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A New Biology for A New Century - Carl R. Woese

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INTRODUCTION

Science is a search for a more true representation of reality, though such a representation may never be perfect. Since the guiding vision, which is a proponent of science, of biology has been realized, humans must now look for a deeper representation of biology. With such representations, scientists can fundamentally deepen their understanding to a degree not possible in the past.

THE MOLECULAR ERA IN THE BIGGER PICTURE

Before looking for a deeper understanding of molecular biology, historical context must first be analyzed. In the 1800s, biology as a science came to life, with scientists observing major breakthroughs in the field. Physicists came also and impacted the field of biology by framing how science should be done. Since many physicists adapted a reductionist approach, the holistic part of biology (e.g. evolution) came to be underdeveloped. This makes sense, as emergent properties are created when the parts of a system interact. It is sometimes impossible to analyze and predict what emergent

properties should emerge, though, as there a system may be so numerous in parts that predicting such properties is infeasible.

Reductionism versus Reductionism

Reductionism can either be empirical or fundamental; empirical reductionism simply looks at a system's parts to better understand the whole, whereas fundamental reductionism makes the leap and states that a system's parts is equivalent to the system. Both Pauling and Delbruck's belief that molecular templating could form the basis of life, as well as the discovery of the DNA structure, set in stone the view of fundamental reductionism of biology in the 20th century. Because of this, it was more difficult to realize the truth of the mechanisms driving holistic aspects of biology, and biology lacked a fundamental understanding of systems.

Synthesis

Due to the previous fundamental reductionist view of biology, it has become hard for the holistic problems of biology to be solved, as they require scientists to understand that some properties of systems that are not observable in a system's parts emerge when a holistic view is realized. Despite this, a fundamental reductionist view has been able to propel the start of biology. It is hopeless to try and analyze the complexities of a system without first delving into its constituent parts.

TOWARDS A NEW REPRESENTATION OF BIOLOGY

The previous representation had tunnel-vision. Problems that could be solved with an engineering perspective were solved, and those that could not remained unsolved. But, one cannot simply try to understand the world by only trying to accommodate evidence and facts that easily fit into one's model of the world; the truth of science is to realize a deeper, more accurate, and more fundamental model of reality, and dismissing confusing evidence directly contradicts this.

CHANGING THE OVERVIEW

The organism can no longer be viewed as a machine; it is an evolving, continuously repairing life form that is greater than the sum of its parts. Only by ridding the view of fundamentalist reductionism was progress made in those problems that that view of reductionism threw to the side. It follows that if the future continues to adapt a holistic approach to biology, a more fundamental understanding than ever before will come to us.

SOME PERTINENT HISTORY

The difference between the molecular perspective and classical biologist perspective was most apparent when interpreting gene expression; classical biologists considered that process as fundamental, but the molecularist did not because the process could not be easily explained. This ‘battle’ is illustrative of how the fundamentalist reductionist view hindered the growth of alternative views of biology. Later, some advanced technology later allowed the universal phylogenetic tree to be mapped out.

THE PANDORA'S BOX OF MICROBIOLOGY

In order for a field of science to be successful, it must not shy away from the overarching problems that surround it, unlike the field of microbiology. Rejecting misunderstood concepts and trying to build a science that hides such concepts is doomed to fail.

The Dismantling of Bacteriology and a Deconstruction of the Procaryote

In the attempt to make a field of science more reductionist, a fundamental understanding of such a science can be lost. Take bacteriology, a science in which reductionists proposed (without evidence) all bacteria were monophyletic - a conclusion that would set up an erroneous understanding of bacteria. The predicament with bacteriology teaches scientists the virtue of patience over immediate answers. Though it may take a long time,

waiting for true evidence in the future will prevent wrong theories from emerging in the meantime.

Other Guesswork Solutions?

There is no fundamental issue to guesswork solutions. However, there arises a problem when such solutions mask true problem-solving. In regards to evolution, it is important that scientists not hail theories of the past as doctrines that are set in stone. Progress in a scientific is only inhibited when previous theories are believed in without sufficient evidence to back up such theories in modern times.

CELLULAR EVOLUTION: THE BUMPY ROAD TO WHO KNOWS WHERE

Just because an idea is a somewhat plausible explanation for a phenomenon doesn't mean that it should be taken as fact and that alternative theories be not considered. For example, though the theory of endosymbiosis proposes that a mitochondrion simply became part of a prokaryote fails to address the fact that cells cannot simply be taken apart and rearranged. It becomes necessary, then, to observe theories that address biology as a whole, a viewpoint which has been largely rejected in the past.

THE DYNAMICS OF CELLULAR EVOLUTION

The dynamics of cellular organization are based on HGT as well as the constraints imposed on the cell by the translation method. Some genes are easily transferred between bacteria, though some are too heavily integrated in the fabric of a cell to have a replacement gene that can do everything the original gene can. These genes are the key to lineages because they do not change much over time. Thus, by analyzing these genes, biologists can hope to trace out the lineages of bacteria that bacteriology failed to do.

The Key to Understanding the Character of HGT

HGT is thought to have been a major proponent of cellular organization in primitive cells. Because of the rampant HGT, it is hard to know whether the cells were actually physically different or only different in an abstract sense. Though not much is known about such primitive organisms, this example demonstrates it is useful to probe biology by playing with different theories in order to gain a more fundamental understanding.

From There to Here

Though it has long been believed that all organisms emerged from one ancestor, there is an argument for the case in which all life emerged from multiple independent organisms that were linked by HGT. In addition, the change that allowed for such great novelty necessary to produce the complex organisms today likely arose from RNA.

An Interesting, if Not Relevant, Aside

Theoretical considerations support the multiplex origin of cell organization; for example, if one makes the assumption that primitive organisms create rough translations of proteins, it becomes clear then that such rough translations can quickly diversify to provide for the wide variety of proteins seen today. This idea goes hand in hand with the belief that theories created should not be set in stone - theoretical considerations, although lacking concrete evidence, may provide alternative explanations of science.

When Is a Tree Not a Tree?

Trying to enforce a simple maxim in a scientific theory may be appealing, though it can lead to erroneous representations. The typical idea that all organisms diverged from one single organism is potentially wrong because there already existed very distinct organisms with their own characteristics before even reaching this root. Only after crossing their ‘Darwinian threshold’ does it make sense to interpret the phylogenetic lineage of organisms through a tree.

ONE LAST LOOK

The reductionist view of physics has plagued much of biology in the past, and the reductionist view still continues today; scientists are at a point in which they must choose to follow the past or break free and view biology from a holistic and integrated standpoint. Only then can society truly understand biology through a biological and not physical lens.