wavelength) is most important to plants for photosynthesis. Explain.

4. Suppose a researcher tested the effect of light wavelength on photosynthetic activity. In the experiment, photosynthesis was measured by O2 production. A graph of the results, called an action spectrum, would look something like this:



The graph resembles the absorption spectra for chlorophyll a and chlorophyll b, but there are some subtle but important differences. Compare the action spectrum graph to the absorption spectra for the chlorophylls. What observations can you make about similarities and differences between the two graphs? Refer to specific wavelengths in your response.

5. Now focus on the left half of the graph action spectrum shown above and the chlorophyll absorption spectra you graphed. Notice that the photosynthesis action spectrum has a wider left peak that the chlorophyll absorption graphs. It doesn't bottom out until 550 to 600 nm. What does that mean? Propose an explanation for this.

Graph 2: *create a graph in your lab book*

Use the data from the table below to make an absorption spectrum graph for caratenoids.

Wavelength (nm)	Caratentoids % of Light Absorption
400	22
425	23
450	49
475	43
500	55
525	34
550	0
575	0
600	0
625	0
650	0
675	0
700	0

Analysis: *answer in complete sentences in your lab book*

6. By looking at your graph, explain why the action spectrum for photosynthesis shows wider activity than the absorption spectra for the chlorophylls.

7. What color are carotenoids? Explain why they are this color, with reference to actual wavelengths.

8. What is the adaptive value of accessory pigments like carotenoids? That is, what advantage do they provide plants?