

The Universal Pattern of Evolutionary Entities and Its Circulatory Ladder-Like Pyramid Feature §

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Abstract

In the past decades, newly discovered subcellular and cellular entities have uncovered the insufficiency of the traditional Darwinian Universal Tree of Life (TOL). Accumulating evidence has indicated that genetic alteration in both prokaryotes and eukaryotes was not only endogenous as neo-Darwinians insisted, but also exogenous as Lamarckians claimed. This challenges the Modern Synthesis, our modern knowledge on evolution as the traditional theoretical cornerstone of many disciplines in the life sciences, including biology, physiology, and medical science. Based on its advantages in multi-disciplines, I propose a novel theoretical model called *the Universal Pattern of Evolutionary Entities (UPOEE)* to complement the inadequacies in the TOL and the traditional definition of life. UPOEE reflects the path of evolution from the simple to the complex, from lower levels to higher levels, and from inorganic entities to living organisms. Moreover, in the UPOEE model, several newly proposed concepts include: (i) *the Last Universal Inorganic Molecular Ancestor (LUIMA)*, *the Last Universal Organic Molecular Ancestor (LUOMA)*, and *the Last Universal Subcellular Ancestor (LUSCA)*, which illustrate the three important starting lines for demarcating the evolution of molecular and subcellular entities from lower levels to higher levels in the UPOEE model, (ii) *evocasion*, *evolvamy* and *evoclash*, which elucidate the opportunity and interaction among evolutionary entities at the same or different evolutionary levels, and (iii) the ‘*circulatory ladder-like pyramid*’ pattern, a facet of UPOEE in addition to the known “tree-like”, “web-like”, and “goods-like” features.

Key words: Tree of Life; the Universal Pattern of Evolutionary Entities (UPOEE); Evolvability; Evocasion; Evolvamy; Evoclash.

Introduction

The concept of the tree of life (TOL) reflects the gradational characteristic of evolution, which was initially based on studies of extant natural macroorganisms, such as plants and animals, and extinct macroorganisms left in fossils.^[1-5] However, the lowest starting point of evolution was unclear in the 19th century.^[6] Later, in the 20th century, the evolutionary root of the TOL was excavated down to the cellular level. The term “prokaryote” was coined for a cell without a nucleus, and “eukaryotes” for cells with

nuclei.^[6, 7] Structurally and functionally, prokaryotic cells are simpler than eukaryotic cells of plants and animals. From an evolutionary perspective, prokaryotic cells should have emerge earlier than eukaryotic cells, and this notion has been supported by fossil evidence.^[1-3, 8] As the only dominant unicellular life form before eukaryotes, prokaryotes were superior to the polyphasic entities of the subcellular evolutionary level, such as viruses, phages, and vesicle-like entities.

As we delve deeper into the unknown, newly discovered subcellular and molecular entities have no place in the traditional Darwinian universal tree of life.^[9] Accumulating evidence has indicated that genetic alteration in both prokaryotes and eukaryotes was not only endogenous as neo-Darwinians insisted, but also exogenous as Lamarckians claimed. This challenges the Modern Synthesis, our modern knowledge on evolution as the traditional theoretical cornerstone of many disciplines in the life sciences.^[9] Moreover, the combination of Darwinian natural selection and Mendelian genetics, which resulted in the Modern Synthesis in the mid-20th century, has been proved theoretically and empirically deficient in accounting for the question “how did and does evolution proceed?”^[9]

