Coding For Medicine Club
Houston, Texas Headquarters
550 Dulles Ave, Sugar Land 77478
Dulles High School

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

Name: Zarik Khan

Date: 10/31/2021

INTRODUCTION

Scientific advancement is a series of representing the laws of the universe with the most effective model possible, with each new representation uncovering another layer of truth within a body that is essentially infinite in depth. These new understandings result in technological advancement, which allows humanity to have the tools required to apply it to new scientific discovery, however these understandings require a guiding vision to apply them the right way. It is necessary to find a new guiding vision for biology, rather than letting the field solely fixate on its current applications, to enable us to have the technological advancement to solve the problems of the future.

THE MOLECULAR ERA IN THE BIGGER PICTURE

The field of biology reached its prime with the discovery of modern fields centered around understanding cells, and the ways they work together and develop. Molecular biology resulted in intersections between chemistry, and biology, developing the field of biochemistry. In my opinion most likely these discoveries resulted from understanding the effects of chemistry within cells, examples of such would be, how nucleotides formed covalent bonds to form DNA and RNA, and the effects of the cell membrane on nonpolar and polar molecules. However this also

later resulted in a new field known as biophysics, which most likely studied the electrical properties formed by these chemical bonds.

Reductionism versus Reductionism

The discoveries in physics in the 19th century resulted in a process known as reductionism to be adopted into biology, there are two forms of reductionism. Empirical reductionism is defined as using the parts of a system to develop a greater understanding of it, while Fundamentalist reductionism is to assume how the system works based on its parts. The flaws of Fundamentalist reductionism, especially in the field of biology, are that systems can have new properties even if their parts don't have those properties. This is due to something known as emerging parts, which states that those parts can combine in unpredictable ways to generate those properties, such as how when carbon, nitrogen, hydrogen, and oxygen form nucleotide bases, but none of those elements can store genetic information individually.

Synthesis

The twentieth century resulted in a shift from focusing mostly on molecular biology, to focusing on more holistic topics such as evolution and morphology. More branches of biology formed within this view of holistic issues, such as molecular evolution, a field that was relatively ignored previously. The overall focus of the scientific community slightly shifted from studying how cells worked, to how they evolve and develop.

TOWARDS A NEW REPRESENTATION OF BIOLOGY

In order to truly understand biology it is necessary to be willing to look at the bigger picture, and understand topics such as evolution and ecology. Molecular biology's success occurred with reductionist thinking, but that resulted in dismissing other issues that had emerging properties, dismissing them. There needs to be an understanding that emerging properties can result in some fields such as ecology and evolution being inaccessible to a reductionist form of thinking, but that doesn't make them worthy of dismissal.

CHANGING THE OVERVIEW

Organisms' capability of homeostasis is what differs it from machines. This makes it necessary to understand them as an organization of properties that can act unpredictably, rather than just carbon based machines. Thus the newest guiding point of the 21st century in biology is based on understanding the organization of biological systems with fields such as evolution, morphology, and morphogenesis.

SOME PERTINENT HISTORY

The issue of gene expression resulted in a divide between classical and molecular biologists. This occurred over differing opinions over the process of translation, those with a reductionist way of thinking assumed it was simply a molecular process, while others believed it was a result of evolution and needed to be more thoroughly researched. Understanding this evolution using Sanger sequencing allowed scientists to make breakthroughs in the study of bacteria.

THE PANDORA'S BOX OF MICROBIOLOGY

Scientists struggled to understand the evolutionary history of bacteria, which prevented it from becoming a legitimized field. The largest problem of the field was its lack of a guiding vision, in which there was little attempt to make the necessary major breakthroughs in the field. Due to the lack of equipment and tools available to study bacteria there was little hope of solving the major problems that plagued the field, and this issue worsened with the discovery of the prokaryote.

The Dismantling of Bacteriology and a Deconstruction of the Procaryote

Microbiologists attempted to solve the problem of a concept of a bacterium by declaring that prokaryotes came from a common ancestor and that eukaryotes are descendants of prokaryotes. However these claims had no evidence or proof to back them up, and were simply a way to release themselves of the burden of solving the real questions of

microbiology. Prokaryotic organisms are highly different and varied, and can only be defined as organisms without any organelles bound by a membrane.

Other Guesswork Solutions?

Charles Darwin's theory of common descent was simply an observation that every organism could be a descendant of a common organism. However this led to assumptions within the scientific community due to a concept known as the Universality Of Biochemistry. Which essentially means finding mutated gene sequences within certain organisms, this legitimized the theory of evolution as there was no other reasoning for how that could occur.

CELLULAR EVOLUTION: THE BUMPY ROAD TO WHO KNOWS WHERE

There is a necessity within the biological community to separate the study of the parts from the whole, and understand the intersection of all aspects of biology, rather than viewing it as simply countless cells interacting. This reductionist thinking does not delve into the greatest problems of evolution such as how humans can form languages that other primates cannot. Alongside this it is necessary to understand cells as organelles interacting in a specific order and manner, rather than just a combination of organelles, the latter of which can lead to creating inaccurate representations of biology inadvertently.

THE DYNAMICS OF CELLULAR EVOLUTION

However, recent discoveries about Horizontal Gene Transfer(HGT) , which is defined as the transference of genetic information between organisms without sexual interaction, can provide a new perspective to the theory of Evolution. HGT can classify genes into groups based on whether they can easily be replaced by adaptaptations, genes that can be replaced by functional alternatives, and finally genes that define the organization of the cell. The more integrated those organizational genes are, the less likely there is a replacement for it, and it tends to undergo very little evolution.

The Key to Understanding the Character of HGT

HGT usually occurs with genes that have minimal interaction with the rest of the cell, such as certain enzymes. This demonstrates that the more integrated a gene or organelle is within the cellular matrix, has an inverse relationship with the effect of HGT on it. This means that it has a stronger effect on simpler organisms with a less connected cellular matrix, such as bacteria.

From There to Here

Evolution occurred by creating stronger interactions within different components of the cell, to take advantage of the emerging changes that occur when they work together, to form a stronger and more developed cellular matrix. Nucleic acids were necessary to this structure as they could undergo translation, and this transition resulted due to RNA interactions. It is theorized that RNA formed entities similar to cells, and that these entities evolved from multiple points in various ways, to represent the diversity of cells and organisms we have today.

An Interesting, if Not Relevant, Aside

Statistical proteins can be used to find new proteins through evolving certain genes on a sequence. They allow researchers to see the effects of evolution on that gene, and its surrounding genes at a faster rate than what it would standardly evolve at. Scientists could use this to study the effects of RNA on HGT and the evolution of RNP entities.

When Is a Tree Not a Tree?

The course of evolution cannot be represented by an organismal tree, until HGT loses its dominance over evolution, at a point known as the Darwinian Threshold. Stable genomes will not occur until a lineage

crosses the threshold, in the order of which is the least evolved. Therefore most likely bacteria crossed the threshold first, then archaea, then eukaryotes.

ONE LAST LOOK

Biology needs to transform from an applied science, to a fundamental science to solve future problems. However the only way this can be done is by abandoning fundamentally reductionist ideas, and accepting that biological systems are not simply a sum of their parts, and how emerging properties can result in systems that appear nothing like their components. The way to solve the problems of the future is to focus on systems rather than parts and delve into topics such as evolution, and center that as biology's new guiding point.