# Evolution, the 'Mechanism' of Big History - The Grande Synthesis

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**Abstract**
Big History traces the Cosmologic arc from the Singularity/Big Bang to the present. Similarly, evolutionary biology, as "all of biology", represents the arc of life from its origins. There is mechanistic consilience between Quantum Mechanics, The First Principles of Physiology and evolutionary biology that is perpetually centered on the unicellular level. The phenotypic adaptations in reaction to geophysical and geochemical changes that culminate in culture are forged at the level of the recapitulating unicellular zygote. This perspective offers a synthesis for the animate and inanimate alike as Big History. The cell as the mechanistic basis for both evolution and Big History offers a novel synthesis for Humanism and Science.

**Key Words**
Big History, Cosmology; Singularity/Big Bang; evolutionary biology; Quantum Mechanics; cell-cell communication

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## Introduction

Since evolution is the 'history' of Man (Darwin, 1871), it should be functionally integrated with Big History (Christian, 2018). Furthermore, conventional Darwinian evolution is not mechanistic (Torday and Rehan, 2012), understanding the causal relationships underlying the process. By merging Big History with 'non-machine like' (Nicholson, 2012) mechanistic evolutionary biology, the ultimate goal of Big History (Spier, 2010) would be realized.

The environment has molded life on earth from its very inception. The spontaneous formation of micelles, or protocells, in the primordial oceans set the process in motion (Deamer, 2017). Subsequently, production of carbon dioxide by plants accumulated in the atmosphere, causing a 'greenhouse effect' that partially dried up the oceans (Romer, 1949), forcing some boney fish onto land (Daeschler et al., 2006). In adaptation to the terrestrial environment, specific self-engineered gene duplications occurred during the transition from water to land (Torday and Rehan, 2017), all of which were existential for survival (Torday, 2005).

Later still, during the Phanerozoic era (Berner, 1999), comprising the Paleozoic, Mesozoic, and Cenozoic, atmospheric oxygen tensions varied between 15 and 35%. The increases in oxygen caused gigantism (Berner et al., 2000), whereas the decreases caused physiologic stress due to hypoxia. The hypoxic stresses were hypothesized to have given rise to endothermy/homeothermy by stimulating catecholamine production by the hypothalamic-pituitary-adrenal axis (Torday, 2015). Endothermy/homeothermy, in turn, gave rise to bipedalism, freeing the forelimbs for specialized functions (flight in birds, tool making in Man), and higher consciousness (Torday, 2015). The latter is critical for the concept of Big History because without a sense of self (Miller et al., 2018) Big History would be immaterial.

Therefore, the saltatory integration of evolution with environmental change weds biology to Big History

causally. That realization offers the opportunity to further probe the depths of such interrelationships than would otherwise be possible by superficially studying these processes as associations and correlations, thus gaining far deeper insights to Big History.

**The Role of Evolution in Big History**

Life on earth has been forged by adaptive interactions between the animate and inanimate through evolutionary biology (Gould, 2002). The perceived influences of the environment on life began with Animism (Bird-David, 1999) and Astrology (Kassell, 2010), the latter culminating in Heliocentrism fostered by Astronomy as the catalyst for the Age of Enlightenment (Debus A, 1987). Subsequently, such insights as The Red Shift and the Big Bang Theory (Hawking, 2011) have added depth to our understanding of our physical origins as a point source (Torday and Miller, 2016a).

Darwin himself hinted at the relationships between the environment and speciation in his Origin of Species, commenting on the topography of Patagonia in great detail, but never developing the idea further for his theory of evolution (Darwin, 1859). On the other hand, Lamarck formally recognized the direct role of the environment in evolution (Gould, 2002), but did not have the scientific knowledge needed to demonstrate the principle. It is only recently that epigenetic inheritance has come back into vogue (Nilsson et al., 2018). It offers the opportunity to recognize the interrelationships between Big History and evolutionary biology.