“Tree-like”, “Web-like”, and “Goods-like” Features

Norman Pace pointed out that “while our understanding of the diversity and evolution of microbial life is advancing rapidly, our textbooks are not incorporating new information or concepts at nearly the same pace. One important consequence is that textbook explanations of life’s organization and evolutionary history are badly outdated.”^[6] Upon many discoveries, such as viruses, plasmids, prions, transposable elements, and horizontal gene transfer (HGT) in the 20th century, the root of TOL has been excavated down to the sub-life level. Particularly, the discovery of Archaea by Woese has indicated that the root of TOL is not at the cellular level,^[10] leading to recent theoretical explorations on the origin of cells^[11-21] and debates on the necessity and the universality of the TOL,^[5, 6, 22-29] while some new theoretical models were proposed as well. For example, Martin argued that “microbial genome evolution is not a treelike process because of lateral gene transfer and the endosymbiotic origins of organelles,” “the tree of life is only one impediment to a better understanding of early evolution ...we might not need a tree of life at all.”^[22] Logsdon claimed that “the prokaryotic tree of life is dead!”^[5] McNerney and colleagues proposed “the public goods hypothesis”, in which “nucleotide sequences (genes, promoters, exons, etc.) are simply seen as goods, passed from organism to organism through both vertical and horizontal transfer.”^[30] Additionally, Torday and Rehan revealed that the molecular homologies of parathyroid hormone-related protein (PTHrP), a peptide secreted by alveolar type II cells, were found to exist in the lung, adrenals, skin, kidney, gut, bone, and brain of extant land vertebrates.^[31, 32] Kutschera wrote that “Darwin's view of a static, ‘Animals and Plants-based Tree of Life’ that does not take into account micro-organisms and endosymbiotic events, is outdated.” Kutschera proposed a tree-like “sybiogenesis, natural selection, and dynamic Earth (synade)-model,” in which sybiogenesis, (directional) natural selection, and the dynamic Earth were viewed “as three important ‘driving forces’ of organismic evolution.”^[24, 33, 34] Recently, O'Malley and Koonin concluded that “the irrefutable

demonstration by phylogenomics that different genes in general have distinct evolutionary histories made obsolete the belief that a phylogenetic tree of a single universal gene such as rRNA or of several universal genes could represent the ‘true’ TOL.”^[23] They suggested that the traditional Darwinian TOL may be “replaced by new, probably web-like representations of genome evolution”,^[23] or may “call for a radical revision (if not abandonment) of the Tree of Life concept.”^[35]

Moreover, some authors have revealed another essential trait of evolutionary pattern that is missing in TOL, which is a net or web-like characteristic.^[23, 36-38]

In my opinion, although viruses have no place in the Darwinian tree of cellular life, they play an important role in both pre-life and life evolution, and therefore actually have unshakable places in the pre-cellular universal tree.^[9] The pre-life’s tree, as the extension of the root of the tree of cellular life, encompasses all relevant inorganic and organic molecular entities. Here, we do not need to redefine “what is life or organism?” because there are different definitions for it at different evolution levels, and while delving deeper into the evolutionary root, the only thing we should do is to put newly found evolutionary pieces in a suitable place, not to replace or change the old parts in the evolution puzzle. Therefore, I propose a new tree named the “universal tree of evolutionary entities” to combine the Darwinian tree of cellular life with the pre-cellular universal tree, in which the relevant inorganic and organic molecular entities, viruses, bacteria, archaea, and eukaryotes have their own specific evolutionary places, and constitute different evolutionary platforms. The study on evolution should be of a specific interest not only in the life sciences, but also in physics and chemistry.

The traditional TOL is not an obstacle, but a supplement for understanding the Universal Pattern of Evolutionary Entities (UPOEE); and moreover, it has its historical and real life in the macro-biological world because of its rooting at the cellular level, and therefore is an indispensable part of UPOEE.

“Web-like” and “Goods-like” patterns of prelife evolutionary entities could be understood as the important development and extension of TOL, the evolutionary background and mechanism of TOL, and a new piece in the UPOEE puzzle. I agree to the view that prokaryotic microorganisms are the evolutionary “background organisms” of eukaryotic multi-cellular macroorganisms;^[24] and I further propose a concept of “Evolutionary Background Entities, EBE”, which refers to those entities of the lower evolutionary levels. According to this definition, EBEs of eukaryotic multi-cellular macroorganisms embrace not only prokaryotic entities, but also include all prelife evolutionary entities, such as viruses, phages, genes, and other relevant organic and inorganic entities.

Evolutionary Gradation of UPOEE

As a consequence of evolution, the emergence of diversification and gradation of evolutionary entities at the population level enabled prelife (or prebiotic) and living evolutionary entities to acquire novel traits or capabilities for their survival.

