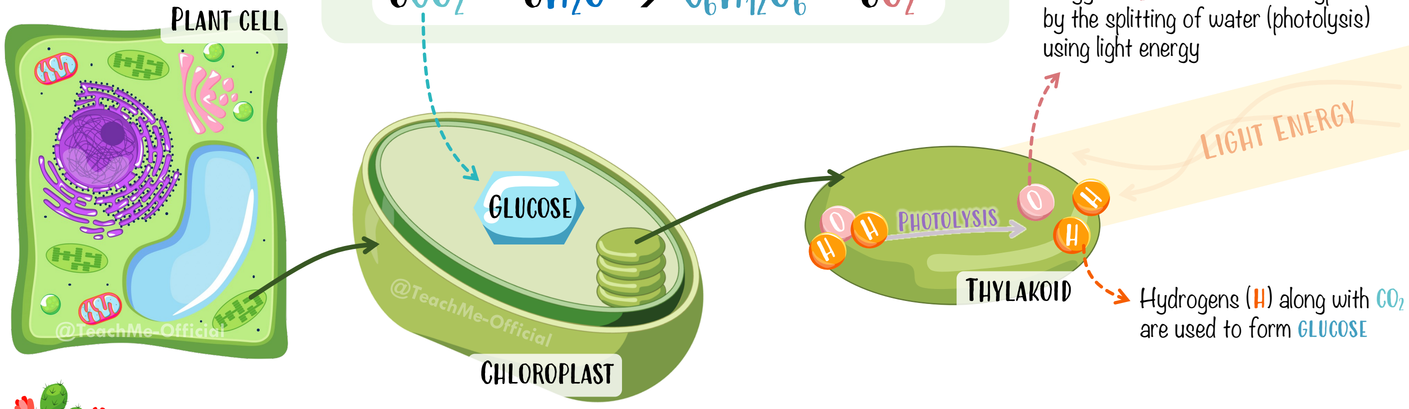
Photosynthesis

PHOTOSYNTHESIS – Synthesis of organic molecules (e.g. GLUCOSE) from inorganic matter (LIGHT ENERGY and CARBON DIOXIDE).

The detailed process of photosynthesis is covered in HL

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

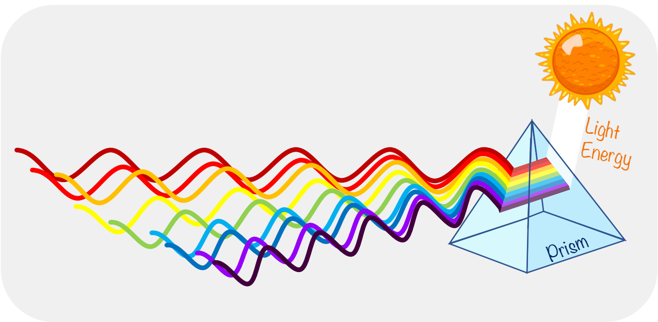


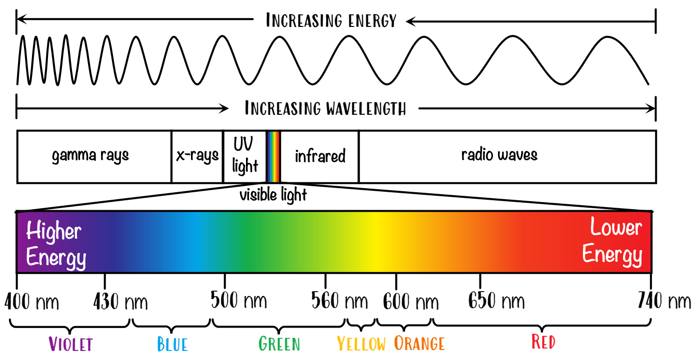
AUTOTROPHS (Self Feeding)

- Organisms that can synthesize organic matter (food) from inorganic matter (seen in B4.2).
- If autotrophs use light to make their food: PHOTOAUTOTROPHS

What IS LIGHT?

Sunlight is a mixture of different colors of light. Colors can be seen when you let sunlight pass through a prism as it separates the lights which have different wavelengths (colors).

