Life’s Greatest Invention: Photosynthesis

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FEW innovations have had such profound consequences for life as the ability to capture energy from sunlight. Photosynthesis has literally altered the planet's face, transforming the atmosphere and cocooning Earth in a protective shield against lethal radiation.

Without photosynthesis, there would be little oxygen in the atmosphere, and no plants or animals - just microbes scratching a meagre existence from a primordial soup of minerals and carbon dioxide. It freed life from these constraints and the oxygen it generated set the stage for the emergence of complex life.

Before photosynthesis, life consisted of single-celled microbes whose sources of energy were chemicals such as sulphur, iron and methane. Then, around 3.5 billion years ago, or perhaps earlier, a group of microbes developed the ability to capture energy from sunlight to help make the carbohydrates they needed for growth and fuel. It is unclear how they achieved this feat, but genetic studies suggest that the light-harvesting apparatus evolved from a protein with the job of transferring energy between molecules. Photosynthesis had arrived.

But this early version of the process didn't make oxygen. It used hydrogen sulphide and carbon dioxide as its starting ingredients, generating carbohydrates and sulphur as end products. Some time later - just when is uncertain - a new type of photosynthesis evolved that used a different resource, water, generating oxygen as a by-product.

In those early days, oxygen was poisonous to life. But it built up in the atmosphere until some microbes evolved mechanisms to tolerate it, and eventually hit on ways to use it as an energy source. That was a pretty important discovery too: using oxygen to burn carbohydrates for energy is 18 times as efficient as doing it without oxygen.

Life on Earth became high-powered at this point, setting the scene for the development of complex, multicellular life forms - including plants, which "borrowed" their photosynthetic apparatus from photosynthetic bacteria called cyanobacteria. Today, directly or indirectly, photosynthesis produces virtually all of the energy used by life on Earth.

As well as providing an efficient means to burn fuel, oxygen made by photosynthesis helps protect life. Earth is under constant bombardment from lethal UV radiation streaming out from the sun. A by-product of our oxygenated atmosphere is a layer of ozone extending 20 to 60 kilometres above Earth's surface, which filters out most of the harmful UV. This protective umbrella allowed life to escape from the sanctuary of the ocean and colonise dry land.

It has altered the atmosphere and cocooned Earth in a protective shield. Now, virtually every biochemical process on the planet is ultimately dependent on an input of solar energy. Take a deep breath and thank those primordial oxygen-hating microbes for their biochemical inventiveness.

Questions to “Life’s Greatest Invention: Photosynthesis”

1. What is the author’s overall attitude towards photosynthesis?
2. Using the text, create a Venn diagram comparing the types of life that existed on Earth prior to photosynthesis and the types of life that existed after photosynthesis
3. Using the text in the article, write a word equation to describe the early version of photosynthesis.
4. According to the article, how did the evolution of microbes that were able to utilize oxygen pave the way for the evolution of complex life and its colonization of land?