In the UPOEE model (Figure 1), the whole evolution can be gradated in the following different ways: (i) the Mono-Phase Period and the Poly-Phase Period are proposed based on the structural phase of evolutionary entities. The Mono-Phase Period refers to the

ancient evolutionary period when monomers and polymers existed independently as monophasic entities, such as inorganic elements and compounds and organic complexes without any envelope-like surrounding or coating structures. Therefore, the environment of an evolutionary entity in the Mono-Phase Period should be more dynamic and changeable than that in the Poly-Phase Period. In contrast, the Poly-Phase Period refers to the ancient evolutionary period when monophasic entities were enclosed by a membrane or coating structure to form evolved polyphasers, such as subcellular and cellular entities, which, however, evolved a relatively stable interior environment. (ii) The Molecular Stage, the Subcellular Stage, the Unicellular Stage, and the Multicellular Stage are based on the complexity of evolutionary entities. Evolutionary entities of the Molecular Stage match those of the Mono-Phase Period. The remaining stages belong to the Poly-Phase Period. (iii) Based on extant entities, the whole evolutionary entities can be distributed into different levels from the top (the most complicated in structure) to the bottom (the simplest in structure) as follows: the level of multicellular macroorganisms, the level of unicellular eukaryotes, the level of unicellular prokaryotes, the level of subcellular entities, the level of organic entities, and the level of inorganic entities (Figure 1).

Moreover, there is a necessary evolutionary course from an individual to a group or population for any given evolutionary entity at the relevant evolutionary level to form a species at the population level. Evolutionary entities of each evolutionary level have/had three common characteristics: (a) relevant evolutionary entities at the same evolutionary level are/were similar in the evolutionary degree of structural complexity from the evolutionary perspective; (b) despite being at the same evolutionary level, they are/were diverse in structural composition and functional behavior, for which, they can/could be divided into different species at the population level and separated as unique individuals at the individual level; and (c) evolutionary entities of any given higher evolutionary level are/were composed of evolutionary entities at lower evolutionary levels (Figure 2).

The UPOEE model could also be dissected into several levels for the distribution of different kinds of evolutionary entities (Figure 1). Moreover, evolutionary entities at the same evolutionary level varied morphologically, structurally and functionally. In animals, evolutionary entities at the macroorganism individual level and the macroorganism population level have different evolutiological significance. In human beings, the macroorganism population level could be further divided into several sub-levels, such as the group level, the tribe level, the national level, and the international level. An entity at the national level is called a 'country' or a 'nation' and at the international level, it is an international or world organization.

The Universal Pattern of Evolutionary Entities

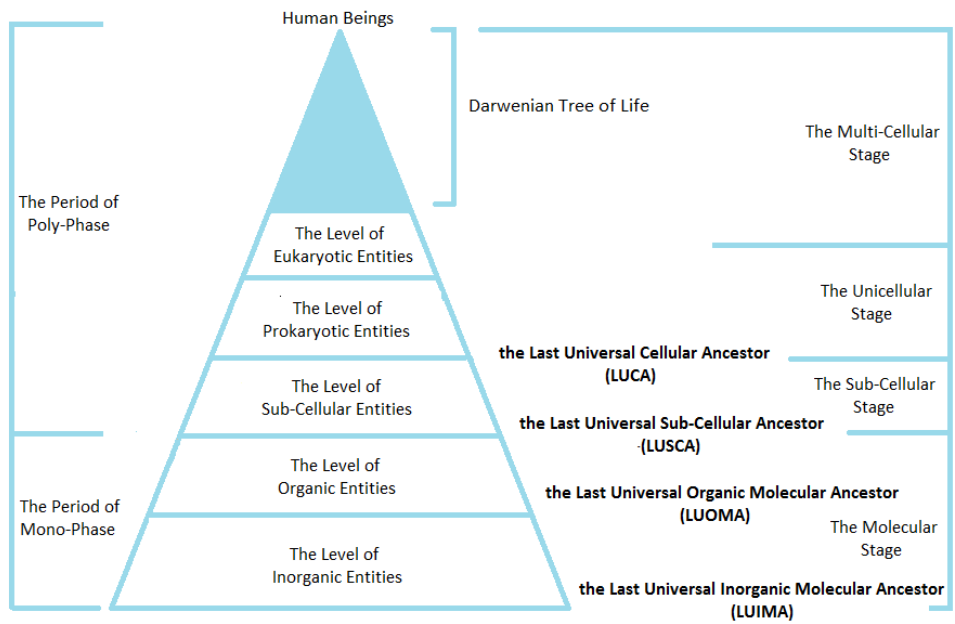


Figure 1. In the model of the Universal Pattern of Evolutionary Entities, the evolution order from simplicities to complexities is illustrated from three aspects as the following: (1) the period of monophase to the period of polyphase, (2) the molecular stage to the sub-cellular stage, then the unicellular stage, and then to the multi-cellular stage, and (3) the level of inorganic entities to the level of organic entities, then the level of sub-cellular entities, then the level of prokaryotic entities, and then to the level of eukaryotic entities.

