

## Photosynthesis

The word *Photosynthesis* means chemical building up or synthesis using light energy.

Light consists of small “packets” of energy called *Photons*. The energy in each photon depends on the *wave length* of light involved. Different *colours* are due to different wave lengths,

### Wave Length of Light

The length of a light wave is very tiny and these lengths are measured in millionths of a millimeter or Nanometers. One Nanometer is a thousand millionth of a METER, which is, in fact one millionth of a millimeter

Thus red light is about 760 nanometers and blue light is about 400 nanometers.

Note: 1000 nanometers is a thousandth of a millimeter or one micron, so we could also say that red and blue are 0.76 and 0.4 microns respectively

### What happens in Photosynthesis?

Basically, photosynthesis in plants is the splitting of water into oxygen and hydrogen *ions*:



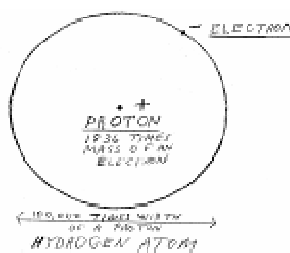
Where  $\text{H}^+$  is a hydrogen ion [NOT *iron!*] and  $\text{e}^-$  is an electron

### What are ions and electrons?

In order to understand these terms we need to know about the structure of the simplest atom known, that is, the hydrogen atom. This consists of a positively charged proton and a negatively charged electron in a sort of orbit around it.

### The Hydrogen Atom

Central massive  
proton 1836  
times as heavy as  
the orbiting electron.  
H atom is  
100,000 times  
size of proton



### Acidity

Hydrogen ions are responsible for *acidity*. *Acids taste sour and turn litmus paper red. They occur in citrus fruits like lemons and oranges.*

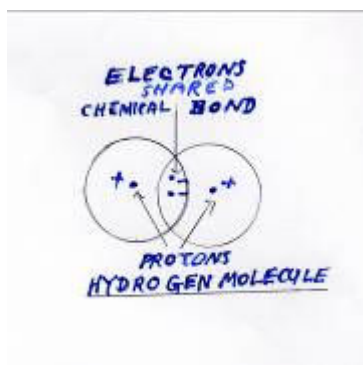
*Hydrochloric Acid is a very strong acid due to dissociation:*



### The Hydrogen Molecule

Hydrogen atoms do not exist on their own. They come in *pairs* called hydrogen *molecules*.

**All chemical bonds are formed by a sharing of electrons between two atoms**

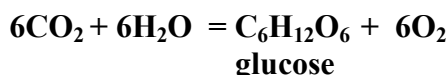


Notice that the two atoms are bound together, and this is due to the fact that their electrons are *shared mutually between them*. This sharing of electrons between atoms, is the principle on which all chemical bonding is based whatever the size of the molecule.

## PHOTOSYNTHESIS

The energy obtained from the splitting of the water molecule is used by plants to make *carbohydrates*. This is the chemical term for *sugars* in a general sense. The common sugar you eat is called *sucrose*. Other common sugars are *glucose* and *fructose* or fruit sugar. There is also *Lactose* which occurs in milk.

Thus plants are able to build glucose from carbon dioxide and water:



This is how plants replenish the oxygen in the atmosphere

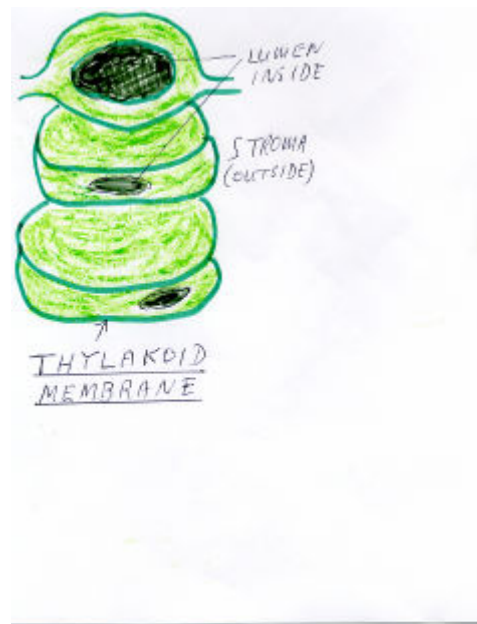
**Photosynthesis** occurs in all green plants, and especially in certain single-celled algae in the oceans, which contribute about half the global photosynthesis. The carbohydrates thus produced are the ultimate source of energy of almost all other organisms including animals and man.

The **green** substance in leaves is called **Chlorophyll** and this, together with many other large and small molecules, is involved. Chlorophyll occurs in special organelles called **Chloroplasts**, about 5 billion per leaf. Photosynthesis takes place in a special membrane within the chloroplasts called the **THYLAKOID MEMBRANE**. The assembly of chlorophyll takes 17 enzymes.

