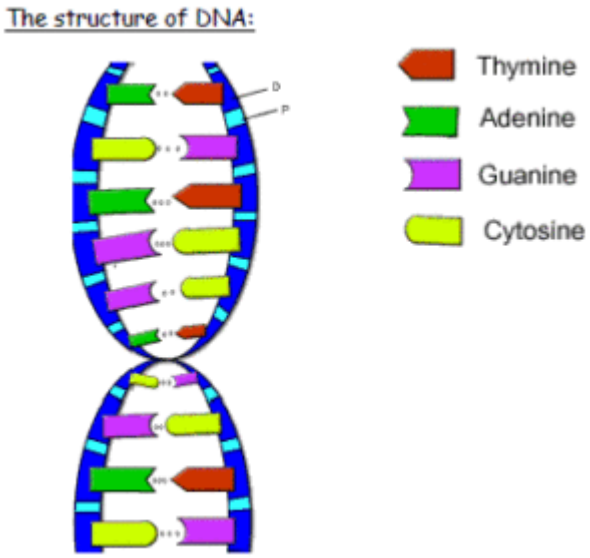
Artificial DNA acts just like the real thing. Does that mean we should we make it?

The apex of the pyramid of human achievement has tended to be developing engineering solutions to stretch the limits of our accomplishments. In the realm of biology at the very small scale, ever since the discovery of DNA and RNA, scientists have wondered if we can manipulate or even create synthetic proxies for these molecules. Now it seems that artificial genetic material can be reliably created that not only interacts like its natural similes, but can even be 'read' by cells.



Alphabet of human genetics

At the very root of DNA's structure are four letters, referring to nucleobases (or usually just called 'bases'): A, C, G, and T. These are shorthand for adenine, cytosine, guanine, and thymine. These four molecules are the 'nitrogenous bases' of nucleotides. These bases form pairs and lead to configurations that cause the classic DNA helical structure to develop.

Decades after the discovery of DNA and its implication in human genetics, in 2006, researchers from Florida developed artificial DNA bases, which have a novel bonding pattern. The artificial bases (called Z and P) bond similarly to how GC and AT (natural DNA bases) bond. In fact, using a method known as X-ray crystallography, researchers have observed that these artificial bases can be incorporated into natural strands of DNA and even show similar function to fully natural DNA bases when interacting with proteins inside of cells.

This is one of a number of attempts to make entirely synthetic organic molecules, and also to probe how different biology can be made to be with targeted insertions and deletions and modifications of artificial molecules. In 2014, researchers researchers announced the creation of a living cell that had two 'foreign' DNA building blocks in its genome. The team inserted the two into a bacterial cell, a strain of E. coli. When the cell reproduced, unwinding its double helix and reconstituting it in new cells, X and Y replicated as well, their chemical bond just as stable as the A-T and C-G pairings in DNA's normal sequence. The

leader of the Scripps research team, Floyd Romesberg, calls the organism “semi-synthetic.”

Ethics and the root of it all

Questions that remain include whether an entirely artificial set of DNA bases can be used, and if so, what sort of proteins would result from this artificial setup? What exactly would be the result of an experiment using entirely artificial genetic molecules?

These aren’t strictly mechanistic questions (*i.e.*, ‘can it be done?’) but they also branch into the field of medical ethics: (‘should it be done, and to what end?’). But before there can be any admonition about our ability to modify or create DNA or RNA as we push the envelope of human achievement, recent research from meteorites has suggested that several nucleobases could have been originally formed in outer space, making us the product of extraterrestrial chemistry, and which adds an interesting wrinkle to the story of complex organic chemistry in genetics and how it really all came to be.

It’s compelling to consider how this genetic manipulation might play out in the future of genetics research. Clearly, some aspects of Lamarckism come to the fore: If changes are made to an organism, are the associated acquired changes inherited by the next generation(s)? For the better part of two centuries, flaws in a purely Lamarckian perspective have been debated, and environmentally-induced changes (epigenetics) are sometimes generously attributed to Neo-Lamarckism. More contemporary debates about these themes (over the last three decades or so) tend to revolve around the semantics of what ‘acquired’ and ‘changes’ mean in terms of heritability.

One thing’s clear though, a Lysenkoist approach (*i.e.*,politically ‘controlling’ knowledge of genetics, in particular advocating neo-Lamarckism), which doesn’t fully respect the power of our knowledge base and understanding of genetics will not be allowed to occur in the current global exchange of knowledge. As these new research findings are put into use, there will be hopefully an appropriate level of scientific rigor and proper treatment of data in order to separate out true effects from transient unrelated differences in gene and cell expression. This will also allow the stratification of effects due to large-scale genetic changes that are heritable from any epigenetic changes which may occur as a result of the new DNA bases leading to differential effects.

Superposed on all of this will remain the ethical questions about how much could/should be studied, and how will we know when that line is crossed; And what is that line?

Ben Locwin, Ph.D., M.B.A., M.S. is a contributor to the Genetic Literacy Project and is an author of a wide variety of scientific articles for books and magazines. He is also a neuroscience researcher and consultant for a many industries including food and nutrition, pharmaceutical, psychological, and academic. Follow him at @BenLocwin.