Unit 3—Sustainability and Interdependence

Key Area 1 : Food supply, plant growth and productivity

(a) Food Supply

Food security is the ability of human populations to **access** food of sufficient **quality** and **quantity**.

Increase in human population and concern for food security leads to a demand for increased food production.

Food production must be **sustainable** and must not have a negative impact on the ecosystem and natural resources.

More food needs to be produced for the same area of land so increased plant productivity and genetic diversity will be required in order to maintain a sustainable food supply.

Plant growth

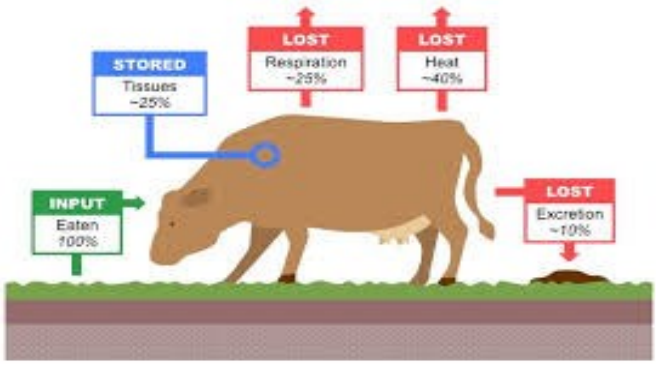
Agricultural production depends on factors that control **photosynthesis** such as;

- light intensity
- carbon dioxide concentration
- chlorophyll concentration
- availability of water
- temperature.

The area to grow plants is limited and so increased food production will depend on factors that control plant growth such as ;

- Breeding of higher yielding cultivars (*cultivated varieties*)
- Use of fertiliser
- Protecting crops from pests, diseases and competition.

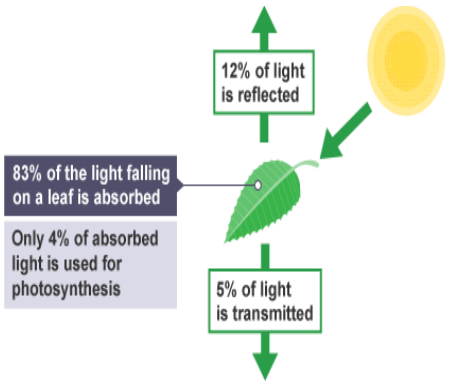
Livestock produce less food per unit area than crop plants due to **loss of energy at trophic levels**.



Livestock production is often suitable in areas unsuitable for growing crops .

(b) Photosynthesis

Photosynthesis is the process by which green plants trap light energy to make carbohydrates.



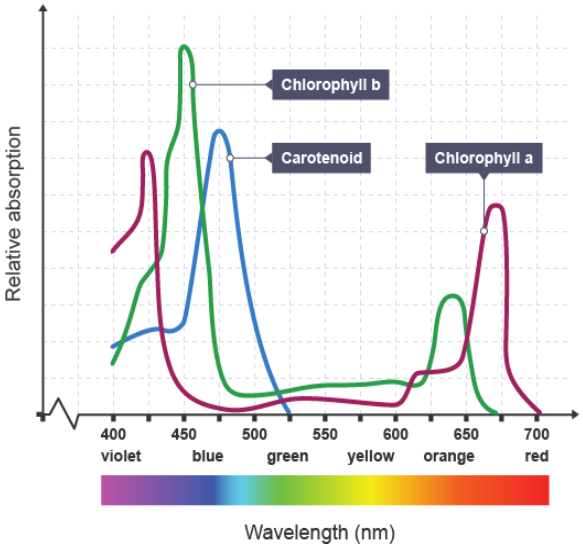
Light hitting the leaf of a plant can be;