The Evolutionary Layers of UPOEE

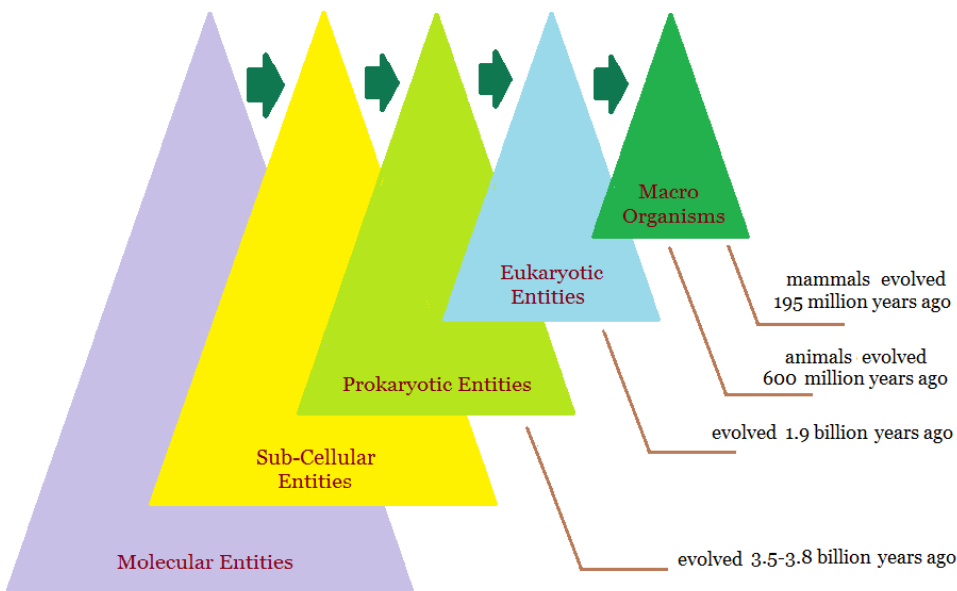


Figure 2. The evolutionary milestones or the evolutionary layers are illustrated in the model of the Universal Pattern of Evolutionary Entities. For a given evolutionary entity, those evolutionary entities at the lower levels comprise its biological and non-biological background and all those non-self evolutionary entities may constitute its ecological and evolutiological environment.

The Evolutionary Levels at the Molecular Stage

Evolutionary entities at the inorganic molecule level and the atomic level include H, O, N, P, S, Ca, Na, K, Fe, Mg, Si, Ni, H₂, H₂O, NH₃, H₂S, and SO₂; and CO, CO₂, CH₄, amino acids, nucleotides, lipids and carbohydrates are the examples of evolutionary entities at the organic molecule level. The members at these two levels cover a wide range of molecular entities, including abiotic elements, abiotic inorganic and organic compounds, which were initially studied by chemistry and physics, then by biochemistry.^[39-48] In the UPOEE model, the Last Universal Organic Molecular Ancestor (LUOMA), the Last Universal Inorganic Molecular Ancestor (LUIMA), and the Last Universal Sub-Cellular Ancestor (LUSCA) are proposed as the three important starting lines during the molecular and subcellular stages of prelife (or prebiotic) evolution (Figure 1). Therefore, theoretically, LUIMA, LUOMA and LUSCA are the reasonable extension of the concept “the last universal common ancestor of viruses, LUCAV”, which was proposed to present the ancient viral entities at the subcellular level of prelife evolution.^[13]

