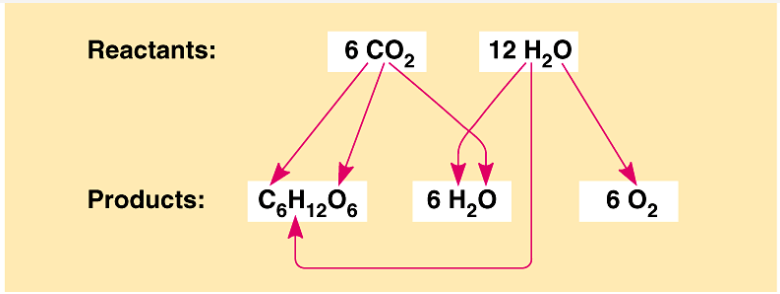
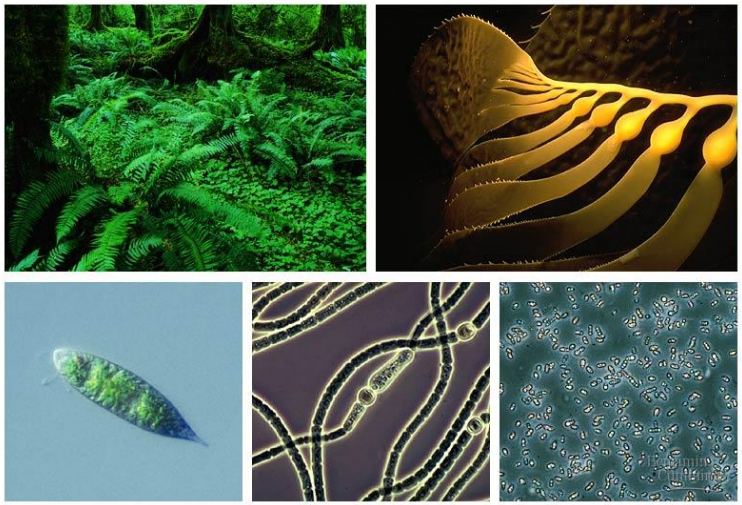
Aim: What early research led to the discovery of photosynthesis?



Autotrophs and heterotrophs

- **Autotrophs** produce their organic molecules from CO_2 and other inorganic raw materials obtained from the environment.
  - Autotrophs are the ultimate source of organic compounds for all nonautotrophic organisms.
  - Autotrophs are *producers*.

- Autotrophs can be separated by the source of energy that drives their metabolism.
  - *Photo*autotrophs use light as the energy source.
    - Photosynthesis occurs in plants, algae, some other protists, and some prokaryotes.
  - *Chemo*autotrophs harvest energy from oxidizing inorganic substances, including sulfur and ammonia.
    - Chemoautotrophy is unique to bacteria.



- **Heterotrophs** live on organic compounds produced by other organisms.
  - They are *consumers*.
  - They feed on plants and/or animals or…
  - They decompose and feed on dead organisms and on organic litter, like feces and fallen leaves.

Photosynthesis: Early research

- 1772 – Joseph Priestley (English clergyman) notes that green plants can reverse the ill effects of burning and animal respiration.
- 1779 – Jan Ingerhousz, Holland, notes that a combustible gas was produced by green plants when placed in sunlight. (oxygen)
- 1782 – Jean Senebier, Switzerland, showed that only CO_2 ("fixed air") could be used in photosynthesis.
- 1804 - Nicholas de Sausure, Switzerland, proved that water was required during photosynthesis and that organic compounds are produced.

Photosynthesis: Early research

- Result of the early combined studies:
  - CO_2 + H_2O + light → organic + O_2
  - Senebier + Sausure → Sausure + Ingerhautz
- *Perhaps carbon dioxide splits and water is added…..but there was no way to prove or disprove this hypothesis.*

Photosynthesis: Recent research

- 1930 – C.B. van Niel (Stanford University) discovers that some bacteria use chemosynthesis to derive energy:
  - $CO_2 + H_2S \rightarrow CH_2O + S$
- Note: CO_2 does not split; H_2S does!!
  - Suggestion: Perhaps water, not CO_2, splits during photosynthesis

Photosynthesis: Recent research

- 1940 – Radioactive oxygen^{18} was used to trace the steps of photosynthesis.
  - Radioactive CO_2 + H_2O → CH_2O + O_2
  - CO_2 + radioactive H_2O → CH_2O + O_2

- Apparently, water splits and the hydrogen is fixed to carbon dioxide. The oxygen from the water is expelled and becomes the molecular oxygen we breath.

Conclusion

- The overall reaction of photosynthesis is:
- $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6\,H_2O$ in the presence of chlorophyll and light energy.
- Photosynthesis is an endergonic redox process; energy is *required* to reduce carbon dioxide.
- It involves two stages:
- The Light Reactions (photolysis) which convert and store solar energy. These are light-dependent.
- The Calvin cycle (once called the Dark Reactions because they are light-independent) which uses stored energy to reduce CO_2 into carbohydrates.