Article

Biological Interaction and Homeostasis in Evolution

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Abstract: Charles Darwin's theory of evolution, his note as regards descent with modification, added greatly to the knowledge that we already possess of how species have survived down the ages. It is evident that this does not provide the necessary knowledge about the origin of the life on earth. However, it provides remarkable evidence about how life has survived. Looking fundamentally at the cellular construct of organisms, we arrive at the fact that cells, both unicellular and multicellular, have organelles that enable them communicate with one another. This ability for living organisms, down to the lowest - cellular life - to communicate is what I refer to as Biological interaction. It is necessary that we articulate more about this concept and see how this all comes to bear as regards Homeostasis. In reference to the latter, it is to be made known that every living organism is also intrinsically aimed towards a projected linear motion in its time riddled existence. This is to say that every living organism operates on an foundational process, amongst others, known as Homeostasis. We understand this term to mean balance that the living system strives to maintain. However etymologically speaking it means staying the same. How has this homeostatic process added to the fostering of life via biological interaction? How is biological interaction fundamental to the theory of evolution?

Keywords: biological interaction; homeostasis; evolution; A. Damasio

1. Clarifying the terms

Homeostasis

Homeostasis refers to a self-regulating process by which biological systems maintain stability while remaining flexible to external conditions.[1] It is by means of this concept that organisms are able to maintain internal conditions that enable them adapt to an ever changing external environment. However, the word is derived from two terms *homoeo* and stasis. *Homeo* is a Latin word that means "similar to". It aligns itself to the Greek word *homio*, meaning resembling, of the same kind, equal. It is actually the expanded form of the word homos, meaning, "one and the same". *Stasis*, a Greek word that means "a standing still, a standing, a positioning of some sort, a point on a compass, a state or condition of something. If we are to combine the meaning of the two words, selectively choosing one and leaving out the rest, we would have a construction as: "similar to-(yet)-standing still". Nonetheless, biologically speaking, it means the process by which a system, a living system to be precise, maintains internal stability arising from the combined efforts of the parts of the system. Homeostasis pertains to living system and how these systems organize themselves in the respect to the external environment. We therefore call to mind the etymological meaning of the word- *homio* and -*stasis*, with out combined meaning of "similar to (yet) standing still". The system has a code of living it has to maintain irrespective of the fleeting elements outward of it. It has to "stand-still" amidst this *fleeting-ness*. The maintaining of this code of living, it attains to both consciously and unconsciously. That is to say that there is conscious and unconscious *homeostatic-ness* (this indicates that the homeostatic process is not only automated, but it is also choice driven) to living systems.

[1] Billman, G.E., Homeostasis. The Underappreciated and Far too Often Ignored Central Organizing Principle of Physiology in *Front. Physiol.*, 11, 200, 1-12, doi: 10.3389/fphys.2020.00200

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According to Antonio Damasio, the classical rendition of homeostasis, also referred to as the traditional stance of the concept, is conceived such that the system is automatically geared towards homeostasis. And yet this is where the error comes in. Reeling off the words of Kotas and Medzhitov, Damasio notes that:

The problem is that the traditional concept of homeostasis does not usually conjure up the fact that there are two distinct kinds of control of internal milieu parameters, and the extraordinary significance of that duality is thus ignored. Specifically, the traditional concept of homeostasis calls attention to a non-conscious form of physiological control which operates automatically without awareness or deliberation on the part of the organism. Indeed seeking food or drink when energy sources are depleted can be achieved by most organisms without any willful intervention on their part. Should food or drink not be available in the environment, hormones automatically break down sugars stored in certain cells and deliver them to the blood as needed to offset the deficit. Likewise, when water balance is low, the kidneys automatically slow down their operation in order to reduce diuresis and restore the level of hydration.[2]

This misconception as regards what the classical (traditional) rendition of homeostasis, is tied to its early usage by the Greek thinkers. We should note that the Greek physician/philosopher Alcmaeon of Croton supposed Homeostasis to be "a balance of opposites", as he sought to explain the divide between health and disease.[3] Making use of the analogies from politics, he sought to give further deepening of this understanding to this divide between health and disease. There ought to be an *evening out*, a clear cut dichotomy between internal functions, to enable better productivity as regards output. Hippocrates, adopted this line of thought and brought it to bear in what pertains to the health of the human person. That is to say that health is the subtraction of what is in excess and the addition of what is wanting in the internals of the human being.[4] Such subtraction and addition was suspected to be automatic, since it pertained to the body, and the body was thought to be self-regulating.