- Absorbed
- Transmitted
- Reflected

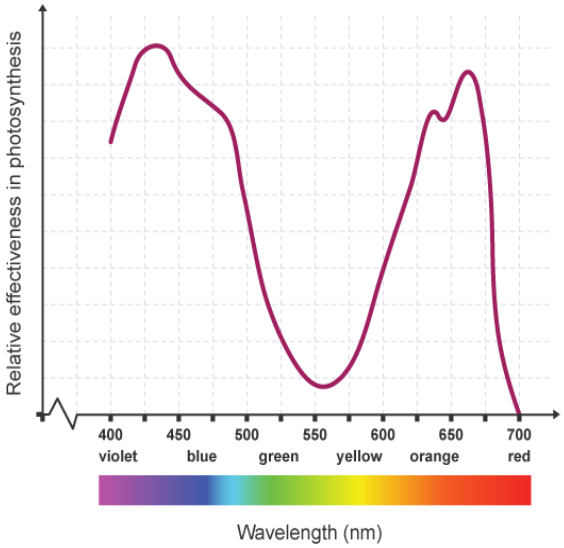
Light energy is absorbed by photosynthetic pigments to generate ATP for photolysis.

Each pigment absorbs a different range of wavelengths of light.

- **Chlorophyll**—absorbs mainly in the **red** and **blue** regions of the spectrum .
- **Caretenoids** are accessory pigments that **extend the range of wavelengths absorbed** and pass the energy to chlorophyll for photosynthesis.



The absorption spectra shows the wavelengths of light absorbed by different pigments in a leaf.

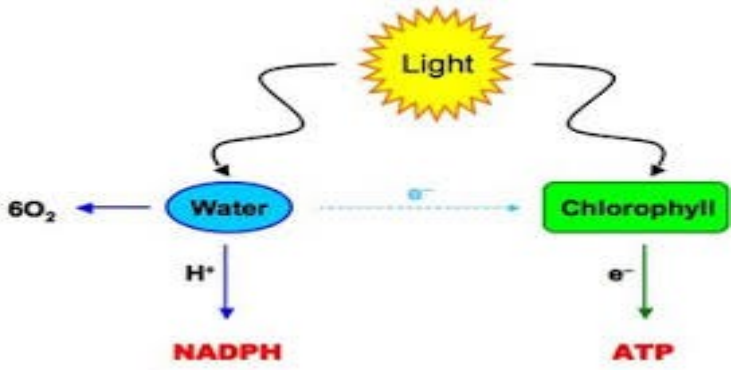


The action spectra shows how effective the different wavelengths of light are for photosynthesis.

The action spectra shows that even when absorbance is relatively low there are still relatively high levels of photosynthesis as the carotenoids are extending the range of wavelengths absorbed and passing the energy to chlorophyll.

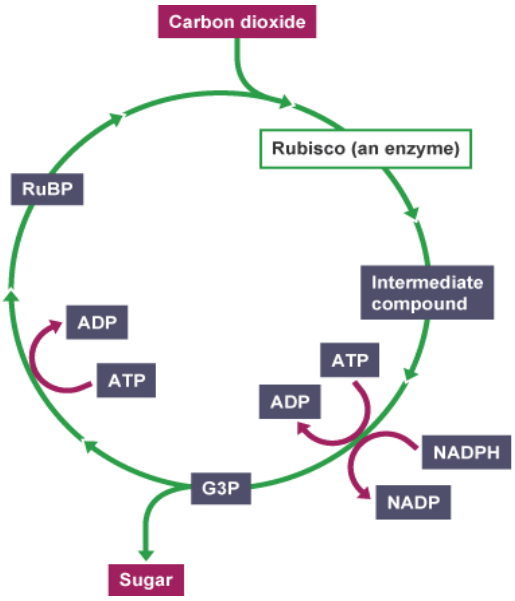
Stages of Photoynthesis

- Absorbed light energy **excites electrons** in the pigment molecule.
- Transfer of these electrons through the **electron transport chain** releases energy to **generate ATP by ATP synthase**.
- Energy is also used for ***photolysis***, in which **water is split** into oxygen, which is evolved, and hydrogen, which is transferred to the coenzyme NADP.



Carbon Fixation

- The enzyme **RuBisCo fixes carbon dioxide** by attaching it to **RuBP** and **3PG** is produced.
- The **3PG is phosphorylated by ATP** and combined with hydrogen from NADPH to form **G3P.**
- **G3P** is used to **regenerate RuBP** and for the **synthesis of glucose**.



Fate of Glucose

The glucose produced in photosynthesis can be used as;

- A substrate for respiration
- Stored as Starch
- Synthesised to Cellulose for cell walls.
- Passed to other biosynthetic pathways to form a variety of substances such as DNA, protein and fat.