Monomers to Polymers

Monomers in this paper refer to chemical elements. Polymers are compounds consisting of similar and/or different monomers linked by various bonds and monomers are building blocks of polymers. Proteins, carbohydrates, DNA, and RNA are polymers, and emerged as monophasic entities during the Monophase Period of evolution. Monophasers are those evolutionary entities including monomers and polymers that lack any enclosing structures. Evolution from monomers to polymers to form organic macromolecules that have biochemical functions in transferring genetic information and catalysis, was one of the premise for the origin of primary cellular structures.^[49-62] More and more research attention from the evolution perspective has been paid to prelife monophasers between LUOMA and LUIMA,^[63-75] which has revealed some new features of evolutionary molecular entities. For instance, studies on protein conformation-based inheritance^[76-79] have clearly indicated that at the molecular level, in addition to polyribonucleotide such as RNA and DNA, some specific oligopeptides can also to play a role as hereditary information carriers.^[9] Moreover, RNA, a polyribonucleotide has been revealed to play a role as catalytic enzymes besides its well-known role as templates for replication and read-out of genetic information.^[9, 80, 81]

Monophasers to Polyphasers

Any evolutionary entity that is enclosed by coating structures, which are composed mainly of peptides and/or carbohydrates or lipids, are polyphasic entities and could be called polyphasers, such as viruses, phages, microvesicles, prokaryotic cells, and

eukaryotic cells. Monomers, polymers, monophasers, and polyphasers reflect different responding evolutionary layers and represent different milestones in the path of evolution. Furthermore, if there weren't some organic polymers to evolve from monophase to polyphase, the origin of cellular life wouldn't have been realized.^[82] This important evolutionary transformation was dependent on the emergence of the other two polymers, called "membrane" and "cytoplasm" as the critical premise for the emergence of the most primitive cells-like polyphasers.

The most remarkable distinguish between monophasers and polyphasers is that polyphasers have a relatively stable interior environment, which monophasers do not, although both monophasers and polyphasers have their own external environments which directly surround monophasic individual entities or polyphasic individual entities at the individual level. As a consequence of the transition from monophase to polyphase, previous monophasic entities evolved to a higher evolutionary level, enabling a group of these previous monophasic entities to have a relatively stable internal environment where more complicated and efficient physical and chemical interactions could occur within different polymers. In addition, according to the composition of core polymers in coating structures, three major classes of extant evolutionary polyphasic entities may be divided as follows: (i) peptide-shell-coated entities such as viruses and phages, (ii) carbohydrate-shell-coated entities such as cell wall-enveloped plant cells, and (iii) plasma membrane-coated entities such as animal eukaryotic cells. The importance of the plasma membrane from the evolution perspective can be further elucidated by research made by Randy Schekman, Thomas Sudhof, and James Rothman, who were awarded the Nobel Prize in Physiology or Medicine in 2013.^[83]

The Evolutionary Levels at the Subcellular and Cellular Stages

Viruses, phages, cytoplasmic organelles, and exosomes are the extant representative of evolutionary entities at the subcellular level; bacteria, archaea, and fungi are the extant exemplars of evolutionary entities at the unicellular eukaryotic and prokaryotic levels; and evolutionary entities at the multicellular macroorganism level consist of all plants and animals in the traditional Darwinian's Universal Tree of Life (TOL). Gould pointed out that the first five-sixths of cellular life history were almost exclusively unicellular.^[4] Clearly, the unicellular prokaryotic level was a rather long period on the time scale of evolution, during which there might have been numerous transitional prokaryotic cellular forms that became extinct, resulting in only the extant bacteria and archaea we can see today.

New Capabilities as the Consequence of Evolution for Survival Vary at Different Evolutionary Levels

Prelife and living entities obtained novel traits or functions through evolution for their survival, and therefore, corresponding evolutionary entities at different evolutionary levels display different capabilities, functions, and behaviors. Although the definition of

life is diverse, blurred, and undetermined, the functions of evolutionary entities at different evolutionary levels are truly distinctive. For example, animals at the individual level of macroorganism have evolved several unique functions, capabilities, and behaviors, such as fighting, foraging, sexual mating, vocal signals, and social learning, which are impossible for evolutionary entities of the cellular level to display.

