Austin Biology

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Mini Review

An Unorthodox View of the Cell- Living Cells Play

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Received: May 09, 2018; **Accepted:** July 02, 2018; **Published:** July 17, 2018

Abstract

The standard view of cell conceives of it as a working machine that carries out work once and again 24/7. There is no room, it appears, for free actions, purposeless activities. Such a view, is a Fordist and Taylorist approach in biology. This paper argues that what the organism experiences - joy, sadness, love or hate, for instance, is exactly what each single cell experiences at any given moment. The argument is supported on a reflection on fractal geometry. If reasonable, the consequences of play in the understanding of cells becomes crucial for histology and pathology.

Keywords: Biology; Cell biology; Health; Degrees of freedom; Fractals; Non-algorithmic processes

The Standard View of Cells

Without being exhaustive, the claim about a standard view of the cell -let's say a sort of "standard model", very much like the expression is used in physics, is something that has already been very well established in biology and the life sciences. Different caliber studies of the standard view of the cell can be seen, among other sources, in [1-3].

The structure of the cell consists of a cell membrane, the nucleus, the cytoplasm, mitochondria, chloroplasts, ribosomes, the endoplasmic reticula, the Golgi apparatus, liposomes, peroxisomes, vacuole, and a number of other stances. Much more interesting is the physiology of the cell, i.e., how it works – for it allows to understand the basic unit of life on earth.

Being a closed system, the living cell however is open to the most basic physical phenomenon that makes it possible, namely energy. Thermodynamics already operates at the level of the cell *via* oxidation and reduction. Throughout thousands of chemical reactions a permanent exchange of energy is produced in and within the cell. As a consequence, the cell metabolizes. Metabolism can recently be safely said to be at the very origin of all living processes. "First metabolism" means a never-ending process of exchange and interdependence with the environment. Shortly said, coevolution.

Enzymes and proteins play a most crucial role in the feasibility of the cell, so much so the energy flows in every single cell activity. Cells create low entropy conditions that radically characterize life, as it is known. Thus, life both creates the very conditions for both its appearance and sustainability as well as its possibilities - at large. In any case, it is well known that ATP carries the energy; it is a coenzyme. Without any further claim, the function of the cell determines its size. Glycolysis and respiration are combined in order to make ATP.

Now, energy is carried in the cell by ATP processes, as well as by the electrons transporters. All in all, endocytosis and exocytosis are combined, so that the cell can both regulate the enzymes, and metabolize. The cell is perfectly fitted to regulate the enzymatic activity in order to keep herself balanced and healthy. The allosteric interaction is crucial here so that enzymes can either be active or inactive.

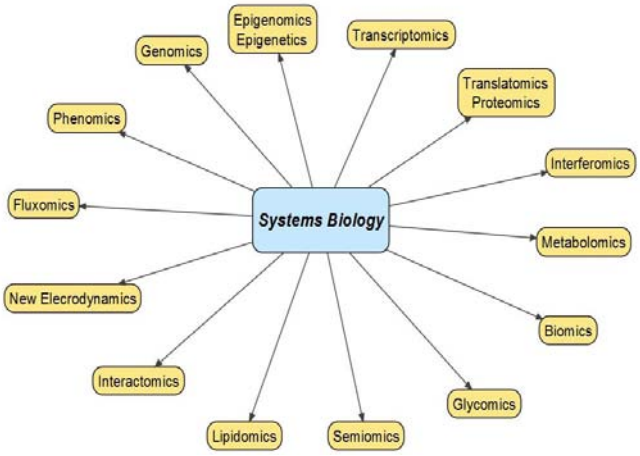

Figure 1: A general map of systems biology.
Source: Own elaboration

Being both anatomically, physiologically and thermodynamically a very complex structure, the living cell knows of further developments. After all, we can distinguish T-cells, dendrites, microglial, monocyte, erythrocyte, and several other types of cells in the human body, for instance – this given the basic fact about the distinction between eukaryotic and prokaryotic cells.

Downwards, the study of the cell leads us to genetics and its varied and closed-related fields. Upwards, it conducts us toward molecular genetic and the evolution to complex organisms up, currently, to mammals always through mitosis, meiosis, and cytokinesis – essential in the production of the genetic variability.

To be sure, originally the anatomy and the physiology of the cell was analytically structured and identified. However, more recently, the coming of systems biology has brought a much more complex and insightful view of the cell. Systems biology allows for a networked and much more dynamic understanding of the cell, i.e. life.

Figure 1 shows a variety of other networks and systems that compound the entire realm of biology according to the most recent developments. Thus, the study of the living cell, for example, becomes

Citation: Maldonado CE. An Unorthodox View of the Cell- Living Cells Play. Austin Biol. 2018; 3(1): 1025.

Table 1: A General View of Lifetime of some Cells.

Cell Type	Turnover Time
Stomach	2-9 days
Gastrointestinal colon crypt cells	3-4- days
Lungs alveoli	8 days
Tongue taste buds	10 days
Blood B cells	4-7 weeks
Central nervous system	Lifetime
Skeleton	10% per year

Source: Adapted from http://book.bionumbers.org/how-quickly-do-different-cells-in-the-body-replace-themselves/

both more accurate, as well as enlarged and enriched. In medicine, such a becoming leads from epidemiology on to transpersonal medicine, a most meaningful advance in knowledge and research.

