How the First Life Forms Made Earth What it is Today

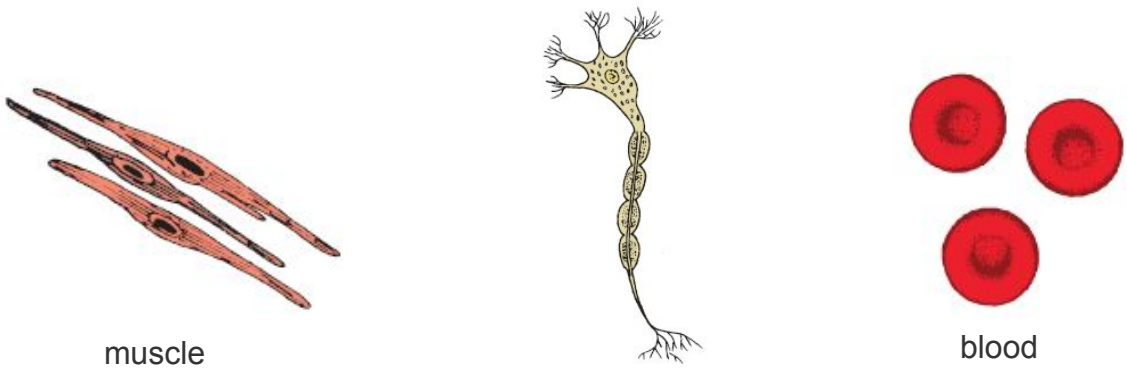
Chapter One: What is Life?

As humans, we're used to asking, "What is the meaning of life?" But there's an even more basic question: What is life? A better question might be: What makes something alive?

Here are some of the characteristics shared by all organisms (scientific term for "living thing"):

All living things are made of cells. What are cells? Cells are the basic building blocks of life. Although the cells of different kinds of organisms are different, they all share certain basic similarities. They are made of similar chemicals and have similar parts that make them up. All cells have a boundary, or membrane, that keeps the parts of one cell separate from the other cells around it. All cells have the ability to reproduce themselves. Almost all cells have a copy of the DNA of the organism.