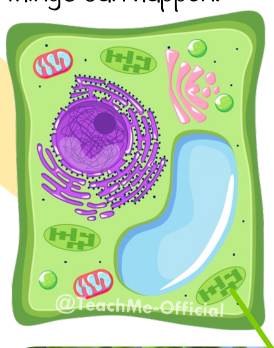




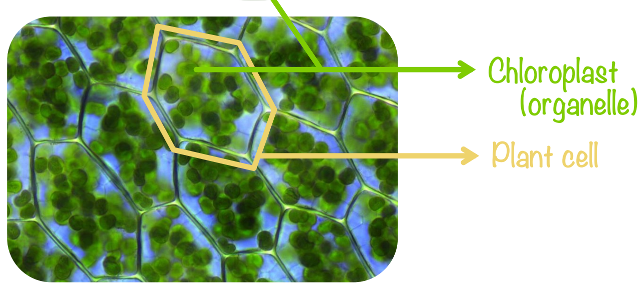
BIG BRAIN TIP!

You need to remember the approximate wavelength (in nm) for each of the colors.

When a PLANT CELL is exposed to LIGHT, one of two things can happen:



- **Absorb that wavelength** (energy absorbed and used)
- **Reflect that wavelength** (energy not absorbed & color seen)



PHOTOSYNTHETIC PIGMENTS found inside plants are responsible for absorbing light. But different pigments will absorb and reflect different wavelengths. Usually, a green plant will contain the pigment called CHLOROPHYLL within the chloroplasts – giving its green color.

- RED & BLUE light well absorbed (used)
- GREEN light is reflected (not used, gives color)

TRY FOR YOURSELF!

Which colors are best absorbed, and which is reflected in a carrot?

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Try for yourself answer: Carrots absorb BLUE and VIOLET light and reflect ORANGE light. The pigment causing this color is carotene.

Photosynthesis

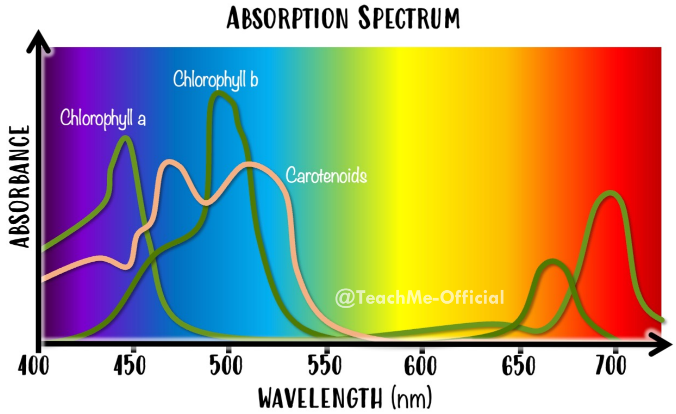
Some examples of pigments include:

- CHLOROPHYLL *A*
- CHLOROPHYLL *B*
- CAROTENE
- XANTHOPHYLL

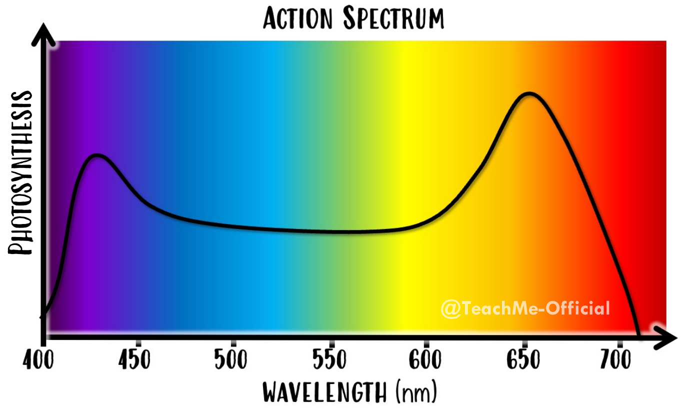
CAROTENE and XANTHOPHYLL: CAROTENOIDS

Each of the pigments and their concentrations are unique to each plant species, leading to variations in color and shade.

