A Short Introduction to Everything – And Why we Need to Know it

By Hope Benne

Thus shall ye think of all this fleeting world:
A star at dawn, a bubble in a stream,
A flash of lightning in a summer cloud,
A flickering lamp, a phantom, and a dream.

-Diamond Sutra, ca. fourth century, CE

As we look around us at the majesty of the natural world, and wonder at the results of our own creative powers, it dawns on us that everything seems made for us. We are delighted by "a star at dawn" and a "flickering lamp" which invite us to appreciate them. We ask ourselves "How did all of this come to be?" Today's universities and the internet offer unprecedented opportunities for grasping the history of everything. Using an interdisciplinary approach, we can explore the origins of the natural world and our own ascent within it. It is easy to discover what the sun is made of, how the continents drifted apart, and how energy and matter interacted to produce galaxies, stars, and planets.

Conceiving of a History of Everything (or a Universal History)

Today's historians document a history of everything based on modern science using data from telescopes, microscopes and powerful computers. But many early peoples also believed in a comprehensive story, a "unified, equal humanity", and a "single reckoning of past events." Indigenous peoples in Africa explained, for example, a potter took clay and formed everything; Native Americans believed a heavenly spirit gave birth to all the people. Early Hindus sang of storied gods in the *Rig Veda and Upanishads,* Hebrew scribes described Yahweh's will manifest in every event in the *Old Testament*, Siddharta declared people equal in the *Lotus Sutra*, and Stoics of ancient Greece, Sima Qian of the Han Dynasty, St. Augustine of Hippo in *City of God*, Paulus Orosius in *Seven Books of History,* Bishop Otto of Freysing in *The Two Cities,* Muslims such as Ibn Khaldun in *Muqaddimah*,

and Catholics such as Jacques Bénigne Bossuet in *Discourse on Universal History,* envisioned the world and humanity as one.

But it wasn't until the 1700's and 1800's in Europe, with growing information about the non-European world, that universal history flourished. In the hands of Gimbattista Vico (*The New Science)* and Johann Gottfried Herder (*Reflections on the Philosophy of the History of Mankind)*), Immanuel Kant ("Idea of a Universal History from a Cosmopolitan Point of View", G. W. F. Hegel (*Philosophy of History)*), and Leopold von Ranke (*Universal History*), historical writing was transformed into a "new science". It was at this time that a modern, scientific history of humanity became a possibility.

Something from Nothing – New Properties Emerging

Now-a-days when discussing our origins and the evolutionary nature of our world, our curiosity is immediately stimulated by how something can come from nothing. This is a phenomenon that has so frequently perplexed people, we have often been unable to find words and explanations equal to the task. Many draw on poetic language. Maya Angelou tried to capture the mystery of beginnings in her poem "On the Pulse of Morning":

> Lift up your hearts
> Each new hour holds new chances
> For a new beginning.
> Do not be wedded forever
> To fear, or yoked eternally
> To brutishness.
> The horizon leans forward
> Offering you space
> To place new steps of change
> Here on the pulse of this fine day.

Maya Angelou thinks of creation as an awakening each new morning. Similarly, a creation story of the Australian aborigines tells of a beautiful woman sleeping in a deep cave. A Great Father spirit tells her to emerge from her cave and stir the universe into life. So she opens her eyes and spreads her rays over the land. She breaths forth a gentle breeze, and awakens all the creatures and plants that had been sleeping. She does this everyday.

These stories reveal that early people often saw creation, not as a single event, but as acts constantly repeated. And this is actually the reality of the universe; it is still expanding. There is a certain permanence in this expansion. As Aboriginal peoples of Australia looked back in time, the past seemed to fade away into what their myths call a "Dreamtime". It was as if the past turned a corner beyond which they could not see it anymore, however hard they tried. (Christian, Maps of Time, p. 20)

How did Humankind make new Discoveries?

Modern scientists attempt to answer questions about origins, but instead of using stories, they use carefully tested data, rigorous logic, and experiments. Advances in our understanding have built on earlier discoveries, and, in this sense, each step forward was the result of a previous step taken. Ancestors of ours in the Homo erectus species used tools, discussed discoveries, and learned how to generate fire. By the time Homo Sapiens evolved, we had inherited a legacy of tool use, speech use, and sociability; and we came into knowledge of how to generate fire. We also kept further evolving due to our impressive inborn capabilities and handed-down knowledge.

Enormous advances in empirical understanding were made by nomadic hunters and gatherers. For 99% of human history hunters and gatherers roamed the earth discovering and exploring the entire planet, except Antarctica. They provided the substrate on which subsequent cultures and civilizations were built. As time went on people made silk, pottery, and glass, constructed the pyramids, and invented written language. Glass-making technologies led to microscopes and telescopes which paved the way for the breakthroughs of the Scientific Revolution of the 1500's-1800's by Copernicus, Kepler, Galileo, Ben Franklin, James Watt, Antoine Lavoisier, Allessandro Volta, Julius von Mayer, James Joule, Edmund Halley, Joseph Thomson, Isaac Newton. These were giants on whose shoulders Einstein, Hubble, and Otto Frisch and Karl Anderson stood.