Photosynthesis in plants occurs in tiny organelles called *Chloroplasts* a few microns across

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Diagram shows a tiny section of the very folded membrane to increase surface area. The inside is called the lumen and the outside the stroma



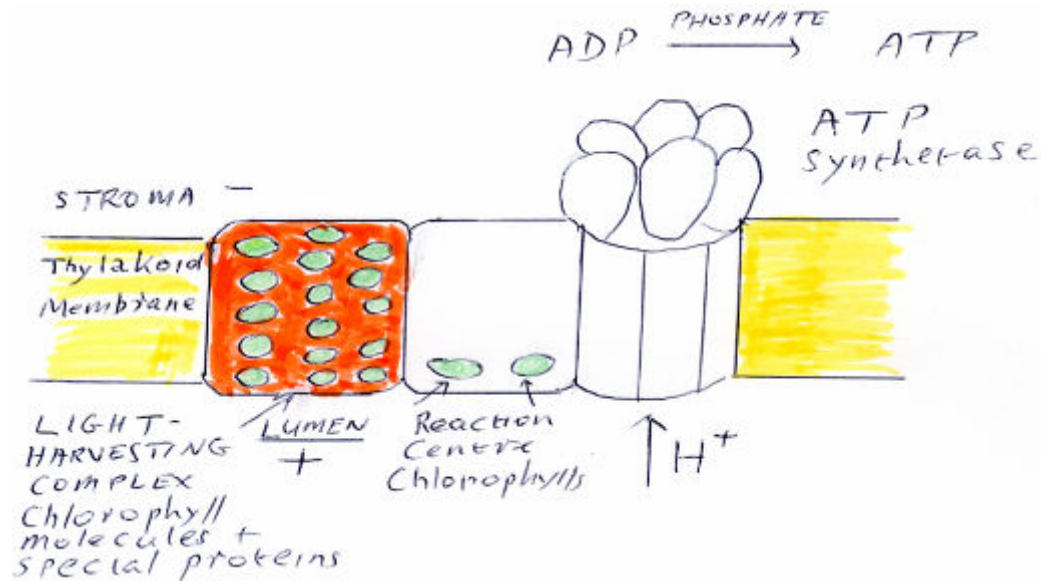
Water (H<sub>2</sub>O) is a very stable compound. Even at 2000<sup>0</sup>C it is very little dissociated. But plants manage this dissociation at atmospheric temperatures, but the process consists of many stages and is complicated.

### MECHANISM OF PHOTOSYNTHESIS

There are two types of chlorophyll, - **chlorophyll a** and **chlorophyll b**. Also **Beta Carotene**, the orange-coloured material in carrots, is also involved. There are two photosystems which are separate yet complementary:

#### **Photosystem I** **Photosystem II**

These are embedded in the **Thylacoid Membrane** and contain **Light-harvesting complexes** consisting of the two chlorophylls and associated protein molecules and the **carotenoids**. The two systems allow a wider spectrum of light to be used.