The human body is self-regulating, yet not in its entirety. Better understanding of the anatomy and physiology of the human body has inspired the thought of a better understanding of homeostasis today. *Why do we say that the human body is not entirely self-regulating?* It is tied to the fact that for these automated actions to maintain an optimum function, the conscious actions of the agent needs to come into play. For instance, if the body is dehydrated, apparently the cells and the tissues, will stand in need of water. There will be a network of messages sent back and forth by neurons that are found in the *lamina terminalis*.[5] The feeling to drink, one that A. Damasio refers to as a *conscious homeostatic-ness* (my coinage), arises by automatic messages, but the decision to heed to this automated call, is a conscious one. This means that homeostasis, must be conscious as well, this further means that the human person is not totally self-regulatory. *What of the other life forms (lower than the rationality of the human being)?* Their movement to get hydrated, seeking the satisfaction that water brings, is also a conscious one, although one that these animals and lower life forms do not intricately understand. According to A. Damasio,

[2] Kotas, M.E. and Medzhitov, R. Homeostasis, Inflammation and disease susceptibility in *Cell* 160, 2015, 816-827j; Damasio, A and Damasio, H., Exploring the concept of Homeostasis and considering the implications for economics, in *Journal of Economic Behaviour and Organization* Vol 126, Part B, 2016, 125-129, https://doi.org/10.1016/j.jebo.2015.12.003.

[3] Billman, G.E., Homeostasis. The Underappreciated and Far too Often Ignored Central Organizing Principle of Physiology.

[4] Jones, W.H.S., *Hippocrates Vol. II. Prognostics*, Harvard University Press, Loeb Classical Library No. 148, Cambridge, M.A., 219.

[5] Neurons within three parts of the lamina terminalis—the subfornical organ (SFO), the organum vasculosum lamina terminalis (OVLT), and the median preoptic nucleus (MnPO)—work together to coordinate drinking behaviors.

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Homeostatic feelings operate within the compass of basic homeostasis. They intervene in the solution of essential problems of life regulation... Feelings are regulatory interfaces and curiously they are double-sided, a trait that tends to be unacknowledged. One side of the feeling phenomenon corresponds to standard physiological operations and includes the chemical and cellular mechanisms that typically allow for the automatic regulation of internal body variables, for example, the uptake of excessive circulatory glucose by fat cells under the influence of insulin, and the simultaneous suppression of release of glucose from cells in which sugars are stored. The other side of the feeling phenomenon is *mental*, and it provides organisms with something evolutionarily new: a direct and explicit *experience*. It allows the owner of that experience to sense the state that its organism is in. Consider for example a restriction of the airway into the lungs, in an enclosed space or under water. The situation generates a forceful, rapid and automatic motor reaction aimed at gaining access to air. This is observable in any living creature, non-human and human alike, that depends on respiration to deliver oxygen to its internal milieu. This is entirely automatic. The fact that in humans this reaction is *also felt as air hunger and experienced as fear* is a bonus that guarantees our attention to the danger the organism faces but is not essential for the basic, automated, motor reaction to kick in.[6]

The feeling of being satiated is yet a mental feeling that is consciously delineated in and by the human person. What is being said here is that there must be what it means to be satiated, and this feeling still situates the living system under that homeostatic wall. "Similar to (yet) standing still", as the etymological imprint of homeostasis, therefore alludes to the living organisms consciously and unconsciously seeking after elements that add to its sustenance and thriving in the world. *Now etymologically we can say that in reference to homeostasis, it is process by which living systems are not the same, but are similarly inclined towards life, while remaining unchanging (standing still) in reference to the changes that occurs in the world. The living system, in clear terms, is actively alive and yet firmly positioned as it traverses the world a midst its many changes*.