Big History traces its arc from the Big Bang to the present as a continuum. The rationale for Big History is spelled out in Rodrigue et al's "Our Place in History" (2016). The book is an introduction to the idea that the 'story of everything' can be told, but in order to make it comprehensive, its physical and biological aspects must be merged as functional elements of the totality (Torday, 2018a). At its largest scale, Lovelock (Lovelock, 2003) and Smolin (Smolin, 1999) have established the organic nature of earth and the Cosmos, respectively. At its smallest scale, Atomic Theory (Pullman, 1998) and biological to cell-cell communication (Torday and Rehan, 2012) provide is mechanistic consilience between Quantum Mechanics, The First Principles of Physiology, and evolutionary biology at the unicellular level (Torday, 2018b). The merging of physics and biology within the cell has offered the opportunity to consider the congruence of the inanimate and the animate, referring all the way back to the Singularity/Big Bang (Hawking, 2011) based on empiric evidence for the first time (Zhang et al., 2017). The vertical integration of those principles has been exploited to explain the mechanism of physiologic evolution (Torday and Rehan, 2017), allowing a rationale for incorporating the latter into the concept of Big History.

**Big History and Consciousness**

There would be no history of biology if we were not conscious of our own existence. But what is consciousness? It has long been debated as to whether it is 'all in our heads' (Kraut, 2013) or 'theater of the mind' (Olcese et al., 2018). More recently, it has been conjectured that it is the essence of our physiology, which is formed by and composed of cell-cell signaling mechanisms (Torday, 2018a). Hameroff and Penrose (2014) have offered an elegant physiologic explanation for consciousness as the networking of neurons through microtubules. Yet all cells possess microtubules in their cytoskeletons, opening up to the concept of consciousness as awareness of our whole body, referred to as allostasis (McEwen, 1998). Empiric evidence for this comes from the observation that when patients recover from general anesthesia they undergo the phylogenetic steps of brain evolution from reptilian to mammalian (Mashour and Alkire, 2013). Conversely, when eukaryotic cells are experimentally exposed to microgravity they lose their capacity to signal with the environment (Purevdorj-Gage et al., 2006) or with one another (Torday, 2003). These observations point

to the fundamental nature of consciousness as the way in which organisms interrelate with the Cosmos, given that gravity was a product of the S/BB.

The advantage of this way of understanding consciousness is that it emanates from the S/BB, integrating the inanimate with the animate as a functional whole (Torday, 2018a). Instead of Anthropic Principle (Barrow and Tipler, 1988), thinking of Man as IN the Cosmos, we are OF the Cosmos, literally (Schrijver K, Schrijver, 2015).

The ultimate purpose for considering Evolution and Big History is ideally to raise our consciousness (Ornstein, 1972). In the past such philosophers as the pre-Socratic Greeks (Guthrie, 1977), de Chardins (de Chardins, 1976), Gurdgieff (Gurdjieff, 1973), Bucke (Bucke, 2009), and scientists such as Alfred North Whitehead (Whitehead, 2019), LL Whyte (Whyte, 1968) and E.O. Wilson (Wilson, 2014) have attempted to do just that, but without a core mechanism like the one being touted herein. Cosmic awareness is implicit in Big History, from the Big Bang forward; it is explicit in cellular-molecular evolution emanating from the Singularity (Torday, 2018a) in a step-wise fashion based on cell-cell communication as a continuum from the origin of life itself (Torday, 2018c).

**In the Beginning**

The earth formed about 5 billion years ago (Hawking, 2011). And because it had no atmosphere, snowball-like asteroids hit the surface and melted, forming the oceans. There were polycyclic hydrocarbons (like lipids) contained within the ice, which spontaneously formed micelles, or prototypical cells (Moroi, 1992). The lipid origin of life on earth makes both *a priori* sense because lipids exhibit hysteresis, or 'molecular memory' necessary for the process of evolution (Walz et al., 2010), and *a posteriori* because lipids can synthesize nucleotides, but nucleotides cannot synthesize lipids (Mansy and Szostak, 2009). The semipermeable-membraned micelles offered a protected space for the First Principles of Physiology-negentropy (Schrodinger, 2012), chemiosmosis (Mitchell, 1961) and homeostasis (Cannon, 1932).

