



Elemental Abundance comparison activity

Objective:

Students will compare the carbon- and oxygen-rich composition of a human being to the background levels of these two elements in the Milky Way Galaxy. They will deduce that people are extraordinarily rich in both carbon and oxygen, and that the reason for this is these two elements' ability to make a diversity of bonds.

Instructions:

Prompt the students by saying, "Human beings have a composition that is based on the elements that are available in the Earth system, which is part of the solar system, which is part of the Milky Way galaxy, which is part of the universe. But how does the proportion of atomic stuff that makes up a person compare to the proportion we see in the larger galaxy. That is what you are about to find out."

Distribute copies of the Excel spreadsheet called "**Elemental abundance comparison**" to the students. Have the students calculate the answers to the following questions (5 minutes?) and then discuss the results in small groups or as a whole class.

Questions for students to answer:

How much more concentrated is carbon in human beings than in the galaxy as a whole? (Calculate the ratio of carbon to hydrogen in both systems.)

What percentage of a human is carbon? How does this compare to the percentage of the galaxy that is carbon?

How much more concentrated is oxygen in human beings than in the galaxy as a whole? (Calculate the ratio of oxygen to hydrogen in both systems.)

What percentage of a human is oxygen? How does this compare to the percentage of the galaxy that is oxygen?

Why are helium and neon so much less common in a human than in the galaxy as a whole?

Discussion points:

How much more concentrated is carbon in a person than the galaxy?
How much more concentrated is oxygen in people than the galaxy?

Author Neil Shubin wrote in his 2013 book *The Universe Within* that, "By weight, we contain such a large amount of oxygen and carbon that we are virtually unique in the known universe." Is he right? Explain.

Think about the chemistry of carbon and oxygen, and compare them to helium, which is much more abundant in the galaxy. What characteristics would make carbon and oxygen so common in people? Similarly, why is helium totally absent in people, in spite of being the second most common element in the galaxy? [Prompt: what about the atoms' abilities to make bonds with other atoms? How many empty spaces are available in the outermost valence level (electron shell) of these various elements?]

Humans are only one kind of life. Why do you think all life on Earth is carbon-based? [Variant: Life on Earth can eat other life on Earth. For instance, animals can eat other animals, or animals can eat plants. Fungi and bacteria can eat dead animals or dead plants. What does this suggest about the chemistry of other life forms on Earth, besides humans?]

Science-fiction spin off: What other elements on the periodic table have a chemistry similar to carbon? [silicon?] On another planet with an independent origin of life and plenty of that element but no carbon, what would life look/act like? How would the food chain be structured on such an exotic world?