Examples of one-celled organisms



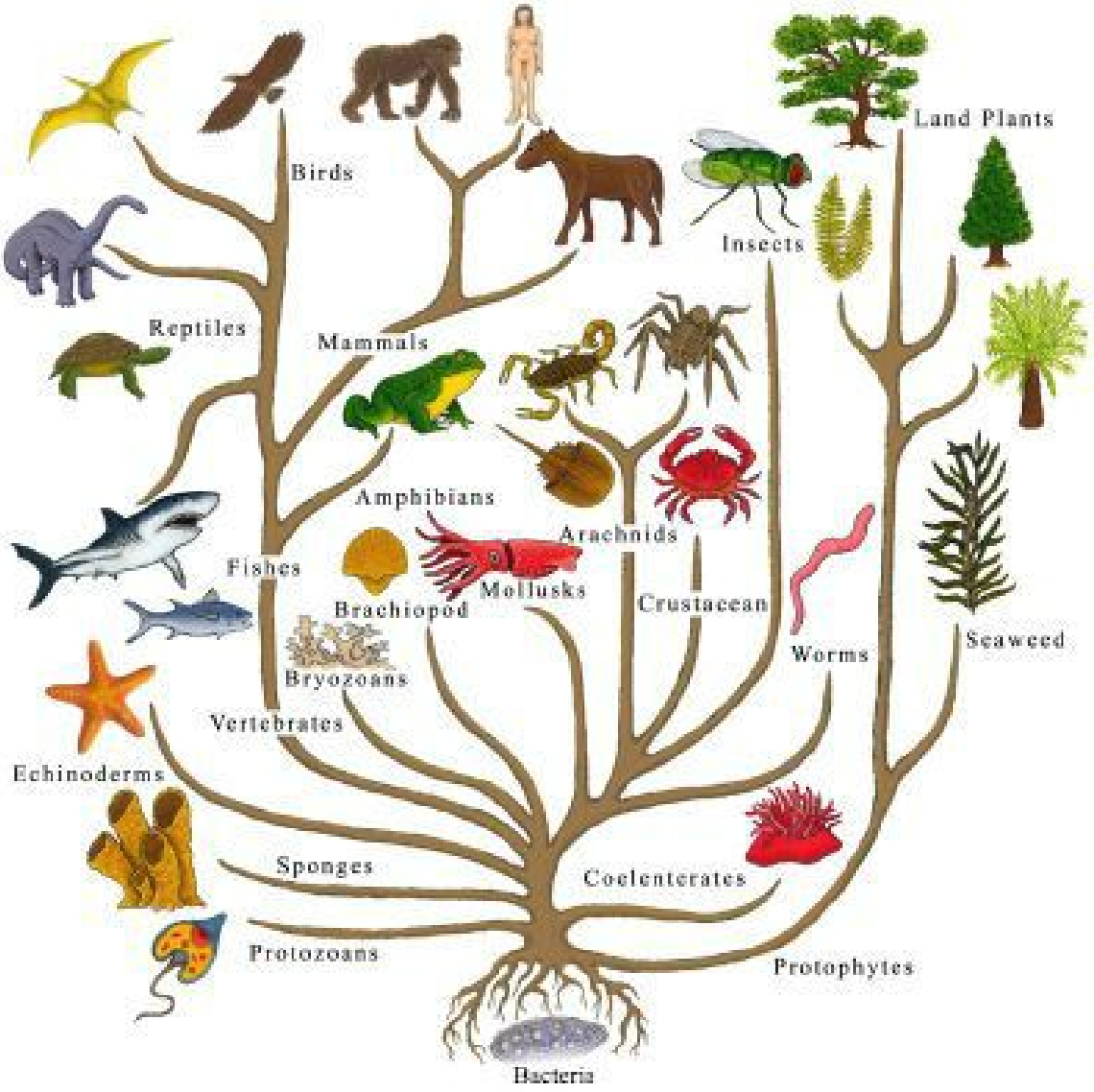
Different cells in the human body

Living things require water and a source of energy.

All living things must have water to survive and some way of getting energy.

Living things reproduce and grow.

All living things have the ability to reproduce and grow. That is how it was possible for everything we see around us to evolve from the very first living things on Earth, which were very simple one-celled organisms similar to bacteria.



This "Tree of Life" diagram shows how all living things on Earth evolved from the simplest organisms—bacteria.

Chapter Two: What were the earliest organisms on the earth like?

Answer: Yes. The earliest organisms that lived on Earth were one-celled organisms called bacteria.

Bacteria Facts

Bacteria are very small organisms. Bacterial cells do not have a nucleus, or "control center," as some other types of cells do. However, they do have DNA, the chemical that allows organisms to pass on their genetic information, and the chemicals that make them up are basically the same as other living things.

Bacteria help our bodies in several ways. They help with the digestion of food, and they help us to produce needed vitamins. Almost all bacteria are helpful to our health and well-being. Only a few types of bacteria cause disease. Many harmful organisms, such as viruses (in everyday life we call these germs) in our bodies are destroyed by bacteria. There are more bacterial cells in your body than there are human cells.

Bacteria also help to make sourdough bread, yogurt, milk and cheese.

