The General Law of Being, Article 3: The Ultimate Cause of Evolution

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This is the third article in a series about the General Law of Being, a science philosophy that was introduced by Chinese scholar Wang Dongyue twenty years ago and then expanded upon by Chen Ye, who linked it to other scientific and philosophical traditions as well as to Big History. We encourage readers to review the previous two articles in the *Journal of Big History*, volume 6, issues 1 and 2.

Article 1 addressed how all entities in the universe – 'beings' – are finite and dependent. Horizontally, their existence is realized through the structural coupling of their *interactive-quality* with other being(s)'s *interactable-quality*, and vertically through the superposition of their historical *structural-coupling* states. Article 2 reveals the interplay of the two opposite forces that govern evolution – conservation and variation. This evolution / variation progress occurs through the differentiation of beings, level by level – each level of organization results from differentiation of beings at a lower level of organization, with the 'adaptation task' distributed to specialized roles at higher levels.

However, this ascent comes with a trade-off – the existence of a higher-level being depends on an increasing number of conditions. These conditions not only facilitate its functioning but also expose it to greater risks, which means that higher-level beings have weaker, or more unstable structures. Meanwhile, the increasing number of conditions perplexes the sense-reaction process, giving rise to more advanced cognitive patterns to coordinate the process.

In this article, we first examine the situation of the most sophisticated 'natural' structure formed by the most complex species – human society, by applying the fundamental principles discussed in Articles 1 and 2. We then systematize various clues in macro-evolution and based on theories previously outlined, we build our model of evolution to address the ultimate driving force behind evolution.

The Formation of Society

The conditions-of-existence of higher-level species is reflected through the forms of their society. Society is not an invention of a species but is instead an essential product of the evolutionary process. As predators that fed on unicellular prey emerged, single-celled organisms had to increase their size to avoid predation, so a practical means to achieve this growth was through aggregation and cohesion. In experiments that introduced predators among green algae (a prokaryote), the algae evolved into multi-cellular groups. This highlights a tendency of living organisms to develop 'social structures' in response to survival pressures.

Because of relatively low survival pressure, prokaryotes typically did not form complex social structures since their rapid reproduction and versatile metabolism endowed them with a stable existence as individual cells. But as the structure of some of them began to differentiate into single-celled eukaryotes, these new living-beings faced new pressures and further adapted. This transformation mainly came about from three situations:

> A. Metabolism became more complex as larger organisms needed high-energy sources to maintain their nutritional equilibrium. This increased their challenge to acquire sufficient food. The problem was resolved through grouping, by which constituent members collaborated for nourishment, ensuring satisfaction of individuals. This serves as the earliest form of an *economic mechanism*.
>
> B. Reproduction and care for individuals was more demanding among higher-level species. It gave rise to consanguineous communities to enhance bonds of interdependence between members of a lineage, including between genders, offspring, and age-groups. This cultivation of inheritance resulted in

resource allocation and emergence of a *political mechanism* in larger related groups.

C. Sensation and reaction became more complex. Sensory / motor organs and a nervous system were strengthened for an organism to make better decisions when facing different situations. Living-beings network themselves into a *sensorimotor net* that integrated information and coordinated reactions. This gave rise to an *intercommunication mechanism* (cultural phenomenon).

The formation of society is not so very different from the formation of a multi-cellular organism. While an organism consists of the interior aggregation and differentiation of cells, **society is the exterior aggregation and differentiation of living beings.** Cells aggregate together when single cells face crisis in maintaining their existence. To form a 'cell society,' they must differentiate into various functions and link with each other to maintain the stability of a 'social structure' – multicellularity.

Competition arose from the pressures described above, and from other challenges, which stimulated further complexification of organisms, by natural selection, bringing about even heavier pressures for living-beings. **When an individual cannot deal with the pressures that threaten its existence, exterior differentiation and coupling is inevitable.** By grouping, individuals can make up for their 'disability' by depending on others. As a result, we can evaluate the adequacy of a species' function by its social structuration rate (Diagram 1).

A non-regulated society implies the adequate functioning of its individual members, while a well-structured society indicates inadequate functioning, which necessitates stronger bonds between individuals. The transition from a low-structured society to a high-structured society represents a shift from individual goals to community goals – altruism. Individuals in a highly-structured society relinquish a degree of self-interest and contribute to the well-being of others.

However, assessing the "superiority" of a high- or low-structured society is meaningless. What matters is only **the suitability of the social structure to the existence state of the species**. The determination of the appropriate balance between selfishness and sacrifice is naturally governed by the Evolutionarily Stable Strategy (ESS) mechanism.

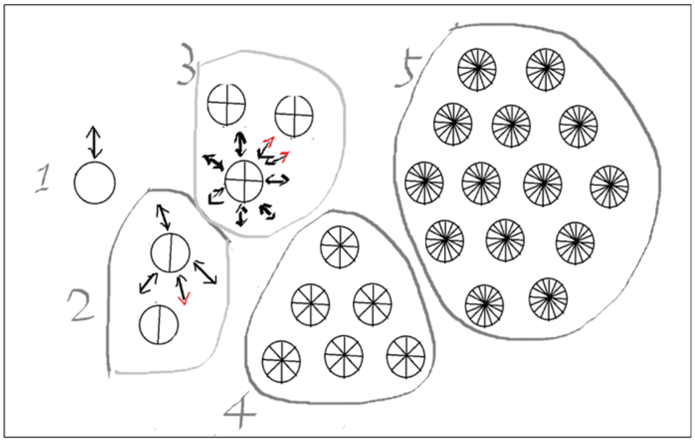


Diagram 1: This shows the formation of society as a unit's structure becomes more complex, a result of the dynamic between external conditions and individual units. The outward-pointing arrows show a unit's interactive-quality coupling with external conditions (shown as inward-pointing arrows). If external conditions are satisfied, the formation of society is unnecessary, with a unit remaining independent (item 1). If external conditions are greater than a unit's innate interactive qualities (more inward-pointing arrows than outward-pointing arrows), individuals form society to compensate for their inadequacy. This generates red arrows, which represent the gap between a units' interactive qualities and external conditions that can be satisfied by structural-coupling with other units to form society. We can imagine more and more red arrows in items 4 and 5 with the complexification of individuals, along with more external conditions that need to be satisfied. Diagram by Ye Chen.

A classic example of ESS is the *hawk-dove game*, which posits two subtypes of a species with different strategies: aggressive 'hawks' and peaceful 'doves.' Most choose a hawk strategy, since it allows access to 'easy' food from doves. But if everyone is a hawk, there is a population loss from hawk in-fighting, which hinders conservation of the species. This drives some hawks to become doves, so the ratio reaches a stationary point of two hawks to eight doves.