Observations of light waves in the 1800's show light waves are split into different frequencies which create different colors. Red is low on the frequency spectrum and blue is high. When scientists observed light generated from starlight, they saw rainbows of the color spectrum, but they also observed absorption lines caused by different chemical elements in the

stars. From this they were able to conclude that absorption lines prove that stars move either toward the earth or away from it.

Later Edwin Hubble, using the largest telescope available in the 1950's, discovered at farther distances away galaxies are expanding farther away. This led scientists to conclude that the universe is still expanding and, thus, is changing and evolving rather than being in an unchanged, static state as previous scholars had thought.

Other advances in our understanding are the result of what is called the chronometric revolution. This revolution in the 1950's brought new technologies for radioactive dating. Reserachers observed that the nuclei of radioactive elements contain large numbers of protons and neutrons. Protons repel each other electrically and weaken the nucleus thus turning it into another element. Decay occurs with great regularity, measured in half-lives, so we can estimate the age of an element by how rapidly large amounts of it will decay. For example, the half-life of uranium 238 is 4.5 billion years. This means if we have a lump of uranium, or a lump of material containing uranium, we know that after 4.5 billion years, half of it will have broken into other elements. Likewise, Carbon 14, with 14 neutrons in its nucleus which break down at a uniform pace, with a half-life of 5,715 years, can therefore be used to date materials containing carbon, which is most living organisms. Archeologists can use it to date events that occurred up to 40,000 years ago. For earlier dates, too little of the original Carbon 14 is left for accurate analysis.

The age of the earth itself was determined by Clair Paterson in 1953 by measuring the breakdown of uranium to lead in meteorites which had hit the earth. Molecular dating is more recent, developed in the 1980's and it includes genetic dating. Using DNA and taking the DNA of 2 different species and comparing them, scientists can tell how far back they had a common ancestor. Based on this dating we now know humans' evolutionary path separated from chimps' about 7 million years ago. That was when one of our early hominid ancestors evolved away from being a chimp into being a different species.

"Big Bang" and Creation of Galaxies

What existed before the universe came into existence remains unknown. However, the various stages that led from the moment when the first tiny speck appeared 13.7 billion years ago to now have become clear. It began with a flowing forth of trillions-of-degrees hot energy and matter moving faster than the speed of light. As this matter and energy expanded, it cooled and differentiated into different types of energy and matter. These changes are called "phase changes." This early energy and matter was in the form of hot clouds of gas or plasma full of sub-atomic particles called protons and electrons. This plasma was alive with electromagnetic energy consisting of wave/particles called photons entangled with the positively-charged protons and negatively-charged electron particles.

Four basic forms of energy - gravity, electromagnetism, "strong" nuclear force and "weak" nuclear force – moved everything. Along with these types of energy, two forms of matter appeared: dark matter (it is unknown what this is) and atomic matter which most things we know are made of.

When the Big Bang occurred (by the way, Big Bang was a term of derision use by astronomer Fred Hoyle in 1950 because he could not accept the theory) the early universe expanded faster than the speed of light to the size of a galaxy.

The plasma existed 400,000 years until another phase change came about. This change was a cooling causing a merging of electrons and protons to form atoms which were electrically neutral (neutrons). Matter lost some of its electricity and photons (wave particles) of light began to move freely through the universe. Huge clouds of two chemical gases, hydrogen (just one proton at its center and one electron) and helium (two protons and two electrons) appeared. With the passing of another 200 million years, hydrogen and helium organized into stars and galaxies that were set in motion in gravitational fields.

Stars (Suns)

Understanding the life histories of stars is vital to understanding the story of life on earth. Stars are balls of heat and energy which pour light and warmth out into the cold space around them. Their gravitational pull organizes and supports planets, comets, meteors, and asteroids.

Stars originated when matter (gases hydrogen and helium) and dust under the influence of gravity became organized. Once organized, a star can last for billions of years. When hydrogen atoms in their core fuse together under pressure and heat, they become helium atoms. This process is called fusion. After billions of years stars cool and collapse and become supernova. Debris from their collapse heats up again and a cloud of hot hydrogen and helium rearranges itself into another star. This time the second generation star may acquire additional elements such as carbon, oxygen, nitrogen, sulfur, silicon, neon and iron which have emerged due to the heat and pressure of the explosion and recombinations of protons, electrons, and neutrons.

Fortunately, during the process of solar formation a gas and dust cloud out of which our solar system was formed contained many valuable elements which were necessary for life on earth. The elements such as iron, nickel and uranium were the residue from other collapsed supernova. The planets were formed in this spinning gas cloud before the sun ignited. Once more pressure in the dust cloud built up, our sun ignited, and began its atomic fusion in its core in which hydrogen is continuously fused into helium until the sun dies. In these rings heavier elements settled nearer the sun and lighter ones diffused farther away. This is the reason why planets nearer the sun have all the elements of the periodic table while the outer planets are mostly gas.