Biological Interaction

Biological interaction as used in this research should not be construed with the ecological term that relates to species engaging interactions between themselves or other species. Biological interaction as used here is specific to everything the living organism (from the simple cell that are found in the body of a higher organism to simple cells that are living alone, to mobile and immobile organisms). does with special reference to living. In fact we allude to the fact that ***living itself is to interact biologically with the environment*** that one inhabits. Biological interaction arises from the question of life.

E. Schrodinger had particular remarks about the what constitutes life in his book-what is life. Particular excerpts from the book that relate to what is being said here arises from his own question: how do living systems evade the sharp decline into decay (thermodynamic equilibrium)? "The obvious answer is: By eating, drinking, breathing and (in the case of plants) assimilating. The technical term is metabolism."[7] The Greek word for metabolism is *metaballein* that which stands for exchange or change. The exchange is between the organism and its immediate or proximate environment. By eating, drinking, breathing and the likes, there is an exchange between the organism and the environment. The decay to equilibrium according to Schrodinger occurs when the organism feeds on negentropy. The eating, drinking, breathing etc., that the organism does is simply just the

[6] Damasio, A and Damasio, H., Exploring the concept of Homeostasis and considering the implications for economics, in *Journal of Economic Behaviour and Organization* Vol 126, Part B, 2016, 125-129, https://doi.org/10.1016/j.jebo.2015.12.003.

[7] Schrodinger E., *What is life? The Physical Aspect of The Living Cell and Mind and Matter*, Cambridge University Press, Cambridge, 1977, 74.

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process by which *it* feeds on negentropy thereby reducing the speed at which the organism attains to thermodynamical equilibrium (death).[8]

Negentropy is free energy, it is opposite stance of entropy. Entropy refers to the degree of disorganization or uncertainty in a system; it is also considered to be on an ever state of increase or it remains constant in an isolated system. In thermodynamics it can be defined with the formula:

$\Delta S = Q/T$
where S is the entropy evolution of the system
Q is the heat exchange in the system
T is the temperature of the system

The steady increase in the energy of a system is further enhanced if and when the system is isolated. An isolated system (this is quite Utopian), is one that does not engage in any exchange whatsoever, be it mass or energy or both. This is quite practical, if there is nothing that infuses, in other words slows down the entropy in the isolated system, it keeps increases, till the system is one with its entropy, that is to say till it attains thermodynamical equilibrium. Negentropy, also known as negative entropy reduces the effect of entropy in the system. And as we have already noted, this happens when the system feeds. For the system to feed, it already indicates that there is an ongoing exchange, an interaction, a communication between the system and its environment. Negentropy is used to explain the presence of "order" within living beings and their tendency to oppose the chaos and disorganization that governs physical systems.[9] When we say that negentropy is used to explain the presence of "order", we mean the process by which "disorder" is counteracted by the interaction of the system with its greater environment.

In every living system, there is one form of biological interaction going on, be it on a cellular scale or on a systemic scale (micro or macro), be it the organism with itself or with the external environment. Interaction is key to biological survival. Therefore we would define biological interaction as

the process by which living organism stands in reference to their individual environment in order to avoid decay to thermodynamical equilibrium, a process that involves the living organism feeding on negentropy.[10]

Its avoidance of decay to equilibrium is automated, but the process by which it engages in this is both conscious and unconscious.

Metabolism underlies the process by which the living organism feeds on negentropy. Metabolism is not the same mode in every organism, nonetheless, it permeates the entirety of the living. As Arturo Sanchez and Raja notes:

Metabolism refers to the whole sum of reactions that occur throughout the body within each cell and that provide the body with energy. This energy gets used for vital processes and the synthesis of new organic material. Every living organism uses its environment to survive by taking nutrients and substances that act as building blocks for movement, growth, development, and reproduction. All of these are mediated by enzymes, which are proteins with specialized functions in anabolism and catabolism. The

[8] ibid, 78.

