With each step upward in the hierarchy of biological order, novel properties emerge that were not present at the simpler levels of organization. These emergent properties result from interactions between components. A molecule such as a protein has attributes not exhibited by any of its component atoms, and a cell is certainly much more than a bag of molecules. If the intricate organization of the human brain is disrupted by a head injury, that organ will cease to function properly, even though all of its parts may still be present. And an organism is a living whole greater than the sum of its parts.

Neil Campbell: *Biology*, 4th ed., Chapter 1: Themes in the Study of Life

Rock Springs Eddies

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Emergent Properties

My mind was constructed in an Irish Catholic neighborhood of the Bronx, amid the loving devotion of an extended family and the chaos of the streets. The phrase "emergent properties" would have meant little to me as a boy—probably referring to the new apartment house going up on 239th Street. In biology class today, this phrase marks the theme that the whole is greater than its parts and occurs whenever one moves up the chain of order, achieving new properties that didn't exist before. In my desire to understand river ecology, I am taking General Biology and enjoying the irony of this phrase.

So in the Catholic teaching of my child's mind, God created the whole world--people, animals, Wekiva, and all--from nothing. That accounted for one great emergence. So whenever we asked "why?" about the state of that world, one simple answer was always, "that's the way God made it" or "God wanted it that way." Then there were other answers like 2 and 2 are 4, water flows

downhill, and Daddy's going to use that wood later to make a cabinet. When evolution was broached in school, the apparent conflicts between Darwin and Genesis were reduced rather easily to the metaphorical interpretation of days and eons; God was like Daddy, he made things over time and planned out our every purpose.

As an adult working on this same pattern of concepts, I began to see that there were three key points where God had to really step in and make something from nothing: the origin of matter/energy, the origin of life, and the origin of thought or reason. Everyone is awed at the prospect of the cosmic creation, sometimes called the Big Bang. Imagine telling your kids, "It all started with a Big Bang." Think of the peace in the household that will generate.

If it starts with a Big Bang, the laws of thermodynamics state that it will end with a whimper; but some cosmo-physicists contend that it will likely reach an expansion from which it will suddenly contract, one giant sinkhole giving up once and for all the whole earth and its universal setting, all properties sucked back down into nothingness. So that's the comforting big picture of science: at any random moment the forces of contraction win over expansion and the Really Great Depression occurs.

The only saving feature of this fearful symmetry is a cyclical concept, that is, the repeated reversibility of the action of creation, a kind of alternating current. This would start any mind that is prone to consolation to imagine Big Bang II, the Return of Big Bang, perhaps a little stronger (if it's put out by Hollywood) or weaker and then a pattern of oscillations with either progress or regress inherent in it.

What's happening here is that I am fishing for a context in which to set Rock Springs Run and the whole system of Wekiva. At fifty-six I undertook to build up from scratch my understanding of the natural world by going back to college and getting the General Biology I needed. This two-course sequence strikes me as the most essential education a college can offer for understanding ourselves, our communities, and the river.

So, inside of this cosmic unknown, we have a zillion little knowns: galaxies, fossils, ages, strata, atoms, proteins, polymers, Mandelian peas, fruit-flies, and the double helix, that cornucopia of earthly life, the encyclopedia of earth and her kind. These things we can see and touch, and the big mystery here on this planet is how can things evolve on their own from chemistry to biology, from mud to lizard, from dust to Adam, from hormones to foreplay and beyond.

No one can ever point to the child of the Bronx and say, "There, Steve, see that? It's matter becoming an elementary life form." Did you ever wonder why life is not emerging from raw material, somewhere on earth, now, where we can watch it? Is it because global conditions have

changed so much? That's silly. We can create conditions beyond anything the history of earth has known. Is it because we don't know how it's done so we don't know where to look? Or is our problem that it happens so gradually we don't have the patience or longevity to wait and see?

But what difference does it make if we know it or see it? Life is just a broad term for a lot of individual emerging properties we can see and sometimes create, but still can't comprehend. Each new property is like a metaphor that works well and so it's kept. My favorite is water: two hydrogen atoms, the earliest element, perhaps thirteen billion years old, found in every star system of the universe and bonded to tons of other substances, plus one oxygen atom, that eighth element so vital to our breath of life and now 20% of our atmosphere and 65% of our body weight. Now there's an emergence!

Think of respiration in the lungs and in every cell of every body of every plant and animal, drawing down energy from the sun and twice married to carbon creating the CO^2 necessary for carbon fixation, the essence of all living and growing stuff. Think of it dissolved in Wekiva's water currents and spiraling out into the great mucky way.

One semester of studying the cell and now suddenly every molecule to me is a big bang, a birth of life, the origin of thought. How did we get from mitosis to meiosis, from gymnosperm to angiosperm, from chlorophyll a to chlorophyll b? We now understand with some precision how we get from DNA to protein to traits of hair color or eyebrows to our body's behaviors that carve out time, love, and memory. Soon the flight of the egret may be reduced to chemical engineering. However, do such facts stop the mystery that a sequence of nucleotides can become a sequence of acids that become a particular feature of body hair? For a time, knowledge, even in small doses, can make the world seem ours, familiar and predictable, but the fact still remains that we don't know how these leaps take place at a zillion different points between the initial starburst and the ideas of this essay in our minds right now.

We need a consciousness or rationale for being the kind of person or individual that each of us is. But maybe the more important part of our mind is the wild part of us that is still unknown, the undiscovered and unexplored territory of the noosphere. That wild part with all of its hopes and dreams for a better life, a deeper love, a stronger family, and a healthy community is what I call the soul, immortal in its chemistry. It's what I teach from, and with, and to: "For every atom belonging to me as good belongs to you." It feeds on apple snails and swimming parties at Rock Springs Run.[1]

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[1] In the years since I first wrote this piece chemists have made extraordinary progress in laying out a process from pre-organic molecules to the reproductive capacities of RNA to the earliest single-celled organisms that would allow for the spontaneous emergence of life on a planet like ours.