Shaking up science with transgenerational epigenetics and blurred species boundaries

Michael Brooks, author of *At the Edge of Uncertainty: 11 Discoveries Taking Science By Surprise* recently wrote a piece for The Guardian on how five of sciences "unshakable truths" have been shaken up. Of these five truths, two are aligned with the topics *du jour* here in Gene-ius.

Transgenerational Epigenetics: Death of genetic absolutism

Number one on his list is is epigenetics, under the heading "Lifestyle can change genes." Even here at the Genetic Literacy Project, where we gather the cutting edge of genetic science day-to-day, the allure of genes-as-immutable is strong. Brooks writes:

> We have come to think that if something is "in our genes", it is our inevitable destiny. However, this is a gross oversimplification. We have each inherited a particular set of genes, but the outcome of that inheritance is not fixed. Our environment, diet and circumstance flood our bodies with molecules that switch the genes on or off. The result can make a huge difference to our destiny – and that of our descendants.

Yes, we have an hard-coded 'instruction manual' built into our cells, but the instructions are highly modular and each bit can be turned on or off; and if a gene is 'off' we might as well not have it at all. But the really dogma-shattering idea — the one that prompted me to explore if famed-for-being-wrong biologist Jean Baptiste Lamarck might be vindicated — is that these on-off settings might be passed down along within genes themselves. In other words, not just an instruction manual but a set of notes scribbled in the margins. This is the idea of transgenerational epigenetics.

Brooks lists as examples the effect of mehtyl groups on the DNA of newborns; the lingering genetic effects of starvation on Dutch women captured by Nazis and their post-capture children; and boys who take up smoking before 11 having overweight children later in life. His examples are becoming *de rigeur* in the growing body of evidence for transgenerational epigenetics, but his final note on the topic offers the clearest conception of the process I've read so far:

> Standard biological thinking says that the body strips away molecules such as a methyl group from sperm and eggs so that they are "reset" to their default state. However, a study published by Cambridge researchers last year showed that approximately 1% of the changes get through the erasure process unscathed. What you eat, what your mother ate, the age when your grandfather started smoking, the amount of pollution in your neighbourhood – these factors have all been linked to epigenetic changes that get passed down through the generations. Armed with this new insight, we can take far more control of our health – and the health of future generations.

This idea of control seems poised to take root among science-minded health enthusiasts, who now have reason to believe what they eat can influence their genes and those of their offspring. The Epigenome NoE public site offers a page titled "Eating for your epigenome." As to how much control we actually have and whether anyone can say with authority just how you should eat to ensure epigenetic health … well, that science is still very much coming in.

Blurred species boundaries: We're not so different, you and I (and chimps and sparrows and sponges)

The other Gene-ius relevant topic of note is that "Humans are nothing special." Brooks writes (emphasis mine):

> We have been taught to think of ourselves as the pinnacle of creation, but that pinnacle is getting rather crowded. In many cases, crows and chimps can use tools – and sometimes abstract reasoning – better than humans. If it's culture that makes you feel superior, visit the Tanzanian Gombe chimps, Canadian killer whale communities or Australian dolphins: they all show distinct cultural practices in the way they relate with one another, hunt or sing. Animals show personality and morality – elephants can be empathetic or insensitive, rats can be lovers of fair play, spiders can be bold or spineless, chipmunks can be extrovert or shy. Cockroaches have feelings, too, it turns out.
>
> Even the hard facts are letting us down: at the moment, researchers know of only a handful of genes unique to humans; it's thought that, when the count is finished and the numbers are totted up, **fewer than 20 of our 20,000 genes will be exclusively human**.

Brooks's observation highlights one of the themes of this column, though it's never explicitly stated: Genetics is the great equalizer. We post often about the blurring of species boundaries, about hybrids coming to the fore in a changing world, and about the tenuousness of the categories into which we place groups of animals — including ourselves.

Consider the recent news that there may, in fact, be more than one evolutionary way to build a brain — the organ we prize so highly as one of the things that supposedly separates us from the rest of animalkind.

In many ways, part of what Gene-ius aims to do is to show the mutability of the seemingly immutable. Genes are not the deterministic arbiters of fate they once (and often still are) considered; species do not exist in neat categories and humans do not sit above and apart. These ideas may seem strange, but strange is and should be one of the defining traits of Gene-ius. In the words of famed French writer Victor Hugo:

> *All science […] commences by being strange. Science is successive. It goes from one wonder to another. It mounts by a ladder. The science of to-day would seem extravagant to the science of a former time. Ptolemy would believe Newton mad.*

Kenrick Vezina is Gene-ius Editor for the Genetic Literacy Project and a freelance science writer, educator, and naturalist based in the Greater Boston area.

Additional Resources:

- "Epigenetic Influences and Disease," Danielle Simmons | Scitable
- "Monkeys Make The Same Bad Gambling Decisions That Humans Do," Jason G. Goldman | io9
- "Coincidental killers: We assume that microbes evolved to attack humans when actually we are just civilian casualties in a much older war," Ed Yong | Aeon