This implies that formation of a social structure is driven by collective biological behaviours, ultimately determined by the species' interactive qualities / structure. **The equilibrium point identified signifies the existence state of the species**, where individuals are structurally-coupled with each other. This existence state plays a crucial role in shaping the species' culture, which is passed down through generations.

Issues Aroused by the Structuration of Society

The death of individuals does not greatly impact other individuals in an unstructured 'social' framework, but the death of individuals can be devasting in a highly-structured 'society.' For example, the death of a single prokaryote does not impact prokaryote society. But when cells have differentiated and joined into more complex 'societies of cells,' in response to external pressures, these new configurations (skeletal, membrane, digestive) are essential to a new society.

Such diverse functions in complex societies necessitate coordination, enabled by the interplay of signal and conversion mechanisms, traffic networks and gene expression control – all involving myriads of molecules. Despite functional redundancy, cumulative errors of individual cells that exceed a critical threshold can lead to disintegration of an entire organism. Even if some cells remain viable before collapse, they ultimately die as the collective functionality of the cell society disintegrates. This reveals a new challenge of complexification achieved by the formation of a society.

In this social complex, the damage to some cells can cause fluctuations that may reverberate through the entire organism. Although formation of a society can alleviate increased external pressures for an individual, it then brings about new pressures for internal social structures, because, in a highly-structured society, the components are so well-coupled that each plays a significant role on which other components rely. This adds tension to the relationship between individuals. **The formation of a society does not mean elimination of survival pressure for living-beings, rather, it means a transfer of pressure from an exterior to interior source.**

As social structures and interdependent / coupling relationships are established, the collective functions / interactive-qualities of a species gain in strength and efficiency. **The degree of structuration within a society correlates with augmentation of a species' functions**. This is akin to the organization of cells within an organism that lead to enhanced functionality. For instance, predation, reproduction and decision-making presuppose sensory acuity and an ability to initiate appropriate responses, which are reinforced within the framework of a social structure.

As to a human society, the collective function of cognition is enhanced by intellectuals such as scientists, philosophers and other specialists, who can be considered vanguards of 'cognitive quality.' They help develop knowledge systems, research methodologies, universal laws, and effective models. By sharing their findings with society, the cognitive quality of the human species is strengthened. For example, visual ability is enhanced by the telescope; information processing by computational technology; food acquisition by automated machinery; and locomotion ability by mechanical transport.

Conditions for Enhanced Social Functions

Enhanced social functions cannot be realized without establishment of an economic mechanism, political process, and cultural background – they serve as inevitable and indispensable conditions to sustain social structures, ensuring that social functions can operate in an orderly and efficient manner.

Consider modern improvements in human locomotion, such as development of vehicles. This advancement necessitates not only the presence of vehicles but also an organized transportation system, streamlined manufacturing process, and regulatory guidelines, as well as infrastructures for oil extraction, refinement, pollution control and management. Each factor engenders additional interdependent requirements, forming a chain of *conditions*.

Vehicles are just one part of a milieu of enhanced social functions. **If we sort out all functions and add them up, the conditions they bring about are gigantic.** The demand to accomplish these conditions stimulates individual and social dedication to certain skills, which further enhances social functions and brings about additional conditions. This shapes positive feedback.

Under such circumstances, labour division arise to facilitate efficient operation of social functions and to satisfy the conditions on which these functions rely. Consequently, individuals deepen their specializations to fulfill their respective roles, which often decreases their self-betterment capacities. This is analogous as to how specialized cells in an organism cannot survive without other cells. This heightened interdependency among individuals leads to further structuration of society.

When structuration of a society increases, internal pressures arise, elevating complexity and risks associated with relationships between individuals. Just consider various facets of daily life: a computer for work and leisure, a cell-phone for connection to the world … food, a bed and a house that is called home. Virtually nothing we utilize is self-produced. We rely on specialized roles performed by others within society's framework.

In return, we contribute value to society by fulfilling our own distinct role, upon which other members rely. This is how a society functions to sustain its existence. The cumulative loss or disruption of some divisions of labour can lead to a breakdown in the interconnected network, which affects all members. This implies that for each level of societal structuration, there exists a corresponding minimum threshold for the degree of interrelation and cooperation among its members that must be met.

A social mechanism must be developed and improved as societal structuration deepens. This social mechanism involves all aspects of a 'social' human – cultural regulation, value systems, measures of justice, moral ethics, taboos, trading laws, and so forth. Meanwhile, a political mechanism must be established to help stabilize these systems. These principles resonate with the *Law of Techno-Humanitarian Balance*, as elucidated by historical psychologist Akop Nazaretyan.

Under a more advanced social system, a greater number of individuals feel secure, reducing the efforts dedicated to basic survival. The society is left with more energy that can be redirected to other endeavours, beyond survival, encouraging development of social functions / cognitive quality, such as theoretical research and technological or business innovations. We then can return to where we began, and another round of development can begin. Actually, there is no precise beginning or end in this circulatory system: **All factors are interrelated and mutually promoted, stimulating the continuous development as well as the structuration of the society** (Diagram 2).

This explains how a society evolves, why it evolves at an accelerated velocity, how it collapses, and how it can be sustained. It also explains why our knowledge about society is constantly changing. **The key lies in the accelerating growth of conditions and the enhancement of social functions**. At different evolutionary stages, human beings need to address different issues concerning increased conditions.

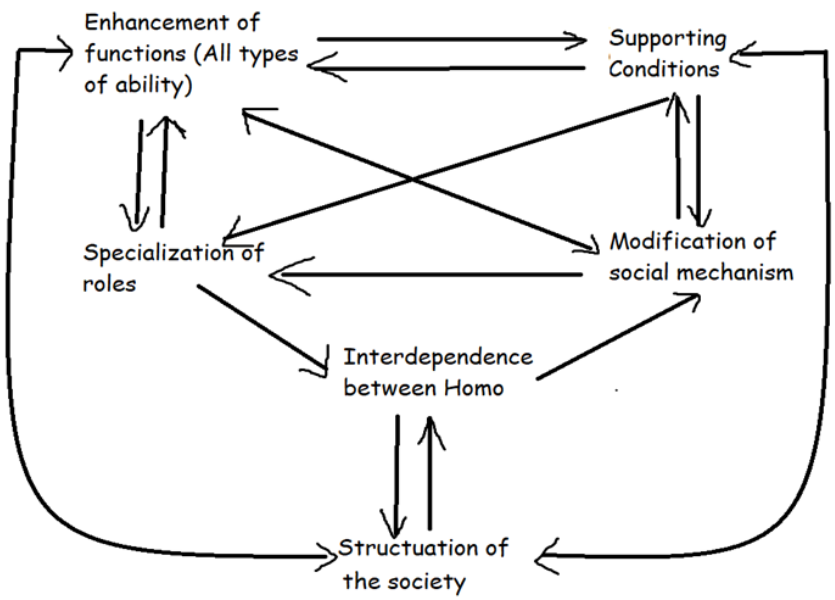


Diagram 2: Interrelated Circulatory System of Human Society. The arrows indicate promotional relationship. Diagram by Ye Chen.

