Lesson 11: Oxygen Changes Everything

Take a deep breath. Hold it a moment. That oxygen filling your lungs was not always there. For the first billion or more years of life on Earth, the atmosphere had almost no free oxygen at all. The ancient bacteria and archaea living in those early oceans had no need for it. Many would actually have been harmed by it. And then a particular group of bacteria discovered something that would transform the entire planet.

Cyanobacteria are a kind of bacteria that learned to use sunlight to make food, a process called **photosynthesis**. Using sunlight, water, and carbon dioxide, they produced food for themselves and released oxygen as a byproduct, the way a fire releases smoke. At first, that oxygen was absorbed by the iron dissolved in the oceans, forming rust. You can still see this evidence today in ancient banded iron rock formations: rusty red stripes laid down in ancient seafloors as oxygen began to accumulate. But eventually, the oceans became saturated, and oxygen began to spill into the atmosphere.

About 2.4 billion years ago came the **Great Oxidation Event**, one of the most dramatic turning points in Earth's history. For the **anaerobic** organisms that had evolved in an oxygen-free world, it was a catastrophe. Oxygen was toxic to them, and enormous numbers went extinct. But for other microbes, oxygen was an extraordinary gift. Organisms that could use oxygen for **aerobic** respiration could extract far more energy from their food than anything before them, energy enough to eventually support complex, large bodies. Oxygen transformed what life could be.

The oxygen also rose into the upper atmosphere, where it formed the **ozone layer**, a shield against the Sun's ultraviolet radiation. Before this layer existed, the land surface of Earth was bathed in harmful radiation that would damage the chemistry of life. The ozone layer changed that. Slowly, the land became available. The patient work of trillions of cyanobacteria, over billions of years, did not just change the air. It opened up an entirely new world.