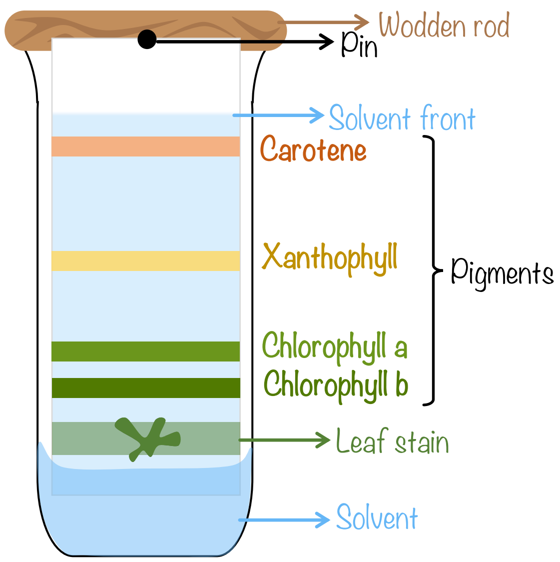
Absorption Spectrum



Action Spectrum



Absorption Spectrum	Action Spectrum
Represents the amount of light (energy) being absorbed by the photosynthetic pigments.	Represents the rate of the photosynthetic process being carried out by the pigment.
Varies depending on the type of photosynthetic pigment present.	Varies depending on the type of photosynthetic pigment present.
Chlorophylls *a* and *b* have a high absorption of light energy in the violet-blue and red-light wavelengths.	Chlorophylls *a* and *b* create a relatively high efficiency rate of photosynthesis.
Pigments like carotenoids absorb light energy at different wavelengths compared to chlorophyll *a* and *b*.	Pigments like carotenoids allow photosynthesis at different wavelengths.
Other pigments exist that are not as efficient as absorbing light energy as chlorophyll *a* and *b*.	Other pigments exist that are not as effective at achieving high rates of photosynthesis as chlorophylls *a* and *b*.

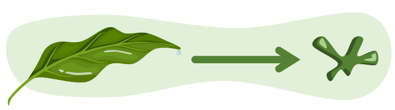


Each of the pigments that a plant possess can be separated using **CHROMATOGRAPHY**

- Those pigments most soluble in the solvent will travel farther up the paper compared to those less soluble in the solvent.
- Different solvents will result in a different separation outcomes.

$$R_f = \frac{\text{Distance moved by substance}}{\text{Distance moved by solvent}}$$

Pigments with higher R_f values are more soluble in the solvent being used.



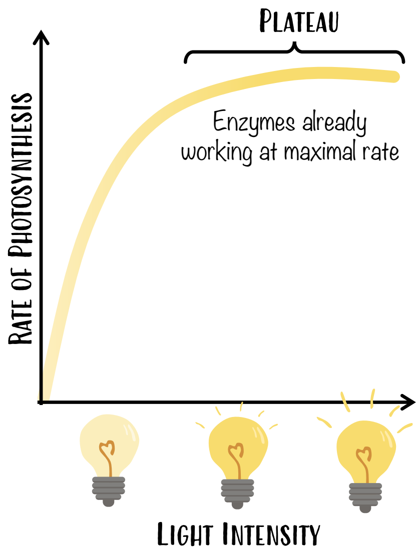
NOTE: A pigment which travels up farther up the chromatography paper does not indicate there is a higher concentration of it. Higher concentration will show as a thicker band.