Failure to address these conditions gives rise to internal fluctuations within the structure, manifested as conflicts, chaos or even wars, thereby posing a threat to the very existence of the social framework.

Weakening Structure

When a society reaches its highest structuration, there is maximum interactive-quality coupling with the external world, maximum conditions arise to sustain its functions, maximum connective points exist among functions, maximum specialized roles are engaged, maximum internal pressure come about, and maximum dependency exists among individuals. Errors in any of these arouse fluctuations that spread throughout the entire network.

A society in its highest structuration is at its most unstable state of existence. It is most fragile and vulnerable. This conclusion reinforces the principle addressed in Article 2: **The process of differentiation is also a process of structuration, which means more and more specialized roles are differentiated and can couple with each other to make more complex, yet weaker, structures**.

In a highly-structured society, challenges appear to be incessant, with each resolved issue giving rise to other problems. In a rapid development state, the number of emerging problems always exceed problems addressed. This is because solutions often are interdependent with conditions. They trigger a chain of social impacts, often extending to seemingly unrelated issues.

This constant influx of challenges is not a reason to depreciate the structuration tendency of society. Structuration and rapid development are a natural evolutionary product defined by the realm of existence of a species. It is owing to the unique intellectual quality ingrained in our own species that brings about rapid development as well as the capacity to engage in intricate problem-solving. While resolving a problem poses new challenges, escaping challenges means abandoning the necessary intellectual quality to sustain the state of our existence.

Some people might say that we should stop developing social functions, then no new conditions emerge, but this is a false simplicity. **The development of society is never determined by individuals but follows the mechanisms of natural selection**. The evolution of human society was determined when our ancestors diverged from chimpanzees. It was only a matter of time for this potential 'intellectual quality' to be activated, which then started the fast train of development.

But when might societal evolution come to a halt? It ceases when it has exhausted its evolutionary potential, reaching a point where human intelligence has reached its limitation or when the structural complexity of human society has reached its maximum. What characterizes a halted social structure? This is where the concept of *natural drift* comes into play.

Natural Drift and Evolutionary Potential

Evolution is a process often characterized by a transition from simplicity to complexity, but it is important to note that not all species undergo this progression. Rather, most species tend to retain their original level of organization with minimal structural variation to couple with change from the external world. This structural variation is described as *natural drift* in biologist Humberto Maturana's autopoiesis theory. Natural drift is controlled by two factors – 1) Perturbation from the external world that triggers an organism's structural change, and 2) An organism's intrinsic qualities that determine whether such change is possible.

Natural drift takes a variety of forms, such as growth of thick fur, changes in metabolism, or massive geographic migration. It also involves the selection of a degeneration of specific functions when a species no longer uses it. Molecular data has shown instances of such adaptation, as among fungi species and parasitic or anaerobic protists. They once had mitochondria, as is typical of eukaryotes, but subsequently lost them, when not needed for energy production. Moreover, many olfaction-related genes have also been lost in humans as they came to rely more on vision.

This also indicates that **every quality within an organism serves to sustain its existence, and there is nothing that is superfluous**. In other words, all interactive-qualities of a being couple with interactable-qualities. Even when a useless interactive-quality appears, it diminishes over time through natural selection.

But what if a species does not possess certain intrinsic qualities that can facilitate proper structural changes in response to external perturbations? In such cases, the species faces extinction. Organisms must work closely and synergistically with the environment. When environmental conditions shift, the prior balance of the organism is disrupted, and so the organism must initiate actions to compensate for this disrupted balance to maintain its identity. In a society where the external pressure has transitioned to internal pressure, natural drift refers to changes in response to these internal fluctuations.

This is not typically 'evolution' but instead *natural drift*. Natural drift describes how entities adapt their functions and structures in response to environmental changes, but it does not entail a substantial increase in their level of organization or interactive quality. In contrast, when we refer to evolution, we specifically mean the process that leads to a complication in the level of organization and enhancement of interactive-quality. **Both natural drift and evolution aim to achieve adaptation, but the former is more a state of fluctuation within a certain level of organization, while the latter signifies an upward trajectory in terms of organization and function**.

Beings that do not evolve but instead only engage in natural drift are considered to lack evolutionary potential. Nature is like a vast laboratory that synthesizes all possible forms of being – including non-existence (failure as a stable being), those lacking evolutionary potential, and those with evolutionary potential. Most fall within the first two categories. For instance, within the limited array of elements in the universe, only carbon atoms possess the evolutionary potential to form and progress into complex biological molecules. This is the result of their distinct characteristics, which set them apart from inert elements or unstable elements like silicon. Carbon's qualities enable it to form stable circular or chain-like compounds resistant to hydrolysis.

In a universe with ample time and space, beings that possess evolutionary potential will inevitably achieve that potential at a specific time and place, giving rise to the emergence of beings with higher-level organization. In contrast, beings with no evolutionary potential remain at their original level of organization and persist by natural drift, until a time comes when they are no longer able to respond to external perturbations or internal fluctuations.

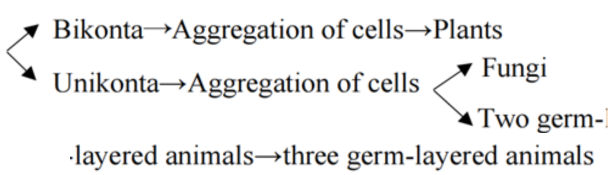
The Evolutionary Route

Our evolutionary roadmap is predicated on our definition of complexity. Complexity can be measured through various methods, and, in this context, we gauge it by considering the levels of organization that become apparent during the differentiation process. With this criterion, we can delineate the evolutionary path following the Big Bang as follows:

> Atoms → Inorganic compounds → Organic compounds → Self-replicating molecules (RNA-based catalysts or enzymes) → Prokaryotes → Eukaryotes (single-celled)

The ten-billion years following the Big Bang was an immense span of time, during which many 'division-coupling' processes had the opportunity to occur, giving rise to diverse raw materials (Diagram 3).

While the likelihood for life to evolve may have been exceedingly small, the vastness of the universe allowed for the possibility of suitable conditions for its appearance



– such as proximity to other stars, orbital trajectories, gravitational forces, and magnetic fields, as well as suitable environments with temperature range and mediums for chemical reactions. Earth is one such place, and similar conditions might well exist elsewhere in the universe.

