Epigenetics Around the Web: Q&A on hype of epigenetics and health link on Reddit Science ‘Ask Me Anything’

New Study Reveals How Broccoli Changes Your DNA For The Better, How Drinking Tea May Change Your Genes and Ancestors’ Genetic “Memories” Could Be Passed On For 14 Generations. These are just a few recent epigenetics-related headlines circulating around the internet. To the untrained eye, it may seem like epigenetics, a discipline of science that investigates a subset of biochemical processes that alter gene activity without changing its sequence, plays a vital role in our health and well-being.

But is this really the case? The answer is that we don’t quite know yet. All of those stories make claims not fully substantiated by science.

Unfortunately, blogs, the credible media and alternative health purveyors are sensationalizing this budding yet controversial science — sometimes out of ignorance (blogs and media) and sometimes out of maliciousness intent (alt-health promoters looking to make a buck). That’s why on June 2, I took to Reddit Science to answer questions from the public about the hype surrounding epigenetics and our health. My goal was to explain why the science on how epigenetics affects our health is still not clear. Below are some highlights of this session. You can read the full text here.

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Hi Reddit! I’m Nicholas Staropoli a science journalist, director of the Epigenetics Literacy Project and a writer/editor for the Genetic Literacy Project—two initiatives of the 501c3 non-profit Science Literacy Project. Both sites cover the intersection of science , media and policy. I also write a weekly report–Epigenetics Around the Web–debunking claims about epigenetics and its impacts. The media, and even many scientists, just don’t understand how epigenetics works—and how little we know about its mysteries.

Question: How are techniques to describe or “profile” someone’s epigenetic state coming along? Do we even know what to look for?

NS: A great question and I think really one of the most promising areas where epigenetics probably has a translatable role to human health.

There’s this big debate surrounding whether epigenetic modifications on their own cause diseases or if there is some other genetic or environmental cause which causes the disease and the epigenetic marks are a consequence of the disease. But either way understanding how patterns of epigenetic modifications form on and around the genome during diseases could lead to some really effective diagnostic tests and even just monitoring general health.

The major thing to point to in this arena is Horvath's clock (you can read a longer description of it here:).

Horvath, a UCLA researcher, has created a DNA methylation based algorithm that looks at epigenetic profiles to determine a 'cellular age' and if that age is significantly older than your chronological age there's an association with numerous health maladies: cancer, higher mortality risk, infection, HIV, Alzheimer's. A life insurance company is actually using this to determine policy worth, which personally I think is wrong because we still don't know a lot about these modifications to be making serious financial decisions based of them (read more here.

Outside of that, several liquid biopsies (for those unfamiliar with the term) based on epigenetic profiles of tumors have shown some promise in accurately diagnosing and staging of tumors. Epigenetic profiling of tumors has also shown promise in determining how well a specific cancer will respond to a specific treatment.

But I'd also caution that we don't know for sure what a 'healthy' epigenetic profile looks like if it even exists (very similar to the microbiome in that respect) so it's hard to gauge how beneficial this information will be in general.

Question: I have more of a general question: What role does epigenetics play in diseases that were previously thought to be genetic in nature?

NS: For cancer, epigenetics it turns out plays a big role and in some cases, epigenetic dysregulation can lead to tumor initiation and growth. This video is an awesome explainer of it:

Outside of cancer, I'd say that's still a matter of debate. A number of diseases are linked to epigenetic modifications (e.g. Alzheimer's disease) but there's still a major question as to cause or consequence. In other words, we still haven't sussed out if these epigenetic changes are actually driving diseases or if other aspects (environmental toxin, genetics) are causing the disease and the epigenetic modifications.

Even if they aren't causing pathologies, these epigenetic modifications could play a big role in diagnosing and monitoring diseases.

Question: Have there been any experiments involving humans yet? These would all have to be pretty lengthy right? So I cant imagine we'll have a good idea of how epigenetics effects humans for quite some time. What kinds of studies would you like to do, or what kinds of studies are currently in progress?

NS: Yea there have been some poor quality (not to be critical more of a statement of the difficulty in overcoming weak instrumentation/methods and strong ethical barriers) that have studied epigenetic changes in humans. This oneI wrote about last year look at epigenetic changes on the oxytocin gene in people and linked it to sociability. But a major problem was they looked at the gene in epithelial cells from saliva and not neurons where the gene's activity matters.

Another poor study human study subjected people to air pollution and saw epigenetic changes, but found

that those who ate more vitamin b were “more protected” from the pollution. But this study was pretty poor too largely because they only examined 10 people.