Teach Me

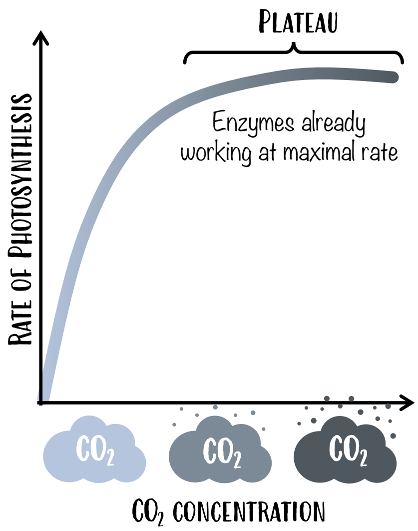
Photosynthesis

Factors affecting Photosynthesis

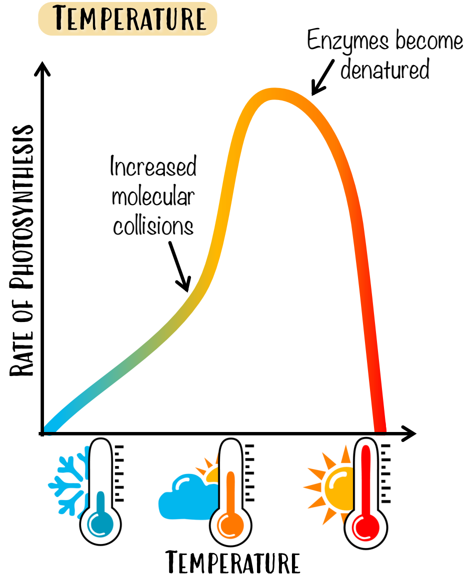
Light Intensity



Carbon Dioxide Concentration



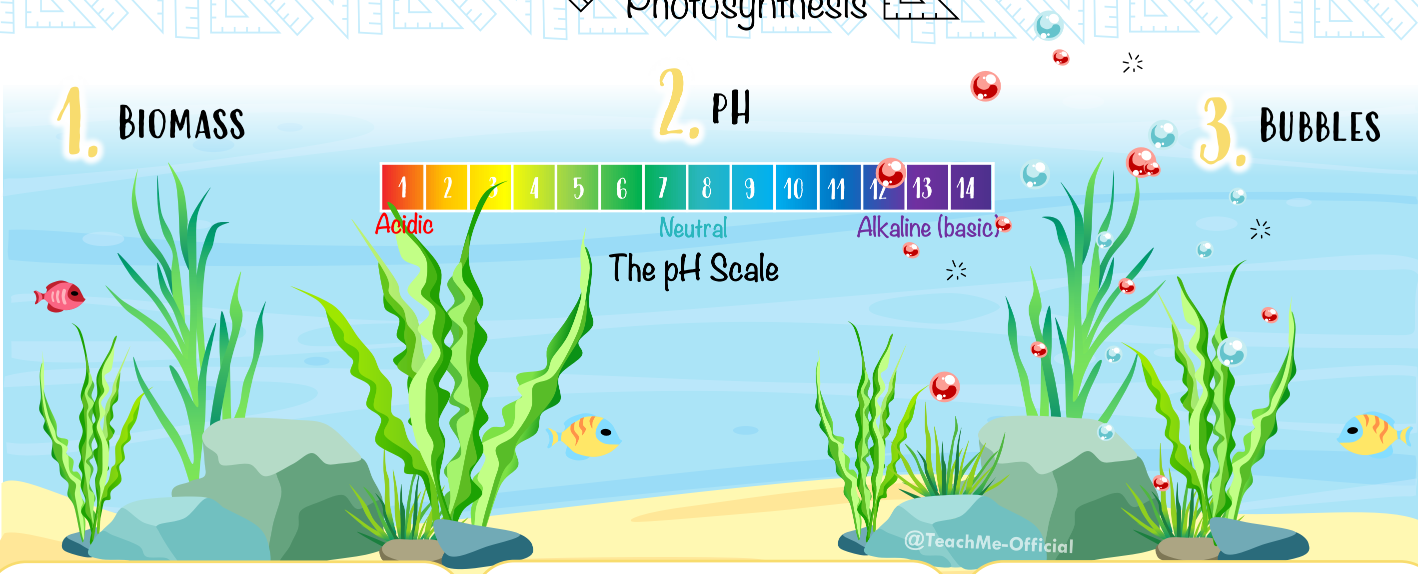
Temperature



As **LIGHT INTENSITY** or **CARBON DIOXIDE CONCENTRATION** increase, it causes the rate of photosynthesis to accelerate until a **PLATEAU** occurs because the chloroplasts are working at their maximum capacity. Beyond a certain point the rate of photosynthesis will not increase, as hydrogen and oxygen are the limiting reactants.

The higher the **TEMPERATURE**, the faster the movement of the molecules (higher kinetic energy) and hence the higher odds of collision. Excessively high temperatures can lead to enzyme **DENATURATION** (alteration of protein tertiary structure) leading to enzyme malfunction & reduced rate of reaction.