Although we don't know exactly when it occurred in the 'division-coupling' process of the universe, organic compounds arose from the coupling of certain inorganic compounds in certain environments, as indicated in the 1952 Urey-Miller experiment. **Environmental conditions are 'interactable qualities' that coupled with the 'interactive qualities' of specific compounds to activate an 'evolutionary potential.'**

This formed primal cells / protocells, and, among them, **one that possessed the highest degree of stability was favoured by natural selection**. This entailed the selection of stable genetic and membrane materials, optimization of efficient catalytic processes, choices of cytoskeleton proteins and structure, allocation of tasks between RNA, DNA and proteins, as well as optimization of molecular mechanisms essential for functions like energy supply.[1] These attempts resulted in the formation and stabilization of prokaryotic cells along the evolutionary route 3.5 billion years ago.[2]

Prokaryotes maintain a relatively stable existence, facing little competition due to their modest requirements, which also diminishes their ability for evolution. The emergence of the original eukaryotic cell is hypothesized to have resulted from a fusion event between two prokaryotes, when an eubacterium infiltrated an archaebacterium, which then evolved into an organelle within the archaebacterium. This event is considered rare, since prokaryotes lack a capacity for endocytosis (movements across the cell wall).

This fusion activated the evolutionary potential of certain prokaryotes, propelling them to evolve into more complex eukaryotic organisms.[3] **The enriched function of a eukaryotic cell is thus traced back to the original gene of prokaryotes, which is what we mean by the 'evolutionary potential' of prokaryotes**. For example, introns, pieces of genes that gave rise to proteins with diverse functions, originally existed in prokaryotes as self-splicing redundancies. These introns gained significance when symbiotic events occurred. Similarly, proteins functioning in the cytoskeleton of eukaryotes can be traced back to the core filament-forming proteins in prokaryotes. **All that a eukaryotic cell did was to elaborate the function through gene duplication and specialization**.[4]

As eukaryotic cells' qualities evolved and endocytosis developed, their survival became increasingly challenging due to the potential threat of being engulfed by others. This initiated a competition of scaling, as larger cells had

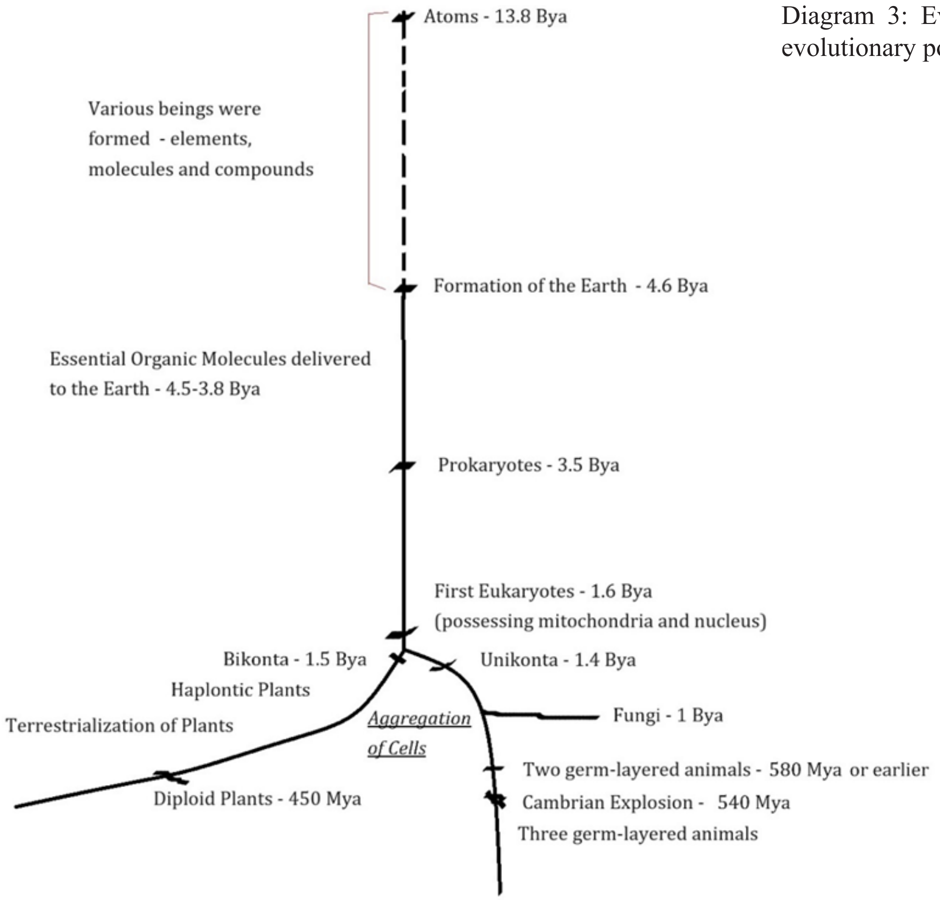


Diagram 3: Evolutionary schema of typical beings having evolutionary potential. Diagram by Ye Chen.

a better chance to avoid engulfment. But simply enlarging the size of a single cell was not a straightforward solution, due to physical constraints – such as the problem of surface-volume ratio.[5] The most efficient survival strategy was cell aggregation. Various attempts were made in this regard – individual cells formed into filaments, clusters, balls or sheets, such as algae a billion years ago and sponges 800–750 million years ago.[6]

However, it wasn't until 600–700 million years ago that a significant surge in atmospheric and oceanic oxygen levels triggered major metazoan diversification. These environmental conditions set up an optimal backdrop for eukaryotic cells to display their diverse evolutionary potential as more interactable-qualities allowed the evolutionary potential of certain eukaryotic cells to be activated and turn into interactive-qualities.

Such evolutionary potential included eukaryotic cells' innate capacity for aggregation, adhesion and cloning, along with dynamic cytoskeletal and membrane systems, and specialized molecular-signalling networks for cell communication. This enabled flexible development routes of multicellularity by realizing different patterns of gene regulation and gave rise to a variety of germ-layered animals.[7]

The transition to multicellularity led to a heightened demand for resources, which intensified external competition and internal aspects of physiological development. The evolution of a digestive system reflected the increased demand for energy and nutrient acquisition.[8] Interestingly, among the eukaryotic cells, some special groups, like fungi, did not engage in this trend and diverged from other eukaryotic cells 1 billion years ago. (Diagram 3).

Fungi chose a different pathway, foregoing the more efficient resource acquisition methods of animals. They developed no circulatory, skeletal or digestive systems but instead retained extra-cellular digestion (a prokaryotic strategy) by absorbing decayed organic materials.[9] Fungi are a typical example of eukaryotic cells that lack an evolutionary potential, which prevented them from developing into a higher level.

Ultimate Cause of Evolution

Firstly: It is evident that **the evolutionary process of all entities starts from *inherent-instability***. This signifies the inability of an entity to maintain its existing state of being or identity. It applies to all entities in the universe. An atom can evolve into a molecule when encountering certain external factors, such as other atoms, while prokaryotic cells, though existing in a stable state for a billion years, still evolved into eukaryotic cells when exposed to other external conditions. It is essential to recognize that all entities, regardless of whether they ultimately do evolve, inherently possess a degree of instability. **Under the right conditions, they can always transition from their existing state and lose their identity**.