**Endosymbiosis Theory**

Endosymbiosis Theory was first proposed by Ivan Wallin (Eliot, 1971), and was later popularized and expanded upon by Lynn Margulis Sagan (Sagan, 1967). They asserted that complex cells with nuclei, or eukaryotes, are the product of the symbiotic partnership between previously free-living bacteria and larger cells. It is now well accepted that cellular mitochondria that are crucial for cellular energy metabolism were formerly free-living bacteria that are now an inherent part of the eukaryotic cellular apparatus. The core concept is that eukaryotes have evolved by incorporating environmental factors over the course of their history. Seen in this context, Big History complements our understanding of physiologic evolution by offering the sequence of changes in the environment, both natural and man-made that have affected our evolution. And since evolution is the history of biology as serial pre-adaptations or exaptations (Gould and Vrba, 1982), it helps in a deeper understanding for the course of human evolution.

**Cell-Cell Communication as the Basis for Physiologic Evolution**

The gleaning of information from the environment wed to the process of cell-cell communication developmentally and homeostatically constitutes epigenetic inheritance (Torday and Rehan, 2017). This intimate relationship between the organism and its environment forms the basis for evolution; when there is a mismatch between them, it causes physiologic stress, or dyshomeostasis, specifically within the tissues and organs being affected, generating Radical Oxygen Species (ROS). ROS are known to cause site-specific gene mutations and duplications (Storr et al., 2013); the resolution of such conditions through adaptation is what is referred to as evolution. Short of remodeling any given physiologic trait, this mechanism ensures that injuries are repaired based on the same

homeostatic principles of cell-cell communication (Demayo et al., 2002).

**Endosymbiosis, Natural Laws and Consciousness**

Based on the Endosymbiosis Theory, the cell formulates its own internal 'laws' based on the homeostatic Laws of Nature, formulated by Claude Bernard as the *milieu interieur* (Bernard, 1974). In the aggregate, the individual cellular homeostases are referred to as allostasis (McEwen, 1998), monitored and controlled by the peripheral and central nervous systems. This organized physiologic process of self-awareness is what we refer to as consciousness.

**The Cell as the First Niche Construction, Integrates Man and Environment**

Niche Construction is the concept that organisms actively fashion their immediate environment in order to optimize their adaptation (Odling-Smee et al., 2013). Yet that is what Endosymbiosis Theory is, so by internalizing factors in the environment that posed a threat to their existence, beginning with the unicellular state (Sagan 1967), can be seen as internal Niche Construction (Torday, 2016a) , or what Bernard referred to as the *milieu interieur* (Bernard, 1974). The concept of the *milieu interieur* was later refined by Walter B. Cannon as physiology (Cannon, 1939). Ultimately, the internalization of physical factors functioning under the Laws of Nature conferred this property on organic life, forming the ties between the cell and the environment as a continuum from the unicell to Gaia (Torday, 2018a). Therefore, Big History could be thought of as the description of this process, whereas understanding the underlying mechanisms that causally link the organism to its environment adds manifold depth to the process (Torday and Rehan, 2016); Torday, 2016a). Furthermore, it offers the opportunity to understand interrelationships that transcend the mere existence of life in the Cosmos, reaching into the interstices to gain fundamental understanding of the process (Torday and Miller, 2018). Such analysis lends itself to finding common ground between eastern and western philosophy (Torday and Miller, 2016b), tearing down the silos of contemporary knowledge to maximize the accounting of Big History (Rodrigue et al., 2016).

**Top-Down, Bottom-Up, Middle-Out**

Biologic control is referred to as top-down, bottom-up or middle-out. Top-down control is in reference to emergence of physiologic properties (Noble, 2008). Bottom-up, on the other hand references the organization of physiologic traits from its component parts (Sagan, 1967). And middle-out is the result of cell-cell communication through growth factor-growth factor receptor signaling (Torday and Rehan, 2012).

**Combined Epigenetic Inheritance and Phenotype as Agent Provides Biologic Scope to Big History**

As mentioned above, epigenetic inheritance constitutes the collection of epigenetic marks over the course of the life cycle. The so-called marks are then integrated into the DNA of the germ cells (egg and sperm) as adducts (methylation, ubiquitination, myristylation, etc) that modify the nucleotide 'readout' in accord with environmental changes. The DNA adducts subsequently appear in specific tissues and organs, where they modify the structure and function of the organisms accordingly as epigenetic inheritance (Nilsson et al., 2018).

The centrality of the germ cells to epigenetic inheritance infers the primacy of these cells in the processes of adaptation (Torday and Rehan, 2017), rather than the phenotypes of the adults, as dictated by Darwinian evolution. In this vein, the phenotype can be seen as an active 'agent' for the acquisition of epigenetic marks (Torday and Miller, 2016c). Seen in this light, the individual takes on an active role in Big History based on the biologic imperative of acting as a vehicle for epigenetic inheritance.