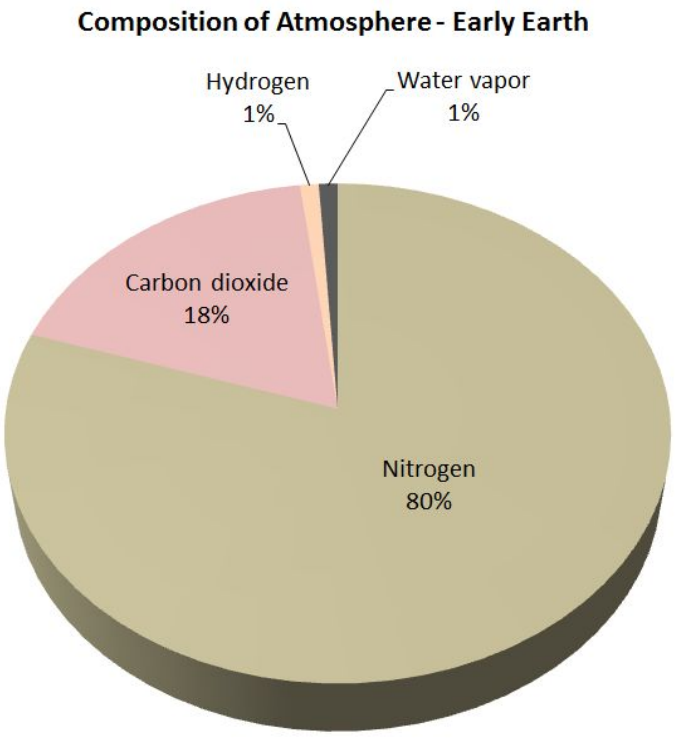
Scientists estimate that bacteria produce nearly half the oxygen found in the atmosphere.

How did Some Bacteria Come to Depend on Oxygen for Energy?

The first bacteria that lived did not breathe oxygen, because there was virtually no oxygen in the air at this time. The fossils of some these oldest known forms of life have been found in Australian rocks dating back 3.5 billion years.

Remember that all living things require water and an energy source. As humans, we get energy from the food we eat and the air we breathe. So do most animals. But not all living things get their energy this way.

Another word for breathing is respiration, which is defined as oxygen moving into the body and carbon dioxide moving out. In biology, cellular respiration means something different. It refers to how living things get their energy from nutrients by breaking down molecules.



This is what the atmosphere was like when Earth was young.

You've heard of aerobics, right? Aerobics is short for aerobic exercise. This is the type of exercise that requires your cells to use oxygen to produce energy from food, and ends up burning more calories than other kinds of exercise. Aerobic respiration simply means producing energy using oxygen. It produces more energy than other kinds of cellular respiration.

There is another type of respiration used by cells, called anaerobic respiration. This kind of respiration does not require oxygen, but it is less efficient than aerobic respiration and produces less energy. An example of this way of producing energy would be fermentation—the same process that makes alcohol and pickles. To make beer you combine barley or wheat and water. The broken down barley and wheat turns into sugar. Bacteria eat the sugars and produce alcohol and carbon dioxide gas as waste products. The first organisms on Earth used fermentation to produce energy.

In the early Earth, the first organisms got their energy from amino acids (chemicals that make up proteins) and sugars that were naturally floating around in the environment. These organic compounds (chemical substances) were formed in the atmosphere, then dissolved in liquid water. After consuming and digesting amino acids, early bacteria produced methane and carbon dioxide as waste products. Methane and carbon dioxide are common

gases in the world today. In the early Earth, the alcohol and carbon dioxide became part of the atmosphere.

Over time, new life forms evolved which were able to get their energy from a different source -- the Sun!