Measuring Photosynthesis

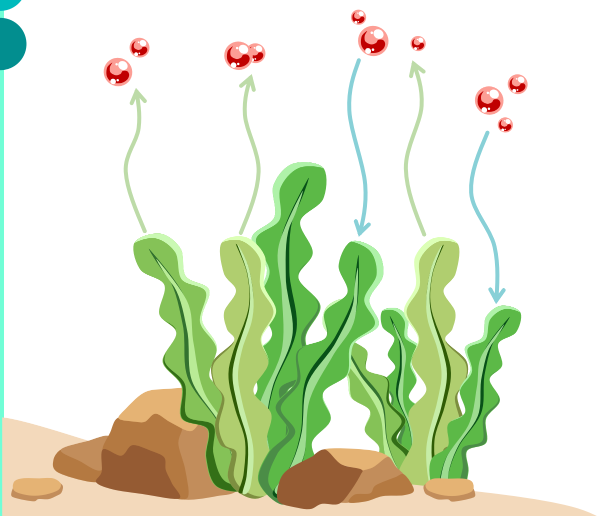


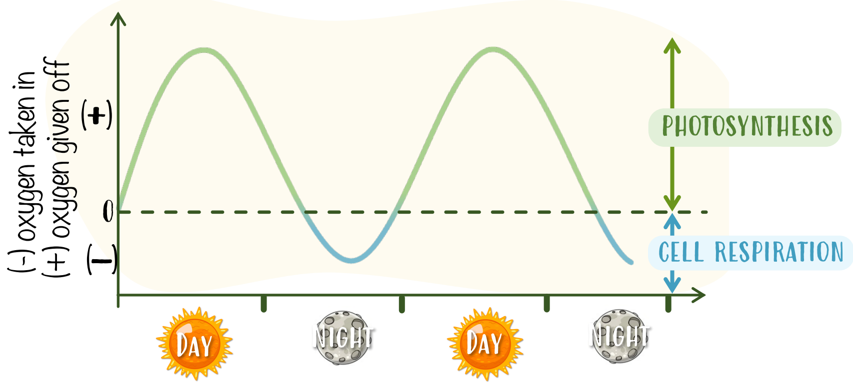
The **MASS** of plants is an indirect reflection of photosynthetic rate, as an increase or decrease in biomass can be caused by a variety of factors as well as the photosynthetic rate.

CO_2 makes water acidic. In the process of photosynthesis, it is used up. Hence the more photosynthesis, the less CO_2 in the water, thus the higher the **PH** (more basic).

O_2 production occurs with photosynthesis. Can directly be observed using our eyes as **BUBBLES**, but also with other more accurate methods (such as **Photosynthometer**).

Photosynthesis





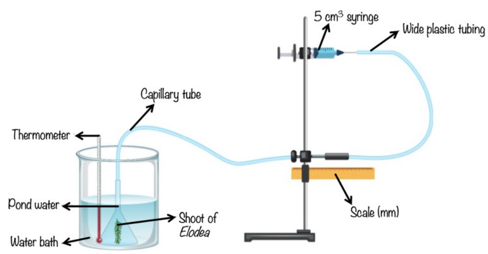
PHOTOSYNTHESIS is virtually zero at night, but CELL RESPIRATION is constant. When measuring the rate of oxygen production or carbon dioxide intake, it is possible to directly measure the photosynthetic rate... if a correction is made for cell respiration!

Example of correction

During an experiment, you use a Photosynthometer to measure the amount of oxygen produced by a plant over 24 hours, your findings are as follow:

- **At midnight** – the plant uses 5 units of O_2 per hour.
- **At midday** – the plant has a net production of 10 units of O_2 per hour.

Conclusion: during the night, ONLY CELL RESPIRATION is occuring, therefore the rate of cell respiration is 5 units of O_2 per hour. During the day, the net production of 10 units of O_2 per hour is a combination of PHOTOSYNTHESIS AND CELL RESPIRATION, therfore, the **RATE OF PHOTOSYNTHESIS** can be calculated to be 5+10 during the day, or 15 units of O_2 per hour.



Photosynthometer

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