The Complex World of Science

Listening to and reading the relentless rants of the national culture war gladiators has become tiring (especially with the political season upon us). I needed something uplifting so I started reading science about everyday materials and living cell life. I had not read any science since high school in 1963. High school science taught at the old Joseph High School building in the early sixties was actually pretty good. Mr. Morrison taught chemistry and he left on a grant from the Federal Government to do research; Jim McGinnis the basketball couch was a very good biology teacher; superintendent Bill Williams was competent at Algebra I and II; and of course there was nuclear engineer (and rancher) Gardner Locke teaching trig and physics with the entire blackboard filled with the math for a derivation proof for one equation. Schools in my era were under great pressure to raise the science knowledge of American kids to compete with the threatening Soviets and their shocking Sputnik, the first human success in outer space in 1957.

However, one thing is clear from my current science readings: the knowledge of our world has advanced enormously since my Joseph High School days. Several books for the non-science person like me (very important) are not only informative but inspirational: *Stuff Matters* and *Liquid Rules* by Mark Miodownik and *Song Of The Cell* by Siddhartha Mukherjee have opened my mind to the world around me, a world I vaguely sensed but did not truly understand. These books are about ordinary materials and living organisms in our everyday world, but they are explained in layman's terms of atoms, electrons, molecules, and cellular life. Are your eyes glazing over yet? Stay with me and let me entice you a bit. Let's talk about concrete as an example of a common material.

The Romans figured out how to make concrete 2000 years ago through trial and error (a local source for high temperature, fused, volcanic silicate powder was critical). The concrete dome of the Pantheon in Rome still stands today (whereas high rise condos in Miami are imploding after a few decades). The Roman concrete was only strong vertically (compression), they had not figured out iron rebar yet for the horizontal. The knowledge of how to make concrete was lost after the fall of the Roman Empire (Christians were more interested in accessing heaven). It wasn't until the late 19th Century that concrete once again begins to appear. Making the powder used in concrete is very complex and requires exact ratios of limestone, aluminum, iron, and magnesium oxide plus heating them to 2,370°F (the exact process is a couple of pages of formulas). At this temperature the electrons in the atoms reform their electrical bonds allowing the molecules to form a new material: a gray powder. Without the high temperature

you get sludge which will never harden. This gray powder is what your local cement business buys from the manufacturer to mix with water.

It is at the local cement business that quality can drop to dangerous levels resulting in buildings that collapse (200,000 dead in Haiti in 2010 from shoddy concrete construction). The concrete powder we use today must be mixed very accurately with water to start the chemical reaction (atoms and electrons again) that ultimately changes the powder into a gel as crystal-like molecular fingers grow and interlock forming a rigid skeleton, which locks in water molecules, and ultimately hardens into concrete. Too much or too little water and the resulting concrete will have weak molecular bonds. When done correctly these molecular bonds continue to strengthen over many years. I simply did not know that this common material required such an exacting molecular formulation. Now a little bit about living cells.

All living things on Earth have the cell as their foundation element. Cells are incredibly complex and we are just in the beginning of unlocking how they work, and there remain many mysteries (see *Song of The Cell* book). There are estimated to be 30 trillion cells in the human body and 200 different types of cells, all working in harmony to keep you happy and functioning…. except when they don't. And that is when you drive to Wallowa Memorial Hospital and seek the knowledge of someone who knows about how cells go wrong and how to repair them. As a child I spent several days in the old hospital in 1952 (brand new then) with pneumonia as the pathogen attacked my lung's cell walls. Lucky for me penicillin had just been introduced (it's molecules penetrate and weaken the cell wall of the pathogen) and in the middle of the night I got my regular periodic shot of penicillin in my butt and thankfully lived to tell about it.

The internal workings inside each cell are astounding in their sophistication and complexity. Cells are like small cities with all the functions to maintain order and continuity. They have a membrane (city walls), a nucleus (the control center), ports (gatekeepers to allow external molecules to enter or to keep them out), communicator receptors to talk to other cells, fasteners to help bind to other cells, auditors (to check the integrity of the new DNA string before the cell divides), a garbage dump (to store unwanted parts), a jail to isolate pathogens, logistics (to transport protein molecules), a post office (where items are coded for delivery to other cells), a generator (to turn food into energy), and it just keeps going. If you unfold the microscopic molecular DNA strings in just <u>one cell</u> and put them end to end it would equal about 6 feet. Put all the DNA strings of all the cells in your body together it would reach to the Sun and back 60 times. Put all the DNA strings in every human cell on Earth together and it would reach to the galaxy Andromeda two and a half times. We are very complex life forms here on this Earth.

So instead of reading all that depressing mud-slinging in the national culture wars, read something fascinating and uplifting…. Read about the fundamentals of matter and life on Earth. Life is so cool on this planet!

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