**Anthropic Principle vs Being Of the Cosmos**

The anthropic principle was mentioned in the

Introduction. It is the concept that we fortuitously ended up in this particular place in the Cosmos (Barrow and Tipler, 1988). In contrast to that, evolution has facilitated our adaptation to our environment largely by endogenizing it, making what otherwise would have destroyed us billions of years ago — gravity, oxygen, heavy metals, ions — useful as what we now recognize as our physiology (Torday and Rehan, 2017). For example, by regressing the genes that facilitated lung evolution against major epochs in the geochemistry of the earth (Torday and Rehan, 2011) one can see the causal relationships involved. Conversely, as Jean Guex has shown in ammonites, environmental stress can disrupt and reverse the evolutionary process (Guex, 2016).

**Evolution, the Mechanism of Big History**

The significance of merging Big History with evolutionary biology is that both acknowledge their origins in the S/BB. In the case of Big History, this perspective confers a deep understanding of who and what we are conceptually. On the other hand, understanding that we have evolved biologically as an 'ambiguity' (Torday and Miller, 2017), our function being to resolve the residual dualities of the S/BB (Torday, 2018a). Seen in this light, evolution offers the organic, epistemologic context for Big History.

**Conclusions**

As is the case for history, evolution 'rhymes' (Pratt 1974) because it is founded on serial pre-adaptations, or exaptations (Gould and Vrba, 1982). When confronted with an existential problem, the organism re-appropriates genetic motifs that were effective at some earlier stage in its evolution, ultimately referencing the First Principles of Physiology — negentropy (Schrodinger, 2012), chemiosmosis (Mitchell, 1962) and homeostasis (Cannon, 1939). Those principles, in turn, reference the S/BB as their origin (Torday, 2018a). So like Big History, biology is also the product of the Singularity/Bing Bang. By recognizing the homologies between the two processes we can better understand the human condition from its source rather than reasoning after the fact.

There are certain principles such as those of the Old and New Testaments, the Golden Rule, the U.S. Constitution, The Scientific Method, the Periodic Table, the Laws of Nature that have served us well. We have inherited certain Laws of Nature biologically that have served us well throughout our evolutionary history. If we were to understand the absolute interrelationships between such principles we would optimize Big History.

The ancient Greek philosopher Protagoras thought that 'Man is the Measure of all things' (Guthrie, 1977); he was right in spirit, but he needed to know what the 'units' of measurement were to support his idea scientifically. For the scientist, it is the cell (Torday, 2015). For the humanist, the cell is the 'syntax' of Big History. The cell as the mechanistic basis for both Evolution and Big History offers a novel synthesis for Humanism and Science, bringing resolution to C.P. Snow's "Two Cultures" (Snow, 1959).

In his Big History, David Christian references the 'Goldilocks' effect explanation for our fortuitous existence (Christian, 2018). What he describes is the mechanism of homeostasis, without which neither the inanimate nor the animate can exist. Morowitz (2004) describes how the electron and proton balance one another energetically within a hydrogen atom. And in the cellular-molecular approach to evolutionary biology, homeostasis is one of the three Principles of Physiology, controlling the interrelationship between negative entropy and chemiosmosis. The Pauli Exclusion Principle and The First Principles of Physiology are both deterministic and probabilistic, offering the opportunity for stability and plasticity (Torday, 2018b).

The S/BB and The First Principles of Physiology both emanate from the same point source (Torday and

Miller, 2016a). The mechanism of biologic evolution is better understood than that of the S/BB, so the homology between the two offers the opportunity to consider the fundamental nature of the S/BB. It has been proposed that the unicell is the primary level of being (Torday, 2018b), and that complexity is an epiphenomenon due to the misunderstanding of what evolution actually constitutes (Torday, 2016b). Big History similarly opens up to the consideration that the present is the functional moment of reality, enabled by our consciousness of the past, present, and future as one, simultaneously (Torday, 2016b). It is what Maslow refers to as a 'peak experience' (Maslow, 1968). This state of being is achieved through the total integration of physiology by such neuroendocrine hormones as endorphins and oxytocin (Fink et al., 2011).

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