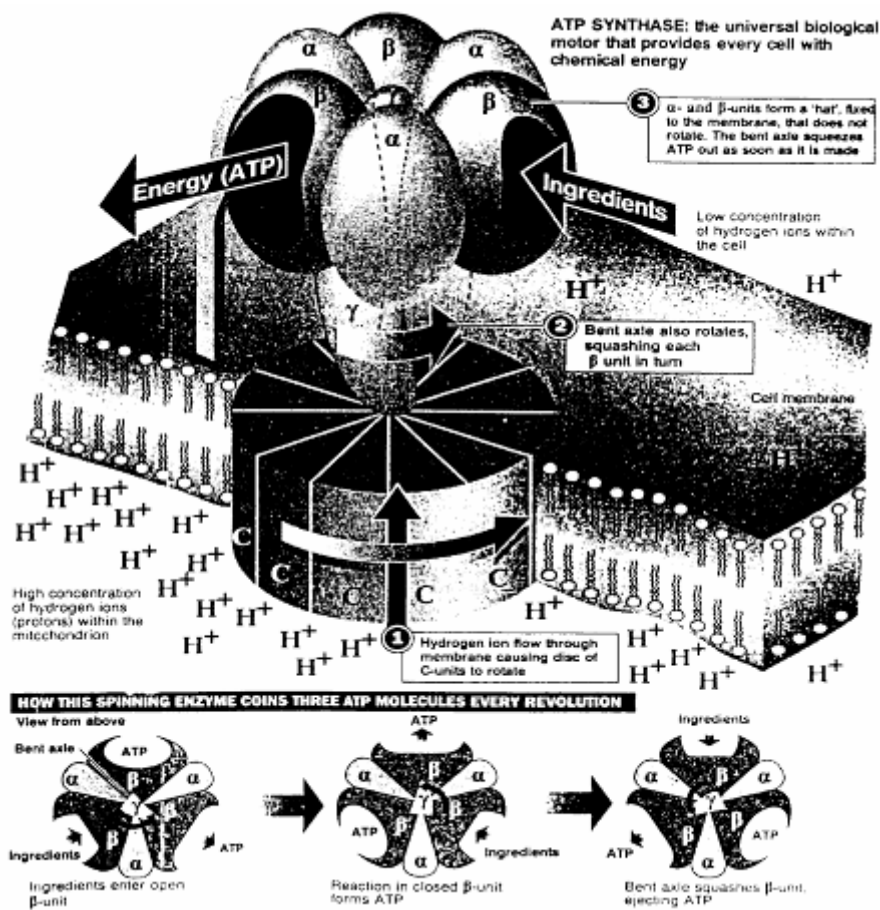


**Photosystem I** absorbs at 700 nm or less.

**Photosystem II** absorbs at less than 680 nm

The strongest known *electron acceptors* are formed which tear electrons from water. This occurs inside the lumen of the Thylakoid Membrane where *protons or hydrogen ions* from water are liberated. The inside of the membrane thus becomes acidic.

Embedded in the Thylakoid Membrane is the complicated motor enzyme **Adenosine Triphosphate Synthetase** which synthesizes **adenosine triphosphate** from adenosine diphosphate and hydrogen ions. It is a wheel which rotates at 6000 revolutions per minute.



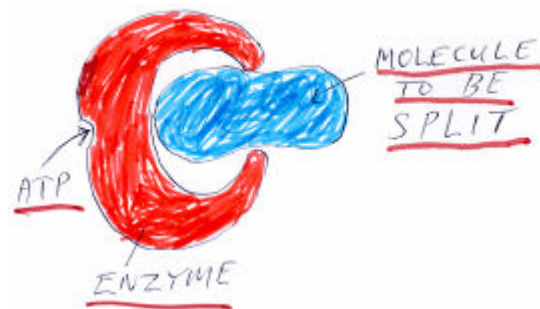
It is this Adenosine triphosphate that is the “petrol” of every living cell from bacteria to man. The structure is:

### Adenine-phosphate-phosphate-phosphate

The third phosphate link easily breaks and enzymes have an active centre which receives which is activated by the energy liberated from the phosphate bond.

The energy liberated by the rupture of the phosphate bond is passed onto the enzyme which then enables the enzyme to function, for example, to break or make a chemical bond. Every chemical reaction requires energy and this is supplied to the enzyme by Adenosine Triphosphate. There is another compound which has similar functions.

**There is a site on enzymes which receives Adenosine Triphosphate and forms ADP and activates the enzyme**



**The Enzyme splits the molecule**

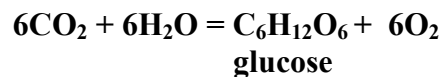


**Enzyme has now done its work and is regenerated**



It is expecting too much for those not trained in biochemistry to describe further details of photosynthesis, but suffice it to say that at least 13 complex entities are involved, in addition to Adenosine Triphosphate Synthetase. These include at least 5 special organic compounds, the metals Iron, Manganese and Copper as well as special enzymes.

The next stage is the buildup of carbohydrates by the incorporation of carbon dioxide:



This requires at least 20 enzymes

### **Problems for the Evolutionist**

Photosynthesis consists of series of reactions producing intermediates that are useless to the cell until the final product is formed.

All 17 enzymes for making chlorophyll have to be all present and in the right order and in the right geometric relationship like an assembly line because the intermediate products would be toxic to the cell if any escaped from the series.

The coding on DNA of all these enzymes and many more would have to evolve before they could be produced. The probability of 1000 base pairs in correct sequence would be about 1 in  $10^{600}$ .

Chlorophylls and other pigments need enzymes that would bind to them before the pigments even existed.

There is the impossibility of evolving the complex motor Adenosine Triphosphate Synthetase.

Photosynthesis is foundational to all life, and, in evolutionary terms, would have to exist in some form in the very first organisms to provide oxygen and carbohydrates for more complex organisms to feed upon and develop.

Yet photosynthesis is so complicated that chance alone could not account for it. It is testimony to our great Designer God.

In addition to all this, chloroplasts are sites for the synthesis of almost all amino acids (the building blocks of proteins), all fatty acids and carotenes, and also the building blocks of DNA and RNA (all pyrimidines and probably all purines)

Thus very many enzymes are involved. All this indicates incredibly skilful design, impossible by chance. Glory to our Creator!

**My street address and phone number:**

**44 Aireville Rise,**

**BRADFORD,**

**West Yorkshire,**

**BD9 4ES**

**Tel: 01274 582959**

**Email: [briancowell@blueyonder.co.uk](mailto:briancowell@blueyonder.co.uk)**