[9] Isa, H.H.S. and Dumas, C. Entropy and Negentropy Principles in the I-Theory in *Journal of High Energy Physics, Gravitation and Cosmology*, 6, 2020, 259-273. https://doi.org/10.4236/jhepgc.2020.62020.

[10] Iwuh, D. *How Biological Interaction explains the origin of life* (unpublished manuscript), Dec. 2022.

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rate of energy production is called the basal metabolic rate and is affected by factors such as sex, race, exercise, diet, age, and diseases such as sepsis or cancer.[11]

The result (this is to be separated from waste product) of metabolism is energy, it is therefore impossible to discuss metabolism without recourse to thermodynamics, with particular reference to the first two laws - energy can neither be created not destroyed and the the outcome of the physical and chemical change is an increase in entropy. With that said, the

The energy that is actually useful, or free energy, is that kind of energy capable of doing work under no difference in temperature. Less useful forms of energy become liberated in the form of heat.[12]

Free energy or useful energy is the energy that Schrodinger intended when he noted that in metabolism, the organism feeds on negentropy. This energy that is generated in metabolism is indicative of the interaction that exists between the organism and its environment. This is what is properly referred to as *Biological Interaction*.

2. How Biological Interaction and Homeostasis meet in the evolution

We have come to a proper definition of the terms biological interaction and homoeostasis. It will become evident as the work progresses that these two concepts are integral to what pertains to evolution.

Evolution should not be likened to natural selection, this is because the latter is one of the mechanism by which the former comes to be. Evolution is the "change through time as species become modified and diverge to produce multiple descendant species"[13]. It refers to "descent with modification; transformation of species through time, including both changes that occur within species, as well as the origin of new species".[14] Evolution as a term has a varied number of meanings amongst specialists, but we can X-ray and sum all those definitions into six namely

1. Change over time; history of nature; any sequence of events in nature
2. Changes in the frequencies of alleles in the gene pool of a population
3. Limited common descent: the idea that particular groups of organisms have descended from a common ancestor.
4. The mechanisms responsible for the change required to produce limited descent with modification; chiefly natural selection acting on random variations or mutations.
5. Universal common descent: the idea that all organisms have descended from a single common ancestor.
6. Blind watchmaker thesis: the idea that all organisms have descended from common ancestors through unguided, unintelligent, purposeless, material processes such as natural selection acting on random variations or mutations; the idea that the Darwinian mechanism of natural selection acting on random variation, and other similarly naturalistic mechanisms,

[11] Sánchez López de Nava A, Raja A. Physiology, Metabolism. In *StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing;* 2022 Jan: https://www.ncbi.nlm.nih.gov/books/NBK546690/

[12] Liu X, Chen T, Jain PK, Xu W. Revealing the Thermodynamic Properties of Elementary Chemical Reactions at the Single-Molecule Level in *J Phys Chem B*. 2019 Jul 25;123(29):6253-6259.

[13] J. Losos, *What is Evolution PDF*, Princeton University Press, Princeton, 1-7, http://assets.press.princeton.edu/chapters/i10100.pdf

[14] ibid.

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completely suffice to explain the origin of novel biological forms and the appearance of design in complex organism.[15]

From all that has been gathered from the above, it is clear that evolution pertains to change that living organisms undergo over a period of time in interaction with their environment (that is the world they inhabit). Evolution does not ponder on origins, but considers how organisms have continually remained alive, adaption to the ever changing environment around them. The essential element on which evolution hangs is life. We thus assert that life and the living is fundamental to any discourse that concerns evolution.