Secondly: **All entities possess an *innate inclination towards achieving stability*, in other words, to avoid potential instability**. This desire for stability can also be referred to as the *desire for continued existence*. This does not necessitate the presence of specific sensorimotor systems; but it is manifested through conservation and variation forces that operate within all entities.[10] When confronted with external factors that challenge their stability, the desire for stability is reflected through the variation force, as when we observe the tendency of particle interaction to form molecules or compounds, and living beings' efforts towards adaptation.

Thirdly: While all entities exhibit inherent-instability and an inclination for stability, **evolution can only take place when an entity possesses the *potential quality to evolve* (evolutionary potential)**. Evolutionary potential appears at different stages along the evolutionary route. Portfolios of all possible qualities are created and accumulate within entities, which are endowed with none, little or strong evolutionary potential.

However, the activation of this potential is subject to intricate passive and active factors. Passive factors have a likelihood of all requisite conditions aligning simultaneously, while active factors involve survival pressures, such as heightened external competition or increased demands for nutrients and energy to maintain their internal dynamics. These active factors spur the selection of a more favourable portfolio of qualities for entities. **Active factors appeared at the stage of living-beings when conditions increased, adding more opportunities for them to develop their evolutionary potential**.

When an entity evolves to a higher level of organization (as a new entity), it means that that its latent evolutionary potential develops into the new entity's interactive-quality. Initially, this evolutionary potential may appear insignificant within the framework of the original entity, akin to seeds awaiting their germination, but it gains significance as it grows into the new being's interactive-quality.[11]

Fourthly: We need to examine the relationship between inherent-instability, the desire to achieve stability, and the potential quality to evolve (evolutionary potential). When an entity at a state of instability, inclines to achieve a new stability – through active or passive means in response to various factors – it departs from its original state of stability and attains a new and higher level of stability. At this point, the entity's evolutionary potential comes into play, serving to compensate the loss of its initial stability and reach a new level of stability. This relationship can be represented in a formula:

(Original Stability) – (Loss of Stability due to specific triggers) + (Development of Evolutionary Potential) → New Level of Stability.

As discussed in Article 1, our concept of existence pertains to beings in an 'adaptation state,' excluding those entities that emerge and disappear rapidly as part of nature's random experiments. The elimination of these momentary entities aligns with the principles of natural selection. Nature favours those entities capable of maintaining a stable existence while eliminating those less capable. This natural process accounts for the remarkable intricacy and congruity observed in various organisms, almost as if they were tailored for specific environments or purposes. This is because entities failing to meet the requirements of an existence state have been naturally deselected.

Article 2 described how beings in adaptation states share an equivalence, as they all indicate structural-coupling of a being's interactive-qualities with its interactable-qualities or conditions. There is no inferiority or superiority in this structural-coupling; it either occurs or does not. With these foundational principles in mind, we can equate 'Original Stability' with 'New Level of Stability.' This can be interpreted as: **A being taps its evolutionary potential to compensate for the loss of stability**.

(Original Stability) – (Loss of Stability due to specific triggers) + (Development of Evolutionary Potential) = New Level of Stability.

Original Stability = New level of Stability.

Loss of Stability due to specific triggers = Development of Evolutionary Potential.

For most entities having limited potential qualities to evolve to a higher level of organization, they adopt natural drifts, adjusting their qualities to adapt to the new conditions. Correspondingly, the formula becomes:

(Original Stability) – (Loss of Stability due to specific triggers) + (Natural Drift Adjustment) = New level of Stability.

So, an entity adjusts its functions to compensate for its loss of stability. It thus becomes clear that for beings with little or no capacity to evolve or to adopt natural drifts, they are unable to reach a new level of stability and will ultimately go extinct and / or disintegrate.

Regardless of whether compensation is achieved through evolutionary potential or natural drift adjustments, it does not eliminate an entity's inherent-instability. This instability often increases as beings reach higher levels of organization, given the greater number of conditions on which they depend. Compensation only provides a temporary solution for loss of stability; it does not alter their inherent-instability. Beings at different levels of organization possess their respective degrees of instability, determined by the portfolio of conditions on which they depend. **Therefore, beyond the formula, there is a hidden parameter that signifies a being's inherent-stability.**

When certain eukaryotic cells experience a disruption in their balanced existence state, their evolutionary potential is triggered, enabling them to evolve into multi-cellularity and achieve a new balanced existence state. This doesn't imply that multi-cellularity solves their inherent-instability. At the level of multi-cellularity, cells are more specialized, and their division of labour more distinct, governed by a more intricate genetic regulatory program.

These new specialized functions then impose greater demands on internal coordination and reliance on external conditions, resulting in lower inherent-stability for multi-cellular species compared to eukaryotic cells. The evolutionary potential of multi-cellularity can be more easily activated due to heightened survival pressure and increased risks, giving rise to higher-order entities.

So, we identify two lines – a concealed line characterizing inherent-stability and a solid line illustrating temporary equivalent stability. The gap between equivalent stability and inherent-stability epitomizes the compensation initiated by entities adjusting for their loss of stability. **This compensation allows entities to temporarily restore their stability while concurrently diminishing their inherent-stability** (Diagram 4).

The fundamental nature of all entities is rooted in their inherent-instability, and their pursuit of stability (stable existence) is the ultimate cause of evolution. This pursuit of stability is manifested by an entity's compensation for its instability, whenever it is disrupted. But its ability to compensate and the strategies it employs depend on the entity's evolutionary potential, which, according to a being's vertical inter-relation, is shaped by the superposition of specific historical stages derived from nature's random experiment.

This concept is a modification of Wang's weakening-compensation model, in which entities are seen as naturally losing their inherent-stability. In this modified version, however, inherent-stability does not naturally decrease**. Its decline is contingent upon whether an entity possesses the potential to evolve to a higher level of organization and whether the necessary conditions exist to activate this potential**. In other words, not all entities experience a loss of inherent-stability.

Entities lacking evolutionary potential remain at their level of organization, subject to natural drift, until they can no longer adapt or lose the conditions on which they rely, resulting in eventual disintegration. The difference between Wang's model and my framework is in the prediction of disintegration. In Wang's system, entities disintegrate due to an inability to compensate or because inherent-stabilities decrease to near zero. In my modification, disintegration only arises from an inability to compensate.