In sum, the standard view of cell, even though it might have become more complex, conceives of the cell as a structured unit that unceasingly carries out work cycles. This approach is justified when looking at the lifetime of the cells: a skin cell lasts nearly fourteen to twenty-one days, a human liver cell, between three-hundred and five-hundred days, intestinal cells, around sixteen years, for instance ([4]; see, further more BioNumbers). It is well established that nearly every seven years most of the human cells are replaced. The replacement of the cells is done geologically in the human body, so to speak. This means, that multi-scale and synchronicity rule in the process of replacement. Health can be understood as a harmonic composition - rather than rhythmic or melodic. A working machine cannot work eternally, it becomes tired after a while.

Playing in Nature, and Biology

Nonetheless, nature is not a machine, in any sense of the word. Computationally said, she is certainly not a Turing Machine, - whether O-TM, U-TM, or of any other kind. As a consequence, playing exists in nature, gaming is an everyday experience in many levels and contexts. Playing stands on a quite different dimension than working - or laboring. Indeed, whereas working is a purposeful activity, an intentionally action - well, a teleological process, playing points to a very different time lapse.

Comparative psychology, biology, primatology, even entomology, to name but some areas, have witnessed and studied playing among various species of animals. Thus, for example, crocodiles, turtles, cichlids, wasps, or octopuses play - not to mention the very well known cases of dogs, cats, birds. This a matter of fact in spearhead science.

Animals have fun, and nearly everywhere in nature, animals exhibit playful behaviors. The question remains as to the plants, but the issue is only too recent to come to negative conclusions. S. Mancuso and F. Baluska have brought brand new and insightful studies relating the behaviors of plants [5-7].

One remark is, in any case, compulsory. Playing in nature is not a representational activity, that is, it is not carried out as a show to be seen and enjoyed (perhaps clapped) by an audience. The question has arisen about why animals play - particularly when seen form a selective standpoint. In other words, what is the selective function of playing. No one single answer has been provided, but a number or interpretations. Thus, for instance, play is important in social development, or also in physical development, not to mention cognitive development. Developmental biology provides a series of answers. A very singular important interpretation has been brought out by [8], namely play may also be training for the unexplored.

Being as it may be, playing means rejoicing, enjoying, having fun. À la limite, being happy. Thus, observations teaches that in nature there is not only necessity, but there are also contingency, chancy events, and randomness. The biological title for the latter is: playing, gaming.

Stated the other way round, a sad, suffering, sick animal does not play. It is subject to necessity and survival. One can safely claim that playing is a clear sign of health, and liveliness.

Living Cells Play: A Fractal Argument

The human body has appropriately be seen as a system of systems. In fact, very well studied and grounded, furthermore, any living system can be said to be a system of systems. Of course, below the systems, we find, organs, tissues, cells, and the relations are both downwards and upwards, according to the departing point. This idea opens up the door for recognizing a fractal architecture of living organisms. Some ideas in this direction can be found in (http://www.fractal.org/Life-Science-Technology/Publications/Fractals-and-Human-Biology.pdf)-namelyparticularly about the lungs, blood vessel, and the brain.

Briefly said, fractality means that a given pattern can be repeated at various scales. More exactly, it is iteration which creates the pattern. As a result, self-similarity is produced that shows that a particular structure corresponds to the very structure of the whole. Fractality does not mean exactly the same, but nearly the same.

Natural phenomena with fractal features include fault lines, mountain ranges, DNA, proteins, earthquakes and snowflakes, among many others. Turning to biology, the fractal geometry of nature allows to safely recognize that the cell as a basic unit is a whole network - namely the fractal network of the living organism. More exactly, one can safely speak of fractal dimensions on networks. I would like to claim that the living organism is a complex network of different time scales. This idea can also be found in [9]. To be sure, the living cell is the basic structure of the time scales within the organism.

B. Mandelbrot, distinguishes two types of fractals, thus: scaling fractals which are deterministic, and non-scaling fractals that are non-deterministic [10]. The latter exhibit non-linear variability, and the former regularity and linearity. To be sure, in the living organism both types of fractals coexist and interact with each other.

The living organism experiences the world and nature as a whole, not by parts or mechanically. This can be phrased not any longer in terms of causality but of correlations. Thus, from the point of view of fractal geometry, what the organism experiences - hunger, thirst, joy or angst -, corresponds to what every system, tissue, organ and cell does experience. Not ultimately epigenetics becomes here a crucial aspect. Here, however, it must remain aside due to space and concretion.

Laboratory and mathematical measurements should and could be done in order to measure the fractal dimension the cell experiences

- along the body as such. Without hesitation the result would be between 1.5 and 2.3 as extremes ranges. This is left for a further experimental study.

Conclusions

If cells play, and enjoy or suffer what the living organism experiences as a whole, this might be of importance for both histology and pathology, and not only for psychologists. In other words, the cell is not an automaton, i.e. an algorithmic "device". Quite on the contrary, it exists non-algorithmically. Playing is a non-algorithmic activity - in biology.

Playing allows for freedom and joy, as well as for errors in the organism. Freedom is a stance of nonchalance vis-à-vis the world. Error opens up the gate for sickness and disease.

The life of the organism is a set of different complex timescales, as shown above in Table 1. The experience of life, world and nature is a phenomenon that implicates the whole organism as well as each level of organization down to the cell, and vice versa. Health is the most basic and the most fundamental experience of life, and yet a particular case of life, namely that case that serves as ground or condition for any possibilities in the world. When healthy, any organism plays. Hence, also cells play. Fractal geometry serves as rationale for this claim.

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Austin Biol - Volume 3 Issue 1 - 2018
ISSN: 2578-949X | www.austinpublishinggroup.com

Citation: Maldonado CE. An Unorthodox View of the Cell- Living Cells Play. Austin Biol. 2018; 3(1): 1025.