The environment in which the organisms inheres plays host to the organism in many ways, and as it changes, the organism itself undergoes changes in order to make it better adaptable to the change about it. Finding a balance in this change is what the organism engages in. For instance, with the human body in reference to the external temperature, a drop in temperature below the human's capacity to bear, will witness to changes in the human body namely shivering. The human body has a capacity to which it can bear a drop in temperature. It operates on a balance of 37° C or 98.6ºF. Pre-hypothermia begins to set in when the body temperature in respect to the external witnesses a drop starting from 35° C. At this point in time, one begins to notice that one is cold. To prevent hypothermia, the brain that monitors the heat level of the body receives signals from the body surface. This signal is sent to the hypothalamus in the brain. As regards heat homeostasis, it is the work of the hypothalamus (it also has other homeostatic functions such as the maintaining of blood pressure, hunger, thirst, mood and sleep). As a swift response to the message it gets from the skin receptors, the brain engages the body in an act of shivering. In this, the skeletal muscles gets tense and relaxes at quick rates, making your body move (these contractions and relaxations also make your teeth chatter). This is the body seeking to warm up itself, because it has stepped out of balance (for such motion of the muscles give out heat, this is because energy is used in doing this. it is this heat that is given off that the body channels into getting itself warm). When this automated response is not fully working, the brain also relays this message, and then the individual is moved to find more warmth or risk death. The same process is seen when there is a rise in temperature. What is being said here is that for the furtherance of life, homeostasis is necessary.

Homeostasis itself is a process that is initiated when there is a communication, an interaction between the living organism and the environment. What is being alluded to here is that Homeostasis pays respect to the process of Biological Interaction.; it is actually the organism's response to its interaction with the environment. Every aspect of evolution has to involve the process of biological interaction in organisms. Consider for instance the aspect of descent with modification using the example given on the Khan Academy website about natural selection:

...a group of mice with heritable variation in fur color (black vs. tan) has just moved into a new area where the rocks are black. This environment features hawks, which like to eat mice and can see the tan ones more easily than the black ones against the black rock. Because the hawks can see and catch the tan mice more easily, a relatively large fraction of the tan mice are eaten, while a much smaller fraction of the black mice are eaten. If we look at the ratio of black mice to tan mice in the surviving ("not-eaten") group, it will be higher than in the starting population. Fur color is a heritable trait (one that can be passed from parent to child). So, the increased fraction of black mice in the surviving group means an increased fraction of black baby mice in the next generation. After several generations of selection, the population might be made up almost entirely of black mice.[16]

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[15] Meyer, S and Kaes, M., The Meanings of Evolution in *Research Gate online journal*, May 2011, 1-19, : https://www.researchgate.net/publication/238529368

[16] Khan Academy, https://www.khanacademy.org/science/ap-biology/natural-selection/natural selection-ap/a/darwin-evolution-natural-selection, (19-12-22).

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The fact that the black mice in the next generation will witness to an increase in population due to the activity of the hawks, also gives credence to this fact of biological interaction. The mice constitutes the environment of the hawk, as much as the hawk is the environment of the mice. The interaction between the hawk and the mice, leads to a depletion of a certain number of mice, the tan mice. This eventually has consequences in the next generation.

3. Conclusion: What then is Evolution?

Evolution is change in time. It is a change in time that rides on the heels of two fundamental process namely - Biological interaction and Homeostasis. In fact, it is to be noted that Biological interaction is more fundamental than Homeostasis, nonetheless, they both are necessary ingredients in evolution. Whatever traits are to be passed down in time, whatever elements are to be strengthened and weakened as time passes, is already known by the constancy of the interaction that takes place between the organism and the environment it inheres. That is to say that the law of use and disuse, in which Lamarck made known to explain why certain organs are no longer found in certain organisms, which has been necessitated to meet a need- That is to say when the organs are no longer called into use by fact of an interaction with the environment or when its use is heightened and deepened again by a demand due to an interaction with the environment. Are we to get rid of the term evolution? No. Nonetheless, it is opined in this text, that there is an ultimately obvious fact that has been overlooked so far, that is biological interaction. Biological interaction as used here has nothing to do with its usage in ecology or in any ecologically related study. It is to be said that evolution and all that pertains to life, all that makes life what it is, is associated with the fact and process of biological interaction (it is also hypothetically alluded here that the origin of life as we have it in the world today is tied to this process of biological interaction).

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