Evolutionary entities at the molecular level cannot demonstrate the functions, capabilities, or behaviors displayed by the entities at the cellular level, such as cellular migration, responding to internal and external cellular stimuli, cellular growth, and division. This is despite the facts that these cellular behaviors are actually the consequence of hundreds of thousands of molecular interactions at the molecular level that occur within cells. A human individual's behaviors, such as speaking, watching, walking, singing, and thinking, are a few exemplars of the functions that we can display at the macroorganism individual level, which, as is well-known today, are the comprehensive consequence of a complex cooperation of numerous cells and organ systems in our bodies. The population level of some animal species is also called the social level. Several social behaviors, such as foraging, reproduction, and social learning, have been observed naturally or studied in some animal species, including ants, birds, fish, rats, dogs, and monkeys.^[84-95]

As the most advantaged mammal species in the evolution process, modern human beings currently stand on the top of the Universal Process of Evolutionary Entity Emergence (UPOEE). However, humans' superiority today is the evolutionary consequence of the past hundred thousand years as the inferior species on the timescale of evolution, not only when the ancestors of hominids were in the ancient mammal period, but also when they evolved to the primate level. Since humans entered the era of modern civilization, newly evolved social behaviors, such as cultures and arts, economics, education, politics, law, healthcare systems, military systems and warfare, religious activities, science and technology, and governments and international organizations have emerged and developed further as the unique symbols of humans at the social level. Therefore, it has been gradually accepted that the social feature of humans and non-human animals is deeply rooted in their biological nature. Unfortunately, such recognition was neglected or rejected for a long time, and even today, the recognition that the social system is the extension of biological evolution and that social problems of human beings are rooted in their biological nature is still a challenge for some sociologists, politicians, religionists, and even some biologists. One of the major reasons for their opposing opinion may be that the extant picture of the whole evolution after the past several billion years is extremely fragmentary, from which we can only micro- and macroorganisms that are dissimilar to each other, and furthermore, we have therefore formulated tremendously diverse definitions of life and species.^[8]

Significance of the UPOEE model

The evolutionary mechanism of macroorganisms has been accounted for by the Modern Synthesis theory mainly from the molecular and macroorganism population perspective, in which molecular alterations of random mutation, genetic recombination,

and genetic drift are believed by neo-Darwinians to be the only source of genetic variation.^[96-98] Neo-Darwinians interpret macroorganism evolution through the notion of reductionism: “Everything is reduced to the sum of the parts; and if we know the parts we can understand the whole.”^[98] This DNA-centered neo-Darwinian reductionism was accepted as a mainstream theory in the life sciences during the past century. However, during the past decade, it has been uncovered that this reductionist understanding suffers from a congenital deficiency because it ignores the significance of evolutionary levels.

The fimpological view is that knowing structurally the parts, or even all parts, of a thing cannot equal understanding functionally the whole of it. In other words, a coordinate function or behavior of an evolutionary entity that is composed of entities at lower multi-evolutionary levels cannot accurately be deciphered by focusing only on the entities of the lower evolutionary levels and without systemically considering their unique interactions at the higher level. Furthermore, a given evolutionary entity that evolved from a lower level to a higher level is always accompanied by acquisition of novel functions or traits for its adaptation to a new environment, or its correspondence to some changes in the previously adapted environment in order to survive. For example, a cell can be divided into two parts: cytoplasm and the nucleus at the sub-cellular level. Cell heredity or cell duplication, as an evolved function displayed at the cellular level, reflects the consequence of the interaction between cytoplasm and nucleus. In fact, the importance of cytoplasmic-nuclear interaction at the subcellular and molecular levels has been revealed via many empirical studies.^[99-107]

Therefore, cytoplasmic role in inheritance cannot be neglected while discussing biological heritage at the cellular level. Moreover, if we discuss the biological heritage of mammals at the macroorganism individual level, female-relayed intact cell inheritance should not be overlooked, which has been discussed in recent theoretical papers.^[108-110] I argue that although evolution and nature selection occur at all evolutionary levels, the mechanisms for evolution of macroorganisms at the individual level should not only proceed at the molecular level, but also operate at the unicellular, multi-cellular, and the subcellular levels.

If we set cells as the starting point of life, the tendency of evolution on Earth could be divided into two distinct parts: (i) the evolutionary age for pre-biological life, during which the earlier the evolutionary entities evolved, the more remarkable their physical and chemical features would display. And (ii) the evolutionary age for cellular life, during which the later the evolutionary entities evolved, the more notable their social features would exhibit. Moreover, during evolution, the initial physical and chemical nature of evolutionary entities has been sheltered by brilliant biological features, and then their biological nature has been further shadowed by social characters. However, these sheltered physical, chemical, and biological characters have never been lost or disappeared, and occasionally demonstrated their existence as forms of various human super-powers, most of which may have been attributed to “mysterious natural phenomena.” Recently, the emergence of a novel disciplinary—Mechanobiology, which studies the essential roles of physical factors playing via the process of mechanotransduction from the molecular, nuclear, cellular levels to the tissue level,^[111, 112] has initiated a new exploration of the physical nature of macroorganism individuals.