Evolution and the Second Law of Thermodynamics

Some people may believe that the evolutionary tendency from simplicity to complexity suggests that to be stronger is the objective as well as the ultimate cause of evolution. This aligns with Erwin Schrödinger's negative entropy in

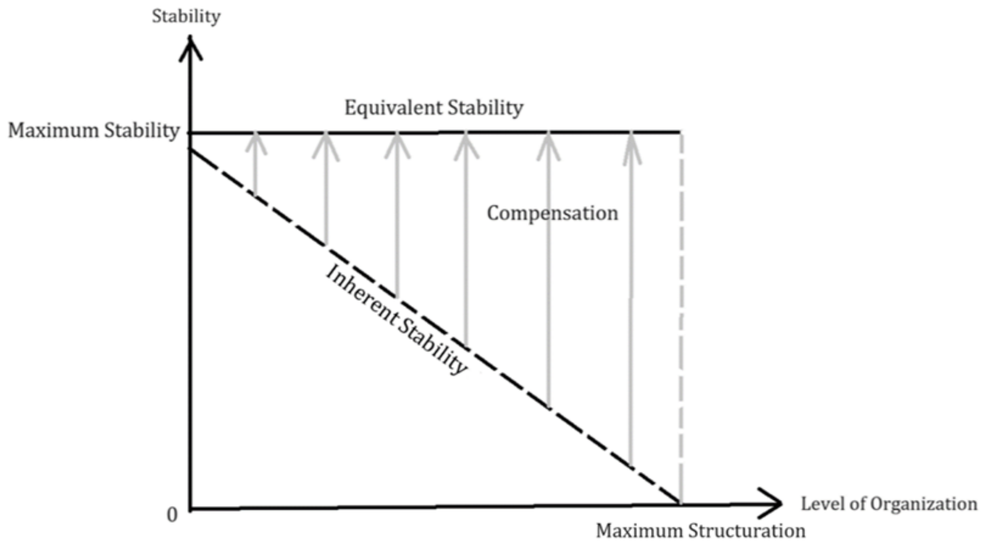


Diagram 4: Model of Existence. The X-axis measures a beings' level of organization, from 0 (simplest) to maximum structuration. The Y-axis shows the degree of stability, from 0 to the highest. Maximum stability refers to an eternally stable state that cannot be perturbated, so it cannot be reached by the inherent-stability of any entity. The progressive level of organization is measured by inherent-stability and compensation. Diagram by Ye Chen.

the system of the living organism, as he argued:

> …Living Matter, while not eluding the 'law of physics' as established up to date, is likely to involve 'other laws of physics' hitherto unknown, which, however, once they have been revealed, will form just as integral a part of this science as the former.[12]
>
> An organism's astonishing gift of concentrating a 'stream of order' on itself and thus escaping the decay into atomic chaos – of 'drinking orderliness' from a suitable environment – seems to be connected with the presence of the 'aperiodic solids', the chromosome molecules, which doubtless represent the highest degree of well-ordered atomic association we know of – much higher than the ordinary periodic crystal – in virtue of the individual role every atom and every radical is playing here.[13]

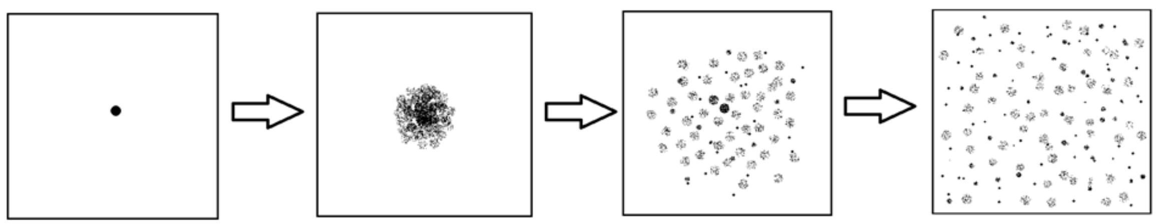
Entropy (S) is a measurable physical property associated with the degree of disorder or randomness within a system. The concept of entropy is based on the second law of thermodynamics, which posits that '… for any transformation occurring in an isolated system, the entropy of the final state can never be less than that of the initial state.'[14] This means that entropy invariably increases in an isolated system, a principle that appears at odds with Schrödinger's notion of negative entropy in living organisms, often referred to as the *Schrödinger paradox*.[15]

Schrödinger resolved this contradiction by positing that life distinguishes itself from other entities in its capacity to function as an open system that can exchange heat and matter with its surroundings. Consequently, the evolution of living organisms can counteract the natural trend outlined in the second law of thermodynamics (Diagram 5).

However, acknowledgment that the principles governing open systems do not align with principles applicable to closed systems (second law of thermodynamics) does not address the relationship between evolution and the second law of thermodynamics. Instead, it only highlights the clear differentiation between non-living and living entities, each adhering to distinct sets of physical laws.

In respect to Schrödinger's perspective, only the 'subject' is the mere concentration, whether it is a closed system of particles or an open system of organisms. But now we need to shift the approach to **macro-evolution – a system that involves both the subject – identity / existence of an entity, and the object – conditions on which the entity relies**.

Consider a primitive entity in macro-evolution – fundamental particles: They possess highly inherent-stability and disintegrate under only very limited conditions.[16] **The *principle of energy dispersal* does not mean they actually disintegrate, but that their uncooperative characteristics lead to no structure**. This aligns with our model of existence – in a closed system, individual particles can maintain their existence without



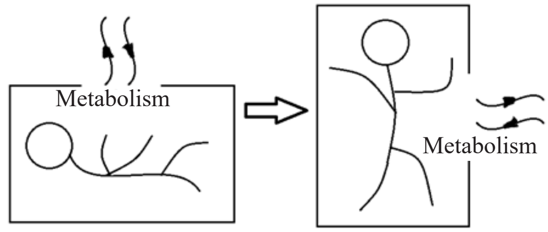


Diagram 5: Schrödinger's Negative Entropy. The upper images depict energy dispersal and entropy generation in a closed system. The lower images demonstrate how organisms function as an open system to allow negentropy. Diagram by Ye Chen.

relying on other particles, as reflected by 'energy dispersal.' It also implies that these particles have no evolutionary potential or that the conditions to activate their potential have not appeared. This is much like the lack of a societal structure among prokaryotic cells in early times.

If all particles lacked evolutionary potential and exhibited uncooperative characteristics, then they would all cease to develop and the universe would be perfectly in balance, staying constant at thermodynamic equilibrium. But this is not the case – no entity possesses absolute inherent-stability. Under specific conditions, the stability of particles can be disrupted, and their evolutionary potential can be activated, leading to the formation of more complex structures. This departure from equilibrium is often referred to as being 'far from equilibrium' in the realm of thermodynamics.

