Epigenetics: Lamarck’s Revenge?

By Lila Abassi — June 10, 2016

The scientific community reacted quite negatively[^1] to an article written by Siddhartha Mukherjee in *The New Yorker* where he was subsequently accused of oversimplifying epigenetics. This topic has generated a great deal of attention by scientists and the public.

But, there is a lot of confusion and misinformation about this relatively new topic, which is exemplified by the following question[^2]: “How can you gain any sort of valuable information or pluck the underlying epigenetic thread of truth from this swirling accumulation of misleading refuse?”

It is that question that led to this article.

Epigenetics[^3] literally means "in addition to" genetics. Our genetic information, or DNA, which is found within the nucleus of our cells, has molecular tags that allow for genes to turn on or off. But that is in addition to the complex mechanisms that allow for genes to make proteins or to keep them from being made.

There are many different molecular tags but the most common ones are DNA methylation and histone acetylation. Methylation is a process that genes off so that they will not make the proteins that they are supposed to make. Acetylation, on the other hand, turns genes on, allowing proteins to be synthesized. Epigenetics has been implicated in in a wide array of biological processes such as aging and cell differentiation.

Epigenetics is also the sexy, science-y term that is now flung around like distraught chimpanzees in a cage. It has become a “catch-all[^4]” phrase to explain pretty much any behavior or condition.

Why are you a loner? – epigenetics.

Why are you anxious? – epigenetics.
This oversimplified and inaccurate view is predicated on: 1) the belief that modifications to DNA are a consequence of the environment that you live in or the lifestyle choices you make; 2) these epigenetic markers can be maintained and/or passed through generations in what's known as "transgenerational epigenetic inheritance."

Two important questions need to be answered: Does the environment have effects that happen anew in each generation or are these acquired changes capable of being passed down to the next?

In reality, the heritability of these markers is not very predictable. Rather, this phenomenon is actually rare and seldom observed in rats and even less often in humans. According to Mark Ptashne [5], PhD, the Ludwig Chair of Molecular Biology at Memorial Sloan Kettering, "[A]ll attempts to show that such modifications are 'copied along with the DNA' ... have, to my knowledge, failed."

Few non-scientists are even vaguely familiar with epigenetics and even the scientific community still has yet to get a handle on the mysteries that surround it. But this hasn’t stopped quacks the likes of Joe Mercola [6], Jessica Coffey [7] and others from using it to further their own agendas. They support the notion that genes are destiny and that the genetic destiny of future generations is in our hands. In reality, lifestyle choices such as meditation or eating a double bacon cheeseburger will not determine the genetic fate of our progeny. This field is still in its infancy, and should not be taken as a fact.

The following is something that helped me gain a clearer perspective [8]:

Think of the human lifespan as a very long movie. The cells would be the actors and actresses, essential units that make up the movie. DNA, in turn, would be the script — instructions for all the participants of the movie to perform their roles. Subsequently, the DNA sequence would be the words on the script, and certain blocks of these words that instruct key actions or events to take place would be the genes. The concept of genetics would be like screenwriting. Follow the analogy so far? Good. The concept of epigenetics, then, would be like directing. The script can be the same, but the director can choose to eliminate certain scenes or dialogue, altering the movie for better or worse. After all, Steven Spielberg’s finished product would be drastically different than Woody Allen’s for the same movie script, wouldn’t it?

The subject of epigenetics is also contentious in that it lends support to the Lamarckian view of inheritance [9] – which has been rejected by science. Jean Baptiste Lamarck [10] and his theory of species adaptation was based on the concept that acquired (non-genetic) traits could be passed on to succeeding generations. A famous example is based on giraffes where giraffes must extend their necks to eat, and Lamarck concluded that the resulting elongation of the neck was passed on. Each subsequent generation stretched their necks further and further resulting in giraffes developing very long necks.

Darwin, on the other hand, believed in natural selection. Those organisms most capable of surviving in their environments passed on traits which enabled their progeny to survive, while other organisms lacking these traits would not. As an example, hawks with good eyesight have a better
time spotting their prey than hawks with poor eyesight, which would starve and die off. So hawks with genetically good eyesight flourished, while the other did not. Gregor Mendel [11]'s research on heredity provided evidence of Darwin’s hypothesis by discovering that heritable traits were passed along through functional units called genes.

In reality, it is not just epigenetics [12] alone that account for gene expression. Of the 22,000 genes that are contained in our DNA, not all are needed at the same time. Therefore, it is required that existing control systems know when the right time is for genes to be turned on or off. Genes do not simply turn on or off, they require continual activity of specific regulators called transcription factors (click this link [5] for more detailed review).

This complex and highly intricate system requires much more examination. To quote Adam Rutherford [12], “The legion purveyors of flapdoodle love a real but tricksy scientific concept that they can bolt their pernicious quackery on to … epigenetics is fascinating but still in its infancy. It’s not heretical, it won’t upend Darwin, or give you supernatural powers. … More, unhyped, work is needed.”

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