Understandings:

1. Explain what photosynthesis is.

- Photosynthesis essentially converts light energy into chemical energy by turning inorganic carbon compound (and water) into organic carbon compound. We have learnt previously that organic carbon compounds are carbohydrates, proteins and lipids.

2. Explain the principle of wavelength of lights.

- We already know the very basics of wavelengths of light. We know that light contains a variety of wavelengths, from visible, UV, x-ray, IR, etc. Perhaps one new thing is that the visible lights we see are usually used by plants as well. This is because the UV, x-ray, and IR and others are comparatively less abundant than the visible light.

Photosynthesis with other wavelengths should be possible, as long as it contains energy. In fact, the very first photosynthetic bacteria used IR to synthesize sulfur.

3. Explain what lights chlorophyll absorbs.

- When a pigment has color, it means that it absorbs some of the visible light because that remaining visible wavelength is what makes them have a color. Some pigments might absorb all of the color, thus appear black.

The most common pigment is chlorophyll. These absorb blue and red but not green as much, hence appear as green.

Other pigments can include carotenoids, pheophytin, chlorophyll a, b, c, d, e and f.

4. Outline the reaction where oxygen is produced through photosynthesis.

- The reaction is simple.

$2H_2O \rightarrow 4e^- + 4H^+ + O_2$

This process is called photolysis because it uses photons (light) to split (lysis)!

The reason for this reaction is because plants need some e^- and H^+ during photosynthesis, thus they split water and produce oxygen as waste product.

5. State the implications of photosynthesis on Earth.

- Long time ago, we had almost no oxygen on Earth. But around 3500 mya (million years ago), plants started to emerge. At 2400 mya, the oxygen abundancy in atmosphere is said to have reached around 2% and this is called Great Oxidation Event.

This led to glaciation. Since there was photosynthesis taking place, concentration of CO_2 decreased and methane reacted with oxygen. When no greenhouse gases are present, Earth cannot maintain its temperature.

However, oxygen levels kept rising and rising and eventually, there was so much oxygen it started to react with iron dissolved in water. Do we know what iron oxides are? Yes, rust. These sunk to the bottom of the sea and now seen as iron ores essential for steel and our lives!

700 mya multicellular organisms started to emerge, thus oxygen level increased to 20% and it is still at that level today.

6. Explain how energy is needed to produce carbohydrates and other carbon compounds.

- The classical formula of $6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$

Since this process requires energy, it is an endothermic reaction. Therefore, photosynthesis can only occur where there is light!

7. Outline the factors that can affect the rate of photosynthesis.

- The most important limiting factors of photosynthesis are:

1. Temperature.

2. Light availability.

3. Carbon dioxide concentration.

4. Water supply.

5. Light wavelength. This is often forgotten. Since the pigments are wavelength-specific, wavelength does indeed affect photosynthesis.

Essentially, the things needed for the overall photosynthetic reaction to take place.

Strictly speaking, there can only be one limiting factor. It is just like the limiting reagent. An optimization of one thing does not affect the reaction as long as there is another limiting reactant “restraining” the reaction.

So optimizing the conditions is not always achieved in nature. For instance, at night, light availability is limiting factor. But during the days, especially when it is hot, temperature might be too high and water evaporated, hence a new limiting factor.

Applications and skills:

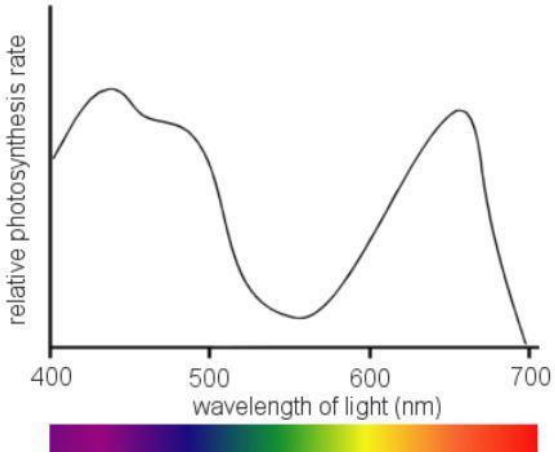
1. Be able to separate photosynthetic pigments through chromatography.
- The principle that is used in this experiment is obviously chromatography and exploiting the different absorption of different pigments, hence different color.

First of all, we need to understand chromatography. The principle is simple, almost as simple as electrophoresis. Instead of separating by mass like electrophoresis, we separate molecules by polarity.

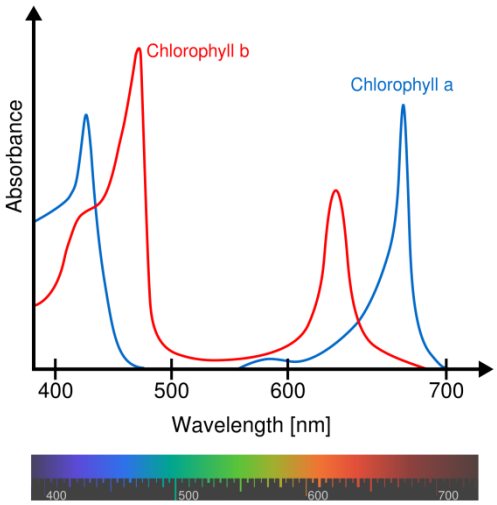
So, what we want to do is that we want to extract the pigments, separate them by making them climb up along the Thin Layer Chromatography (TLC).

The way to extract the pigments and separate etc. will be covered in detail during class.

2. Be able to draw an absorption spectrum of chlorophyll and an action spectrum for photosynthesis.
- Action spectrum is just as it sounds. It is measuring the action of something for each component (wavelengths) in a spectrum. Thus in this case, we see the action of photosynthesis for each wavelength.



We have photosynthesis rate on y-axis in % and the wavelength on x-axis, in nm.



Likewise, absorption spectrum is the amount of absorption in % made by a certain pigment for each wavelength in nm.

The important thing to notice here is the correlation between the two graphs. It is quite obvious since when there is high absorbance by pigments, there must be high activity of photosynthesis.

3. Be able to design experiments to investigate the factors affecting the rate of photosynthesis.

- Yeah good luck.