According to systems-theorist Ilya Prigogine, a system that moves out of equilibrium tends to transition into a state characterized by increasing randomness and begins to exhibit exceptional sensitivity to external fluctuations. This sensitivity can give rise to the emergence of novel patterns, representing 'a new coherence,' in which autonomous cooperation among entities develops an 'adaptive organization' fit to the environment. This is what Prigogine termed a 'dissipative structure' and suggests that evolution originated from instability – symmetry-breaking, a notion that Prigogine expressed as 'nonequilibrium being a source of order.'[17]

Compared to the chaotic behaviour of particles in thermodynamic equilibrium, the more complicated state of non-equilibrium reveals coordination between its components and the overall endeavour (compensation) to combat external fluctuation.[18] **The chaotic particles and orderly-organized entity share one thing in common – the maintenance of their identity – as simple particles or a complex organization**. Their orderly or chaotic manner reflects different existence states as well as different degrees of inherent-stability (different identities at different stages of evolution).

The second law of thermodynamics applies to all entities. Entities with a high inherent-stability manifest independence, so they appear as chaos. In contrast, complex entities with a low degree of inherent-stability must maintain stability by relying on other entities, for example, ensuring the coordination of internal networks and exchange of energy with the environment. Failure to do so results in their transition towards a state of disorder leading to disintegration. Structures with optimal capacity to maintain their identity are favoured by nature.

The second law of thermodynamics compels entities to evolve from passive existence states to more active ones. Compared to their ancestral entities, newly derived entities rely on more conditions and so must adopt increasingly proactive approaches, transforming disorder into order. Such initiatives are discerned in the ‘cooperative behaviour’ of some non-living entities. In a hypothetical world characterized by negentropy (reverse entropy), these entities would not develop such initiatives, since nature would have already put them in a state of order.

The Primal Singularity Hypothesis

If inherent-instability constitutes an ultimate cause of evolution, we must ask – from where did it come? In other words, what causes the symmetry-break that led to a thermodynamic state far from equilibrium? This gave rise to a primal singularity hypothesis.

(You may first review the principles I provided above on the Ultimate Cause of Evolution before moving on to the following hypothesis.)

The seed of inherent-instability lies in the Primal Singularity, where differentiation and evolution did not yet begin. As the simplest, undifferentiated entity, it relied on the least conditions to exist, hence it lies at the maximum inherent-stability (the leftmost point in Diagram 4). It cannot possess absolute, eternal stability, otherwise it would be non-reactive, and the Big Bang wouldn’t have occurred. Thus, maximum inherent-stability is not equal to maximum stability, but instead is slightly below maximum stability, which means its symmetry can still be broken on certain conditions. This gap between maximum stability and inherent-stability can be viewed as a permanent and minimum loss in stability existing in the Primal Singularity, as well as all its derived entities. In other words, inherent-instability existed at the beginning of the universe – the common ancestor of all entities.

This symmetry-breaking moment signifies the first time in the universe that an entity (primal singularity) loses stability. It is this loss of stability that triggers the singularity’s potential to evolve into specialized entities with specialized forces, striving to combine them to reach a new level of stability. However, the evolved entity’s inherent-instability becomes even less than its initial state, and, as it continues to evolve, it can only lose more (Diagram 4). Thus, the primal singularity has a permanent and minimum loss of stability, since its derived and differentiated roles only temporarily resolve the loss to reach a new level of stability, while increasing its demand for conditions in the maintenance of its existence.

Conclusion

According to our theory, evolution is driven by two factors – entities’ inherent-instability and the desire to achieve stability. An entity achieves stability through its unique way of making structural changes, by which it is able to compensate for the loss in stability. However, inherent-instability is the nature of all entities and cannot be fixed; only instability can be temporarily addressed through effective compensation.

Structural changes take place through two approaches – natural drift or evolution. The former refers to variations without upgrading the structure, while the latter’s structure rises to a higher level with enriched functions. Only entities with evolutionary potential can evolve into a more complex identity and, when they succeed, their inherent-instability increases, since their higher-level of structure relies on more conditions, both internally and externally. Please note that evolutionary potential is not an absolute but a relative concept – it is never something existing intrinsically at the start but appears at some point in its history, as we can only infer later when it gets activated.

Preview of Article 4

In this paper, we have introduced the foundational model of existence. In our upcoming article, we will delve into a range of topics that are subjects of extensive debate within the field of philosophy. These topics include consciousness, time and space, the law of causation, logic, and the profound implications of the model of existence. These discussions will be informed by the principles we have derived from the first three articles, as well as insights from the fields of animal diversity and molecular biology.

References

Bernardes, Joana; Uwe John, Noemi Woltermann and others, 'The Evolution of Convex Trade-offs Enables the Transition Towards Multicellularity,' *Nature Communications* 12 July 2021: 4222.

Cai, Huaqing; Karin Reinisch and Susan Ferro-Novick, 'Coats, Tethers, Rabs, and SNAREs Work Together to Mediate the Intracellular Destination of a Transport Vesicle,' *Developmental Cell* 12 (5) May 2007: 671–682.

Checkland, Peter; *Systems Thinking, Systems Practice*, Chichester: Wiley, 1981.

Davila, Alfonso; and Chrisopher McKay, 'Chance and Necessity in Biochemistry: Implication for the Search for Extraterrestrial Biomarkers in Earth-Like Environments,' *Astrobiology* 14 (6) May 2014: 534–540.

Dworkin, Jason; David Dreamer, Scott Sandford and others, 'Self-Assembling Amphiphilic Molecules: Synthesis in Simulated Interstellar / Precometary Ices,' *Proceedings of the National Academy of Sciences* 98 (3) January 2001: 815–819.

Emelyanov, Victor; 'Mitochondrial Connection to the Origin of the Eukaryotic Cell,' *European Journal of Biochemistry* 270, April 2003: 1599–1618.

Fermi, Enrico; *Thermodynamics*, Toronto: General Publishing, 1936.

Fillingame, Robert; 'Coupling H+ Transport and ATP Synthesis in F1F0-ATP Synthases: Glimpses of Interacting Parts in a Dynamic Molecular Machine,' *The Journal of Experimental Biology* 200 (Pt 2) January 1997: 217–224.

Fox, Sidney; and Kaoru Harada, 'Thermal Copolymerization of Amino Acids to a Product Resembling Protein,' *Science* 128 (3333) November 1958: 1214.

Grosberg, Richard; and Richard Strathmann, 'The Evolution of Multicellularity: A Minor Major Transition?' *Annual Review of Ecology Evolution and Systematics* 38 (1) December 2007: 621–654.

Gunner, Marilyn; Muhamed Amin, Xuyu Zhu and others, 'Molecular Mechanisms for Generating Transmembrane Proton Gradients,' *Biochimica et Biophysica Acta – Bioenergetics* 1827 (8–9) August-September 2013: 892–913.

Jacquot, Adrien; Grégory Francius, Angelina Razafitianamaharavo and others, 'Morphological and Physical Analysis of Natural Phospholipids-Based Biomembranes,' *PLoS One* 9 (9) September 2014: e107435.

