LIFE & PURPOSE

A BIOLOGIST REFLECTS ON THE QUALITIES THAT DEFINE LIFE

By Ursula Goodenough, adapted by Newsela
What’s the difference between nonlife and life? To answer this question, we must first define life. Below are the key features of life. Answering this question depends on understanding these features.
It’s important to understand that every organism is a “self” or a “being.” A “self” performs two basic activities. It generates itself and maintains itself.

**Self-generation**

Self-generation is the making of a self. A yeast is an organism made up of just one cell. Self-generation for a yeast means starting out small, growing large, and dividing into two small daughter-yeasts that start the process again.

Humans are multicelled organisms. We start out as a single fertilized egg, develop from an embryo to a fetus, then take the path from newborn to old age. All organisms on our planet today use proteins to self-generate. Proteins come in particular shapes with bumps and cracks. Like a puzzle piece — the bumps stick out, and the cracks are the holes. These shapes allow proteins to do two major activities.

First, proteins interact with each other. Bumps from one protein fit into the crevices of others. They combine to form the chemical structures that make up a cell. Most parts of a cell are made from proteins. Second, proteins serve as enzymes. Enzymes allow efficient and accurate chemical reactions to happen inside the cell.
Every organism is instructed

The proteins we’ve been talking about are encoded in genes. The genes are embedded in DNA molecules. Each gene controls a particular protein. Genes tell proteins what shapes to fold into.

A full set of genes that can create a self-generating and self-maintaining self is called a “genome.” A yeast genome and a human genome have many genes in common. These are mostly the ones that deal with self-maintenance. They also have many genes that are different. Parent organisms pass down copies of their genomes to daughter organisms. This allows organisms to continue and spread.

Genomes can “turn on” and “turn off” certain genes and proteins. When it’s time to copy DNA into daughter molecules, genes controlling DNA-copying enzymes are “turned on.” When the copying is finished, these genes are “turned off.” To make red blood cells, genes controlling the hemoglobin protein are switched on in certain bone-marrow cells. However, they stay switched off in most of the cells in your body.

A genome isn’t just a collection of genes. It continuously controls self-generation and self-maintenance.

Self-maintenance

Every self must get the energy it needs to self-generate. Some organisms use photosynthesis. They turn the Sun’s light energy into food. Other organisms eat. They consume molecules, and break them down. They use the energy released for self-generation.

Self-maintenance also requires self-protection. Each self must avoid environmental hazards, predators and disease.
Every organism can evolve

DNA is usually copied with great accuracy. But mistakes can happen. These mistakes produce mutant genes that make proteins with different shapes.

Some mutations have basically no effect. The daughter organism can survive normally. Other mutations are deadly for the daughter organism. It may die immediately. The most interesting mutations are when the daughter survives, but is a little different than its parents.

For example, a parent duck may have thin webbed feet. A mutant daughter may have extra-thick webbed feet. What happens next depends on the environment where the ducks live. If the ducks live on mudflats, the mutant feet may help the duck. It may be easier for the duck to walk on the mud, find food, and avoid predators. Here, the thick-footed trait would probably spread into future generations. But if the ducks live in grasslands, the mutant feet may make the duck slower. It might not survive. The trait is less likely to spread.

I've just described Darwinian evolution: passed-down mutations and natural selection. The biodiversity around us is thanks to living organisms’ ability to evolve. Without it, we humans would never have showed up.

Ernst Haeckel’s 1879 illustration of the "tree of life" shows humans as the pinnacle of evolution, a common view among early evolutionists.
Every organism has purpose

Now we understand what life is. But is there one thing that distinguishes life from nonlife? How is a mountain really different from a whale? After all, both are made of molecules. Both engage in chemistry. Both change over time.

For me, the answer is purpose. A whale has purpose, but a mountain does not.

Organisms are about something, for something. Muscles are for movement; eyes are for seeing. Organisms have goals. The short-term goal is to self-generate and self-maintain. The long-term goal is to pass the genome on to offspring. This can only happen if an organism self-generates and self-maintains. Mountains are splendid of course, but they don’t have purpose or goals. They just are.

We can say that when life showed up on Earth, something completely new showed up: purpose. Whether life, and purpose, exist anywhere else in the Universe is unknown. It may remain a mystery. Meanwhile, we can enjoy and appreciate the astonishing purpose that surrounds us here on Earth.

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