Cyanobacteria make their own food through photosynthesis

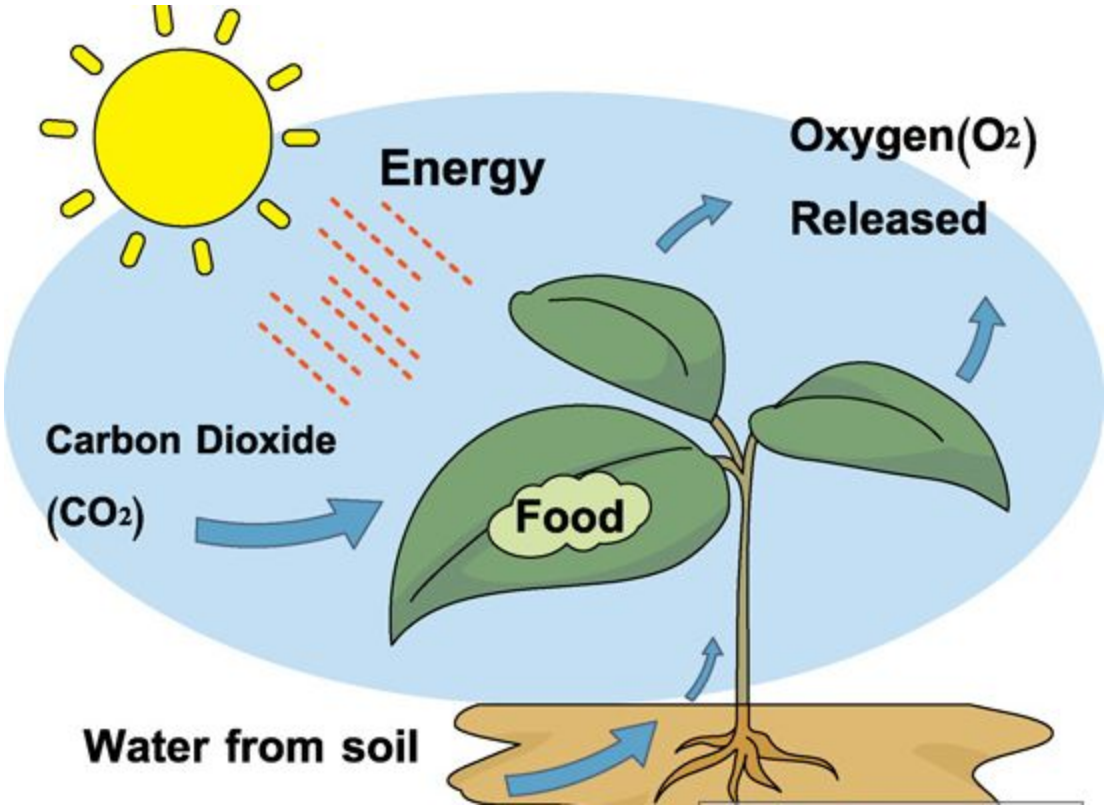
Chapter Three: What is Photosynthesis and Why is it Important?

Over a very long time, gradual changes in the earliest cells gave rise to new life forms called cyanobacteria. These new cells were very different from the earlier one-celled organisms because they were able to get their energy from a new source—the Sun.

Organisms that are able to make their own food (in the form of sugars) by using the energy of the Sun are called autotrophs, meaning "self-feeders". For example, plants are autotrophs. Plants use energy from the sun to make sugar from water and carbon dioxide through a process called photosynthesis. Oxygen is released as a waste by-product. (Organisms like humans which cannot produce their own food, are called heterotrophs, meaning “other-feeders”, because they have to consume other organisms to survive.)

Because the autotrophic bacteria were able to feed themselves by using the energy of the Sun, they were no longer dependent on the same limited food supply as their ancestors and were able to survive and grow in population. Over millions of years of evolution, photosynthetic bacteria eventually led to the development of the plants we see around us.

The appearance of organisms capable of performing photosynthesis was important—if it weren't for the photosynthetic activity of these early bacteria, Earth's atmosphere would still be without oxygen and organisms that need oxygen, including humans, would never have appeared!



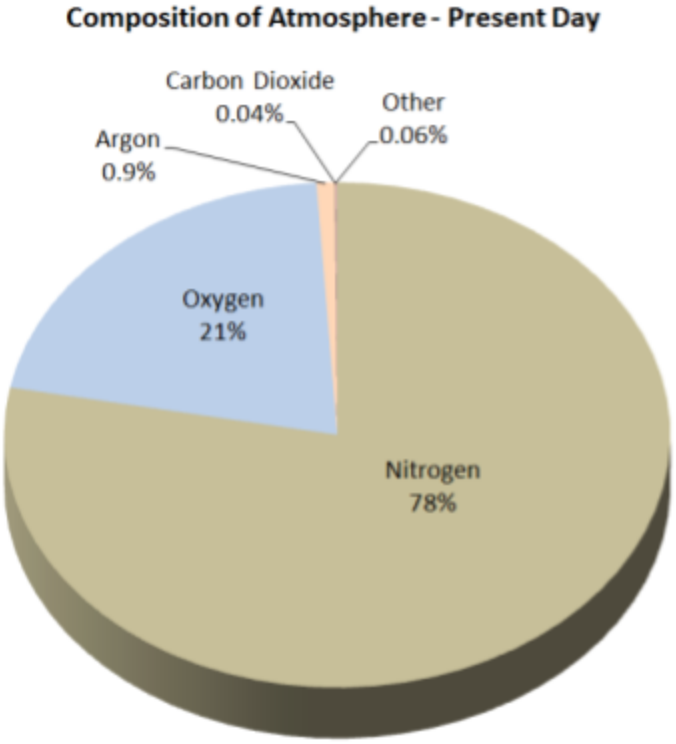
This diagram shows how photosynthesis works in plants.