Our sun is a star of middle brightness, 4.6 billion years old. It is expected to live another 4-5 billion years. It is a very large star, but not the largest. It is powered by nuclear explosions in its core as burning atoms of hydrogen and helium release energy. It travels around the center of the Milky Way every 225 million years going about 500,000 miles per hour. (Christian, Maps of Time, p.53)

Earth

As previously discussed, the chemically-rich environment of our solar system's gas cloud provided the elements for our earth to evolve the way it did. The earth was intensely hot and molten at the beginning, heavier metals such as iron and nickel moved to the core and lighter elements and gases drifted to the outside. The iron and nickel in the core give the earth its magnetic field which has protected earth, shielded it from space particles and excessive radiation, and limited its chemical processes. Nevertheless, the earth's first few million years were violent. Planetary bodies were like

billiard balls, they were hit by other bodies such as meteors, asteroids, comets and space debris. Volcanic reactions occurred all over the surface.

Once earth was fully formed, its gravitational pull was strong enough to hold gasses, such as carbon dioxide, in its atmosphere. As earth cooled and comets slammed into it, water from the comets evaporated into the atmosphere. Then rain caused by this evaporation created the oceans and the molten earth became solid. Additionally, for the next 2 billion years, the first life forms, prokaryotes and eukaryotes, created enough oxygen in the atmosphere to support multi-cellular life.

The geology of the earth includes the outer layer called the lithosphere with a crust of silicates such as granite 22 miles thick. Relative to the earth as a whole, the lithosphere is as thin as an eggshell. A sea-floor crust of basalt is only about 5 miles thick. The core, or magma, consists of iron and nickel. This metallic core gives earth its magnetic field which has deflected harmful radiation and shielded chemical processes which have generated life here. The mantle, between the core and crust, is hot and under pressure. Water was brought in by cometary bombardments. As the earth cooled down, water vapor that had accumulated in its atmosphere fell in torrential rains lasting millions of years. These downpours created the earliest oceans. The fact that water exists on the earth's surface means Earth's temperatures were suitable for the molecules which made up the earliest life forms.

Venus, by contrast, received much more sunlight and developed a carbon dioxide atmosphere causing a greenhouse effect so the surface of Venus is hot enough to boil lead. Mars is smaller, has a weak gravitational pull, and hardly any atmosphere. Earth possessed a rare combination of circumstances. Once life formed, living organisms, namely the bacteria prokaryotes and eukaryotes, created the oxygen atmosphere making earth suitable for multi-cellular life.

Since the emergence of the theory of plate tectonics in the 1960's, it has become clear that continental plates have moved over the earth's surface, gradually changing the configuration of continents and seas.

What patterns and truths emerge from Universal History?

From all that has happened in the universe, the galaxies, in our solar system and on planet earth, we can detect patterns which emerge from this universal

story. One truth is that we are part of evolutionary processes. From the earliest beginnings, physical changes with heating and cooling led to chemical changes, and chemical changes led to geological and biological changes. Each process affected the next process and new properties emerged.

Another theme which emerges from this story is complexity. As time went on certain components such as atoms with electrons and protons, evolved to new and more complex structures such as molecules when conditions were right. Flows of energy maintained structures. The more complicated the structure, the more energy was needed to hold it together. Some scholars, such as astronomer Eric Chaisson, believe planets and living creatures are even more complex than stars, and that modern human society may even be the most complex of all things known.

Another common pattern in this story is, borrowing from biologist Stephen Jay Gould, "equilibrium systems". Equilibrium systems can be natural systems, for example, the solar system, or they can be man-made, for example, empires. These systems achieve a temporary but precarious balance; they undergo crises, they re-establish new equilibriums, but they eventually succumb to larger forces of entropy.

A Unified History in the Largest Context

Despite the various patterns manifested in universal history, and despite the awesome diversity and complexity of modern knowledge, we who study history in our times see a unity and coherence to this story. It provides a sense of orientation so we can understand the larger scheme of things. It is about all the living species, living on one planet, with one sun, in one galaxy, in one universe. Knowing this remarkable story helps us unify our knowledge and expand it by making connections where we can. The diligence we bring to our effort will enable us to harmoniously fit into the natural world and also into our interconnected man-made world.

Treasuring Planet Earth

The more we treasure planet earth, the more we will want to do what we can to preserve and conserve it. Our understanding will help us make wise decisions so that we can be proud of our stewardship and proud of our efforts to pass down a healthy world to future generations.

This essay was primarily based on two sources: Maps of Time by David Christian, University of California Press, 2004 and From Nothing to Everything, by David Christian, Cynthia Brown, and Craig Benjamin, Preliminary edition, McGraw-Hill, 2011. My deepest thanks are owed these pioneering historians, also including Fred Spier (Big History and the Future of Humanity, Wiley-Blackwell, 2011) and Marnie Hughes-Warrington ("Historically Speaking", Vol. IV, No. 2, 2002), who are telling the story of the human venture in its largest known context.

Websites which contain more information can be found at The Big History Project, www.bighistoryproject.com, the International Association of Big History, http://ibhanet.org
http://www.learner.org/courses/worldhistory/units.html