Teacher Tune-up

Quick Content Refresher for Busy Professionals

What do scientists mean when they say the cell is the basic unit of life?

Cells are often called the "building blocks" of life, but they are so much more than just small pieces that make up the structure of an organism. When you build a house of blocks, blocks make up the matter of the building, and cells certainly do this for an organism – they form a body's legs and arms, or stems and leaves, or fins or feathers. But basic blocks can't do what cells can do. They aren't capable of making copies of themselves, taking in materials from the outside, getting rid of waste, or using energy to perform a wide variety of functions. Cells are the most miraculous of blocks because they contain all the information needed to regulate all aspects of an organism. They can also grow and replicate independently, creating copies of themselves to increase a population or build a new tissue or organ in a body. And they do all of this at a scale that no human eye can see.

All living things are made of cells. At the smallest level, organisms can be made of just one cell, such as bacteria, protozoa, or simple forms of algae. These cells contain all the hereditary information, which is contained in DNA, needed to function and reproduce. Multicellular organisms, such as a pine tree, a mushroom, or a cat, are often made of so many cells working together that scientists can't keep track. An average human, for example, may contain ten thousand trillion or

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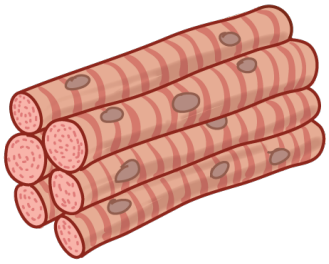
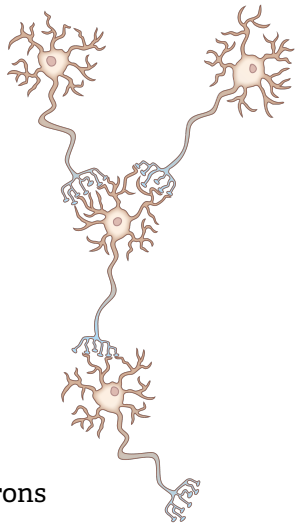
cells, though scientists debate this number within several orders of magnitude. All of these cells, however, can do the same basic things that bacteria can do: they can monitor their environment and respond to it; they can take in materials and get rid of waste, using energy to make and take apart molecules as needed; and they can reproduce, passing on all of their instructions to their daughter cells. These abilities make the cell the fundamental unit of life.

One of the most fascinating aspects of a multicellular organism is that all of its cells have the same DNA, the instructions for all of its functioning and reproduction, and yet the cells look so very different. In humans, if you look at a red blood cell, a muscle cell, and a cell in the brain (known as a neuron), it almost seems impossible that all of them are reading from the same instruction manual.



muscle cells



neurons

red blood cells

While the average human cell is about two-hundredths of a millimeter wide, their shapes and sizes can vary widely. Long projections from the center of a neuron might stretch several feet, while red blood cells form tiny, flexible discs, and muscle cells look like long tubes. All of these cells contain the same DNA. How can they look so different? A cell's shape or function is determined not just by the DNA it contains, but also by the specific parts of DNA that a particular cell reads. While every cell has the instructions for every function of the human body, specific cells only read specific parts of the manual. Because of this, neurons, skin cells, muscle cells, liver cells, and so forth all look different, though they are all contain identical DNA.

Look Out! Common Student Misconceptions

Students commonly think about cells from a structural standpoint, imagining the diagrams of cells so commonly seen in textbooks. (*See the video L5t1, "The Cell Is Not a Shoebox" for more about this misunderstanding.*) Because of this, many students believe that all cells are of a similar size and shape. Conversely, students may believe that if cells look different, they must have different DNA, not recognizing that all cells of a multicellular organism come from the same ancestor cell, and thus all have identical DNA. Lastly, students may see different organisms as having radically different cells, assuming that cell theory only applies to certain species. Helping students to see the similarities between, say, a yeast cell and a human cell, will allow them to appreciate the fundamental aspects of cells: that all cells are the smallest unit of a living organism that can function and replicate independently; that all cells use energy; that all cells take in materials; and that all cells produce waste. To help students appreciate these big ideas, some teachers use Venn diagrams or comparative terms that emphasize the commonalities between different types of cells.