Kirk, David; 'A Twelve-Step Program for Evolving Multicellularity and a Division of Labor,' *Bioessays* 27 (3) March 2005: 299–310.

Knoll, Andrew; 'The Multiple Origins of Complex Multicellularity,' *Annual Review of Earth and Planetary Sciences* 39 (1) April 2011: 217–239.

Koonin, Eugene; 'The Origin of Introns and Their Role in Eukaryogenesis: A Compromise Solution to the Introns-Early Versus Introns-Late Debate?' *Biology Direct* 1 (2) February 2006: 22.

Martins, Zita.; and Mark Sephton, 'Extraterrestrial Amino Acids,' *Amino Acids, Peptides and Proteins in Organic Chemistry*: *Origins and Synthesis of Amino Acids,* vol. 1, ed. Andrew Hughes, Weinheim: Wiley-VCH, 2009.

Mashoura, George; and Alkireb Micheal, 'Evolution of Consciousness: Evolution of Consciousness: Phylogeny, Ontogeny, and Emergence from General Anesthesia,' *Proceedings of the National Academy of Sciences of the United States of America,* 110 (suppl. 2) Feb 2013:10357–10364.

Maturana, Humberto; and Francisco Varela, *The Tree of Knowledge: The Biological Roots of Human Understanding*, Boston: Shambhala, 1987.

Miller, Stanley; 'A Production of Amino Acids Under Possible Primitive Earth Conditions,' *Science* 117 (3046) May 1953: 528–529.

Nazaretyan, Akop; 'Life's Meaning as A Global Problem of Modernity: A View from Big History and Complexity Studies Perspective,' *Journal of Globalization Studies* 1 (2) November 2010.

Oh Hye-Ji, Choi Dongjin and others, 'Loss of Gene Function and Evolution of Human Phenotypes,' *BMB Report* 48 (7) July 2015: 373–379.

Prigogine, Ilya; and Isabella Stengers, *Order Out of Chaos: Man's New Dialogue with Nature*, New York: Bantam Books, 1984.

Ring David; Techeskel Wolman, Nadav Friedmann and others, 'Prebiotic Synthesis of Hydrophobic and Protein Amino Acids,' *Proceedings of National Academy of Sciences* 69 (3) March 1972: 765–768.

Ridnina, Marina; Malte Beringer and Wolfgang Wintermeyer, 'How Ribosomes Make Peptide Bonds,' *Trends in Biochemical Sciences* 32 (1) January 2007: 20-26.

Schneider, Eric; and Dorion Sagan, *Into the Cool: Energy Flow, Thermodynamics, and Life,* Chicago: The University of Chicago Press. 2005.

Schrodinger, Erwin; *What Is Life?* Croydon: Cambridge University Press, 1944.

Schwabe, Christian; 'Genomic Potential Hypothesis of Evolution: A Concept of Biogenesis in Habitable Spaces of the Universe,' *The Anatomical Record* 268 (3) October 2002: 171–179.
Smith, J. Maynard; and George Price, 'The Logic of Animal Conflict,' *Nature* 246 November 1973: 15–18.
Steenkamp, Emma; Jane Wright and Sandra Baldauf, 'The Protistan Origins of Animals and Fungi,' *Molecular Biology and Evolution* 23 (1) September 2006: 93–106.
Traverse, Alfred; *Paleopalynology*, Dordrecht, Springer Netherlands, 2007.
Varela, Francisco; 'Organism: A Meshwork of Selfless Selves,' in *Organism and the Origins of Self*, ed. Alfred Tauber, Dordrecht: Springer, 1991: 79–107.
Wang Dongyue; *A Unified Theory of Evolution*, Beijing: CITTC Press, 1998. [Chinese publication].
Wickstead, Bill; and Keith Gull, 'The Evolution of the Cytoskeleton,' *Journal of Cell Biology* 194 (4) August 2011: 513–525.
Zhu Qinshi; *General History of Life*, Beijing: Peking University Press, 2019. [Chinese publication].

Endnotes

1 Zhu 2019. Jacquot and others 2014. Rodnina and others 2006. Gunner and others 2013. Fillingame 1997.

2 Traverse 2007: 71.

3 Emelyanov 2003.

4 Koonin 2006. Wickstead and Gull 2011.

5 As cells increase in size, they encounter the challenge of maintaining an appropriate surface-to-volume ratio. This is because the surface area (measured in square units) increases at a slower rate compared to the volume (measured in cubic units). Consequently, the surface area available for exchange with the external environment (nutrients in and waste out) doesn't keep pace with the metabolic needs of the growing cell.

6 Knoll 2011.

7 Grosberg and Strathmann 2007. Knoll 2011. Kirk 2005.

8 Primitive organisms, such as *Trichoplax adhaerens*, employ a straightforward method of intracellular digestion known as phagocytosis. In this process, the cell membrane surrounds and engulfs food particles to create food vacuoles, followed by the release of enzymes for intracellular digestion. Moving up to coelenterates, a single opening for both ingestion and waste elimination was developed, marking the introduction of an alimentary canal which allows for partial extracellular digestion. However, the digestive system's incompleteness at this stage restricts complete extracellular digestion within the organism's body. It is only with the evolution of more complex animals, such as mammals, that we witness the development of specialized organs dedicated to extracellular digestion. These specialized organs enable the sorting and processing of food in a manner that allows for efficient extracellular digestion.

9 Steenkamp and others 2006.

10 In Article 2, I addressed how the conservation force exists in all beings. Although we do not see a strong 'willingness' to be conserved in non-living beings, as we do in living beings, the immense proportions and age of non-living beings in the universe imply a more robust and powerful natural conservation force operating on them.

11 For example, wisdom of the ancient Greek philosophers did not play an important role in enhancing the social functions of ancient Greece. During that era, fields such as philosophy and mathematics were more like logical games engaged in by erudite minds. Yet, it was this very wisdom that served as the 'seed' responsible for the Renaissance and Enlightenment periods, which subsequently catalyzed the augmentation of societal functions, particularly during the Industrial Revolution. In this perspective, the wisdom of Greek philosophers can be regarded as the evolutionary potential that ultimately evolved into the distinctive 'interactive quality' of the new society.

12 Schrodinger 1944: 68.

13 Schrodinger 1944: 77.

14 Fermi 1936:77.

15 Schneider and Sagan 2005: 15.

16 In Article 2, I compared the energy required to bind bottom quarks, protons with neutrons, electrons with nuclei, and atoms with atoms. We observed that as particles exhibit increased structural complexity, they display a greater susceptibility to disintegration, accompanied by a significant reduction in the energy necessary for their dissociation.

17 Prigogine and Stengers 1984: 13, 84, 124, 129, 165, 187.

18 Prigogine and Stengers 1984: 189.