Chapter Four: How did Oxygen Slowly Build up in the Earth's Atmosphere?

So, first of all, what do we mean by "atmosphere?" We are used to saying, in everyday life, "the air we breathe." What we really mean is the oxygen we breathe. Actually, our air, or atmosphere, is made up of more than one type of gas, and oxygen isn't even the most abundant one.

Look at the diagram below to see the composition of the atmosphere now:

The atmosphere of Earth has changed over time. It took a long time for oxygen to build up in Earth's atmosphere. At first the atmosphere was made of hydrogen, then after volcanic eruptions the atmosphere was made of carbon dioxide, sulphur dioxide, ammonia, and other gases. Eventually, the atmosphere was made mostly of nitrogen. Today the atmosphere is about 80% nitrogen and 20% oxygen.

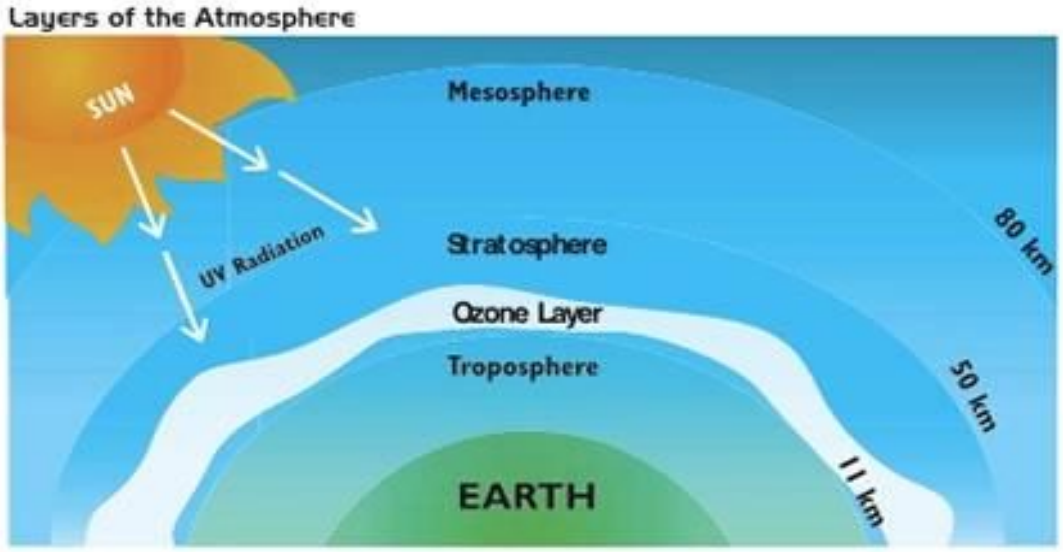


The diagram above shows the gases that are in the air now.

