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

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INTRODUCTION

Science progresses through the creation of new representations that are more accurate or beneficial than older ones. This progression is caused by technological advancement that allows for more accurate data collection to prove or disprove hypotheses and a guiding vision that gives foundation for how to plan those experiments. In the context of biology, the guiding vision has brought humanity to understand the main principles of biology, but now a deeper look must be taken in order to fully understand the specifics. This means that it is important that we create a process to allow us to do so.

THE MOLECULAR ERA IN THE BIGGER PICTURE

Biology became a well established science in the 1800s through the advancements of aspects throughout cells, heredity, and natural selection. This led to the creation of two separate groups of studies: within the cell and the evolution of those cells. These studies were backed on prior physics knowledge which I would assume to be related to electrostatics since that relates to polarity, one of the major reasons why biomolecules shape the way they do. And in the process, the biologists probably also simplified many aspects of physics to make their science less complicated.

Reductionism versus Reductionism

Empirical reductionism is using observations to understand biology and it doesn't assume anything to be true, but fundamentalist reductionism uses the parts of an object to understand the whole object. One thing that can be inferred is that fundamentalist reductionism might be more commonly used when there is a lack of technology since if there is technology available to directly observe something, most likely, the scientist will use empirical reductionism. Fundamentalist reductionism has been used in the past with the structure of DNA that showed how gene replication was possible.

Synthesis

The twentieth century was a turning point in molecular biology because scientists brought together the parts to create a more involved whole. This can be seen through the advancements in evolution and ecology. Furthermore, there was a greater focus on peripheral problems than the main one that allowed for more branching of sciences to occur.

TOWARDS A NEW REPRESENTATION OF BIOLOGY

In order for people to advance in biology, they need to turn away from a fundamental, mechanistic approach to fully reductionistic. In other words, scientists must examine concepts as a whole and not only look at the parts while also not disregard topics like evolution. This transition can be seen in the success of molecular biology in the past century.

CHANGING THE OVERVIEW

People shouldn't think of organisms as static machines but rather as dynamic structures that change according to their surroundings. This can be seen through the formation of adaptations that change the organism and allow it to live better in its environment. Therefore, this makes it easier to think about the evolution of cellular organization since those changes that are beneficial pass on, but others are left behind. This allows for a dynamic structure of organisms and species.

SOME PERTINENT HISTORY

The biggest problem between classical biology and molecular biology was the understanding of how genetic information worked. This surfaced with the discovery of DNA and gene expression of the DNA through translation. Originally, translation was just understood through codon pairings, but by understanding the evolution of translation through rRNA using sanger sequencing, scientists were able to connect and discover new forms of life.

THE PANDORA'S BOX OF MICROBIOLOGY

In the 1900s, bacteria didn't really fit in with other more complex organisms, so it created a new biological discipline, bacteriology. This science disregarded any questions it had or tried to answer them by just guessing instead of using empirical reductionism. This probably made sense in the past when equipment wasn't that advanced and the scientists were too scared of breaking bacteriology apart; however, it ended up doing so shortly with the discovery of the prokaryote.

The Dismantling of Bacteriology and a Deconstruction of the Procaryote

When the word "prokaryote" was first made, it was used to define organisms similar to bacteria that didn't have a nucleus. However, this definition was the basis of many assumptions of evolution such as that "all prokaryotes come from a common ancestor" and that "eukaryotes came from prokaryotes." These assumptions were unfounded, so it showed that these molecular biologists were just using the term to hide the fact that they didn't know anything about the evolution of bacteria. Therefore, the term can no longer be used as a similarity between organisms but instead as something that isn't a eukaryote.

Other Guesswork Solutions?

Another example of a guesswork solution like the evolution of prokaryotes was the idea of common descent. This was originally speculated by Darwin but in no way confirmed. However, since the idea that all organisms came from the same common ancestor seemed appealing, it was most likely assumed to be true by evolutionists. In order to prevent these speculations, scientists must now use modern evidence to prove that they are valid to use.

CELLULAR EVOLUTION: THE BUMPY ROAD TO WHO KNOWS WHERE

In the past, scientists have taken organisms apart and understood their pieces, however, this only encompasses one part of the main part of biology. By putting together the organisms with their environments, scientists will be able to understand evolution as a whole. This is because the systems are dynamic, so it is important to study how the parts interact with each other to create a more complex system.

THE DYNAMICS OF CELLULAR EVOLUTION

Evolution is driven by two factors, horizontal gene transfer and constraints from evolving translation apparatus. The amount that a gene changes due to horizontal gene transfer depends on its importance in an organism. This allows scientists to classify genes into groups:

cosmopolitan genes that can easily be replaced by adaptations, genes whose functions are needed in cells that can be replaced by functional equivalents, and genes that give the basic character of the cell that rarely evolve.

The Key to Understanding the Character of HGT

HGT normally occurs with a gene that isn't deeply connected with the other parts of the cell. As a result, it will end up being the driving factor of evolution in simpler organisms which can be seen through the creation of complex translation mechanisms of gene expression. Therefore, primitive cells must also have been simple in order to host simple, loosely connected genes.

From There to Here

Evolution brought simple cells to current advanced multicellular organisms by increasing connectivity through genes past the Darwinian Threshold. Most likely this transition occurred due to RNA since RNA is responsible for translation. However, nucleic acids remained the backbone of evolution because it acted as a shared language across all biomolecules that told them what to do. Furthermore, evolution most likely began from multiple points as a better was to explain the diversity seen today.

An Interesting, if Not Relevant, Aside

In order to see the effects of evolution quickly, statistical proteins can be used. This is because they operate on certain parts of a gene allowing observers to see what happens when those genes change. This strategy can likely be used to test the multiplex hypothesis of RNA evolution.

When Is a Tree Not a Tree?

There is no root of the phylogenetic tree because when you go before the Darwinian threshold, you notice that HGT dominates evolution making it difficult for stable genomes to occur. Therefore, the tree representation is only useful after the threshold. Furthermore, when each lineage crosses the Darwinian threshold is also different. Bacteria crossed it first and then archaea and finally eukarya.

ONE LAST LOOK

In conclusion, biology must move from a reductionist view to non-linear in order to progress. This is because biology took ideas from physics and chemistry that didn't match how biology should be studied because they place emphasis on the parts. However, it is more important to understand the whole, understand evolution how life came to be.