Evolutionary entities at the eukaryotic cell level consist of unicellular eukaryotic cells and multicellular eukaryotic cells. Multicellular eukaryotic cells have a unique characteristic: they need an embryonic period or a series of growth and developmental stages to complete their transformation from a single fertilized cell to a multicellular macroorganism individual. Plants and animals are the best embodiment of this unique characteristic. In the fimpological view, each individual of evolutionary entities of a given evolutionary level should be embodied in a corresponding collection or species at the population level, and evolutionary entities at higher evolutionary levels evolved from and are composed of entities that belong to lower evolutionary levels. For example, a human body at the macroorganism individual level is a single evolutionary entity. However, at the cellular level, an adult human body contains more than 10^{13} host eukaryotic cells and 10^{14-15} prokaryotic cells,^[108, 113-115] and there should be a much higher number of evolutionary entities at lower levels, such as the subcellular and molecular levels. According to the Modern Synthesis's notion, evolution occurs at a species, not at macroorganism individuals of a species,^[116] a paradoxical question arises: would a human body at the population level not be considered able to evolve, but at the cellular level, there are different host eukaryotic cellular and prokaryotic cellular species or lineages in the human body that can evolve? Similar questions could arise at the subcellular and molecular levels. In fact, three decades ago, Ernst Mayr already admitted that "how does a given evolutionary principle or phenomenon actually operate in an individual case?" was a question that the Modern Synthesis had not answered yet.^[117] Clearly, from the fimpological perspective, the Modern Synthesis neglected genetic and non-genetic variation-induced evolution that occurs at the subcellular and cellular levels.

Relationship and Interaction among Different Evolutionary Levels: Evolvamity, and Evoclash

In the fimpological view, evolution happens all the time at every evolutionary level,^[9] for which, it's necessary to develop some novel concepts to describe the relationship and interaction of evolutionary entities among different evolutionary levels. In this paper, I propose two novel terms: evolvamity, and evoclash, as the expansion of the term "evolvability". "Evolvamity" refers to the harmony of evolutionary entities between different evolutionary levels or within the same evolutionary level, and "evoclash" refers to the discord of evolutionary entities between different evolutionary levels or within the same evolutionary level (Figure 1 and 2).

In fact, the interaction between different evolutionary levels has already been mentioned before by a few researchers. For instance, Michod, Nedelcu and Roze pointed out that there are often conflicts or disagreements between the higher level and the lower level,^[118] and Paenke, Jin and Branke argued that the dynamic environment is a decisive factor for the balance between the individual level and the population level.^[119] The cooperation of different nations, such as the Central Powers and the Allies, were an example of evolvamity, while the first and second world wars were the examples of evoclash at the social level. Moreover, the phenomenon of the six models of pregnancy-associated eukaryotic cell transmission between fetus, mother, and the phenomenon of

infant fetal cells coexisting normally within maternal organs and tissues, ^[109] are the exemplars of evolvability between the cellular level and the individual level. In contrast, diseases of plants, humans, and non-human animals may be cases of evoclash between pathogenic evolutionary entities of the individual level, the subcellular level, and the molecular level, and host evolutionary entities of the individual, cellular, subcellular, and molecular levels.

Obscure viral infections are the consequence of evoclash between the pathogenic viral subcellular level and the host molecular and cellular levels, but not between the viral subcellular level and the host individual. However, if viral infections develop into clinical diseases, their evoclash correspondingly involves the viral subcellular level and the host molecular, cellular and individual levels. Organic phosphorus herbicide-induced clinical diseases reflect evoclash between the toxic molecular level and the hominal host molecular, cellular and individual levels. Homicidal death reflects the different consequences of entities' interactions at or between different evolutionary levels: (i) the consequence of evolvability among murders' molecular, cellular and individual levels for operating homicidal idea and act, (ii) the consequence of evoclash between murders' individual level and victims' individual level, and (iii) the legal penalty faced by murders exemplifies the evoclash between murders' individual level and the social level of the human society.