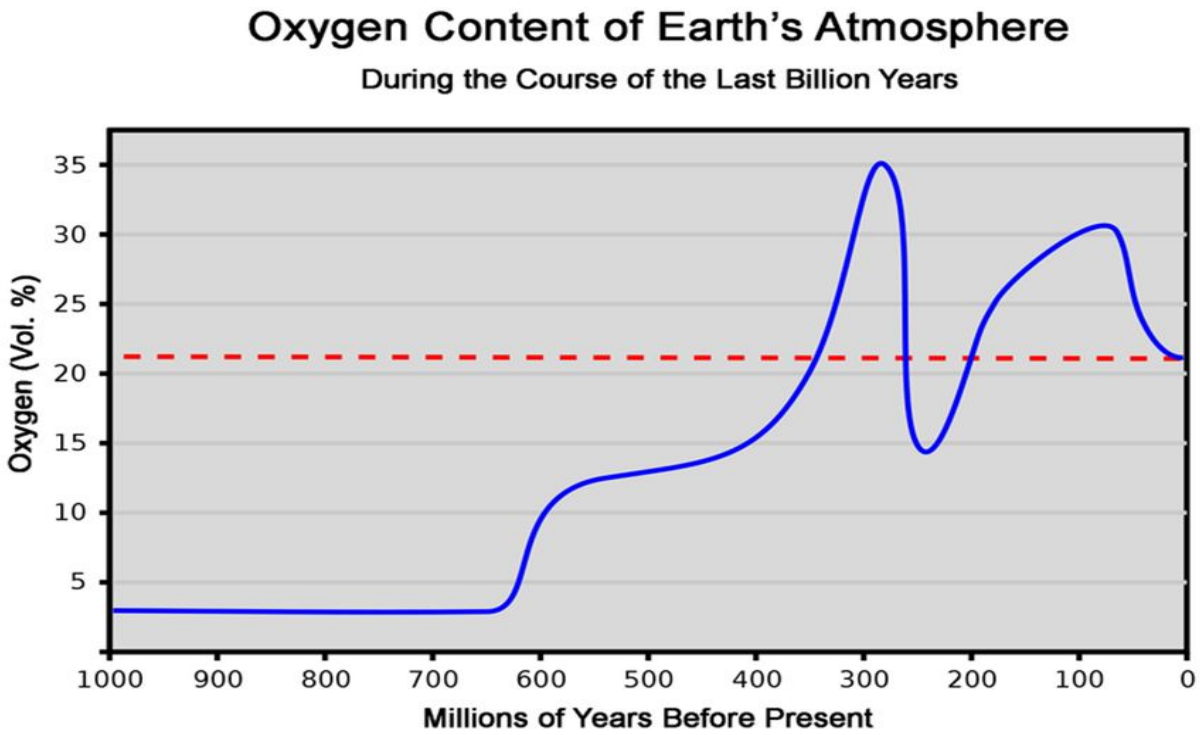
In the early Earth there was very little oxygen. Three and a half billion years ago there was only 0.01% oxygen in the atmosphere. 2.5 billion years ago there was only 0.1% oxygen in the atmosphere. Imagine how hard it would be to breathe in the environment of the early Earth!

The formation of life on Earth played a very large role in the build-up of oxygen in the environment. As early as 3.5 billion years ago, bacteria began to produce oxygen as a waste product of their activity. About 2.5 billion years ago, enough oxygen was in the atmosphere that simple organisms like protozoa and amoeba started to use aerobic respiration to produce energy.

After a long time, organisms that used photosynthesis became more efficient, so the production of oxygen in Earth's early environment accelerated. Oxygen continued to build at an accelerating pace until 1% oxygen levels were in place. The more oxygen accumulated in the atmosphere, the larger became the protective ozone layer (formed from oxygen in the atmosphere). Ozone helped protect developing life from the harmful effects of the Sun's ultraviolet radiation. Then other life forms such as sponges, worms, and other organisms came to be.



Once oxygen levels of 1% were achieved, and an ozone layer developed, there seemed to be enough oxygen present for the development of many different kinds of life forms, including reptiles such as dinosaurs, mammals and the great diversity of life we see around us.



This graph shows how oxygen built up over time in Earth's atmosphere, as more and more living things began to produce oxygen through photosynthesis. The higher oxygen content allowed more oxygen-breathing organisms to live and reproduce, and eventually evolve into the complicated beings that we are now.