

The Basic Chemistry Set for Life

- 20 amino acids
- A few nucleotide bases for making RNA and DNA
- A few lipids

Think of it as an industrial city; tiny structures work like factories. They take in the raw materials and transform them into the “hardware” to produce new cells. They must also produce power to keep their industrial units rolling.

What are the Options...

... being considered as the location or source of the first life on Earth?

Option 1: Warm water pools on the surface

Option 2: Hot water vents on the deep ocean floor

Option 3: Cooler alkaline vents on the deep ocean floor

- *This is now the leading proposal for the origin of life on earth*

Option 4: Life arrived fully formed from outer space: “Panspermia”

- The problem with this proposal is that it simply displaces the search for the origins of life to another location. This may simply suggest that life requires TWO planets to get started: one to begin and another on which to thrive and survive.

Cosmologists are more and more convinced that life is everywhere in the Universe.

Is there other intelligent life? This is a much more difficult question to answer.

“We are all connected; To each other, biologically. To the earth, chemically. To the rest of the universe atomically.”



– Neil deGrasse Tyson

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A Brief History of Life on Earth



“The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pies were made in the interiors of collapsing stars. We are made of starstuff.”

– Carl Sagan, Cosmos

A Brief History... as we Understand it TODAY

The origin of life on Earth is one of the big questions humans have asked themselves for millennia. Science and religion arrive at very different answers. For now, neither has a demonstrably adequate answer to the origin of the universe and everything we find in it, but science provides us with an explanation based on evidence and facts that allows us to understand the way life may have emerged on this planet we call Earth, the only rock in that universe we know of that can support us.

Here is a brief synopsis of the main steps in the process that lead to our existence, as science tells it today:

- **13.8 billion years ago:** The Primeval Atom expanded (aka, "The Big Bang") and some of the energy coalesced into subatomic particles, those into atomic particles, and then into hydrogen; the early universe is dark!
- **13.3 billion years ago:** As the early universe cooled, hydrogen collapsed to form stars; the universe is lit!
- Atoms of basic chemicals emerged in stars and, as they were drained of their energy, in some cases, the results were supernovae which generated many of the heavier natural elements (this process continues today)
- Basic chemicals formed compounds (this process continues today)
- Accretion of dust and gases around new stars led to the formation of planets, asteroids, comets, etc. (this process continues today)

- **4.6 billion years ago:** Our Sun emerged in this way and the early Solar System took shape around it
- *Under the conditions of the early Earth,* inorganic compounds formed organic ones
- *Under the conditions of the early Earth,* organic compounds collected in necessary ways to form cellular life (*i.e., life on Earth began*)
- **4.1 billion years ago:** Evidence has been found that indicates early forms of life may have existed at this point in the history of the Earth
- **3.0 billion years ago:** Single-celled life developed the ability to generate oxygen (*i.e., photosynthesis*)
- Single-celled organisms grouped together in communities that began to behave as single organisms, and cells specialized; the information encoded in the DNA became more complex
- **800 million years ago:** First multicellular organisms may have arisen
- **522 million years ago:** The survivors of Snowball Earth (*i.e., a time at which the Earth's surface became entirely or nearly entirely frozen*) inherited an oxygen-rich planet and diversity increased rapidly (Cambrian Explosion)
- **3.8 million years ago:** Ostrich eggs were left behind and their discovery includes the oldest proteins discovered to date
- **250,000 years ago:** *Evolution led to the emergence of our human ancestors*

Some More Background...

... on the process and our current understanding of it:

The milestones along the path are few:

- The origin of life
- The presence of oxygen leading to complex life
- The rise of intelligence

The three main parts of a living organism are

- *Metabolism:* a chemical reaction that powers the life (power source)
- *A wall or sack* that separates you from the outside environment (protective sack)
- *A stored blueprint* or description of yourself (plans for making more protected power sources)

DNA is the Plan

DNA is a long molecule built up from small units called nucleotides. It contains the instructions for building a cell's protein engines using small molecules called amino acids. It also tells the cell how to make lipids, which are used in forming the cell's protective sack. This process results in the most basic form of life: *a cell!*