Evocasion—Unequal Chance for All Evolutionary Entities at the Population Level

It is worth pointing out that not all individual members of a species can equally catch an evolutionary opportunity. In other words, the opportunity of encountering evolution or evocasion is unequal for each member of a species. For example, destructive volcanic eruptions and earthquakes were usually regional geological events that may cause the previous micro- and macro-environmental conditions of the affected area to change and result in an active- environmental-alteration-driven evolution processes for the microorganisms and macroorganisms, including plants and animals, within that region or area. However, these events do not affect the microorganisms and macroorganisms of the same species outside the region, a new term 'evocasion' is proposed for such inequality.

The capacity of entities to evolve has been called evolutionary adaptability, or evolvability, which has been widely discussed at the molecular, cellular, and individual levels;^[120-126] and yet, what evolvability concerns is focused on the internal opportunity and mechanism of evolutionary success for those evolutionary entities under nature selection. In contrast, evocasion refers to the external opportunity of evolution that will initiate a process of nature selection acting on targeted evolutionary entities. Evocasional variation may be an initial environmental or external reason for diversity which has occurred in a widely dispersed species.

Opportunity and spatiality are the two important characteristics of evocasion, which means that (i) the occurrence of environmental alterations, or events including volcano eruptions, earthquakes, desert formation, and collisions of asteroids and comets with Earth usually last for a certain period with a range from seconds to years, and affect the micro- and macroorganism entities within a limited space and area; (ii) the majority of

evoccasional events occurred only once in the timescale of evolution, which means that not all of the individual members of a species at an evolutionary level would have an equal opportunity to evolve to a higher evolutionary level; and (iii) the evolutionary consequences are usually difficult to reverse or to replicate mainly because we still know little about the history of evolution and it is unrealistic to simulate regionally and geologically a series of evoccasional events.

The Circulation-Based Ladder-like Pyramid Model

Moreover, in addition to “tree-like”, “web-like”, “goods-like” and external environment-driven features, UPOEE should have another facet—the “Circulation-Based Ladder-like Pyramid” pattern (see Figure). In other words, there are several cyclic features in the UPOEE model. One of them is the cycle operating between lower levels and higher levels, among which, and the carbon cycle is one and another is the cycle between individuals and populations. The ladder-like pyramid pattern reflects the relationship of continuous evolutionary layers according to the time scale of evolution, in which, human beings are at the top and inorganic entities at the bottom. The further discussion of the third circulatory feature of UPOEE will be later in other papers.

In the UPOEE model (Figure 1 and 2), the shape of the “Pyramid” means that the number of entities in the higher levels is always smaller than the number of entities in the lower levels from which the entities in the higher levels evolved, which is the consequence of evoccasional inequality. For instance, at the subcellular level, viruses (bacteriophages) are the most abundant evolutionary bioentities on Earth, with approximately 10^{31} viral particles in the oceans;^[127-131] at the unicellular level, the number of prokaryotes on Earth was estimated to be 10^{30} cells;^[132] and at the macroorganism population level, humans’ population is 7.2×10^9 ^[133].

Concluding Remarks

In this paper, I propose a novel theoretical model, called UPOEE, to complement the inadequacies in TOL, in addition to several new concepts, such as LUIMA, LUOMA and LUSCA for illustrating the three important starting lines for demarcating evolution of molecular and subcellular entities from a lower level to a higher level in the UPOEE model, and evoccasion, evolvability, evolvamity, and evoclash for elucidating the opportunity and interaction among evolutionary entities at the same or different evolutionary levels, as well as the “circulatory ladder-like pyramid” pattern, a facet of UPOEE except known ‘tree-like’, ‘web-like’ and ‘goods-like’ characteristics.

Abbreviations

TOL: the Tree of Life;

UPOEE: the Universal Pattern of Evolutionary Entities;

EBE: Evolutionary Background Entities;

LUIMA: the Last Universal Inorganic Molecular Ancestor;
LUOMA: the Last Universal Organic Molecular Ancestor;
LUSCA: the Last Universal Sub-Cellular Ancestor;
LUCA: the Last Universal Cellular Ancestor;
LUCAV: the Last Universal Common Ancestor of Viruses.

[§ This revision of “The Universal Pattern of Evolutionary Entities and Its Circulatory Ladder-Like Pyramid Feature” was finished on January 19, 2023.]

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