As with so many other fields, studying on humans is hard. But in particular it’s very hard with epigenetics because it’s very difficult to conclusively say an effect is epigenetic and not genetic because the processes are so tightly intertwined. Many epigenetic changes are controlled by genes which complicates the matter too. So does the fact we really don’t fully understand just how complicated genetics is.

“What kinds of studies would you like to do”—this is my favorite question I’ve ever been asked. I had to think for a few minutes but here’s my answer:

We need to figure out whether or not epigenetic modifications can get passed epigenetic reprogramming of the embryo and if they can how and under what circumstances it happens.

All the ideas and opinions that epigenetic modifications affect subsequent generations and play a role in evolution are based entirely on the (currently) unsubstantiated belief that these changes magically get survive a process that we know removes or alters almost all of them. If someone can prove how that happens it would be huge. If someone could definitively prove it doesn’t or can’t happen in humans (and I completely understand how hard it is to ‘prove a negative’) that would stop a lot of debates about the field’s significance.

Question: Do epigenetic modifications carry over in generations? To use your example, is there evidence to suggest that rats that were licked as pups also produce offspring with better stress tolerance?

NS: Yea so in that example they did see the same epigenetic changes in the descendants which implies they were inherited. As a resource this is a great interactive about the study.

Other studies on model organisms have found the modifications carrying on for as many as 14 generations according to one recent study in roundworms.

I think it’s important to realize a few things though when trying to translate this very famous study to humans.

First of all only about 30 percent of rodent studies translate to humans. So just because we see this in rodents doesn’t automatically mean it has human implications–in fact it’s more likely it doesn’t.

Second, behaviors like stress are very different in humans than in rats, roundworms and mice. For these animals, it’s very instinct based. But we are conscious beings we can overcome stress and make a decision or an active change, something other lower animals can’t.

Question: Are there any companies doing anything with epigenetics?

NS: Yes. The epigenetics-product market is booming.

There are a handful of epigenetic drugs already on the market to treat cancer and there are several in various stages of clinical trials. There's another in phase II of a clinical trial (I believe) for Alzheimer's disease which I think is the only one not for cancer.

There's also several detection kits and instruments for research purposes. And in the near future many diseases may have diagnostic kits that are based on epigenetic modifications.

Based on one market report I saw, the market for epigenetic products is supposed to grow 5 times from 2011-2020.

Question: Are we gonna see the concept of Designer Babies in action? How long would it take?

NS: In terms of designer babies, I don't think that's realistic for epigenetics. In other words, you can start methylating (or demethylating) intelligence-linked genes in an embryo and expect the baby to be brilliant. Epigenetic modifications are transient and in a constant state of flux during early development so I think there's zero chance an epigenetic modification like that would last.

That be said, some people do believe that someday we'll have a pill that will target an intelligence-linked gene and increase its activity via epigenetic modifications. Proponents believe this is a nice compromise that allows human enhancement without full on gene editing of humans (where the germline could be affected). But I'd caution this likely won't happen. The complex traits we'd be targeting are so multifactorial (environment, genes, gene-gene interactions) that we won't ever be able to make a difference just by increasing a few genes. Again the often transient nature of these markings also means they may not last long enough to have the desired effect.

Question: As a Biology teacher, I used to talk about Lamarck as a counterpoint to Darwin – acquired inheritance as a wrong idea to better illustrate what natural selection is not. In recent years I've begun walking this back as we just begin scratching the surface of epigenetics. Can you weigh in on this? How should this work impact what students learn about Lamarck?

NS: First of all, I'd like to thank you for your work as a biology teacher (assuming high school if you're talking about evolution and Darwin vs Lamarck). I think we can all agree scientific literacy (not just epigenetic literacy) is in a disaster state in the US. To me that's largely because we aren't getting science education (particularly evolution but other topics like genetics, health and physiology) right in schools. So, people grow up with a poor understanding of science and then are incapable of making educated decisions as adults—whether those decisions be voting practices or just how they generally take care of themselves. So kudos for all your hard work.

To your question, I would advise you to change nothing in your approach. No legitimate scientist believes that epigenetics disproves Darwinian natural selection or our current understanding of evolution. In fact, if

you look at the Royal Society meeting on this topic that took place in November 2016 (New Trends in Evolutionary Biology) nobody was attempting to repeal our current view of evolution the so-called ‘Modern Synthesis.’ These scientists were trying to add the idea that sometimes environmentally induced acquired characteristics are inherited and therefore could affect evolution (i.e. transgenerational epigenetic inheritance).

Transgenerational epigenetic inheritance still has a long road ahead of itself to be proven as scientific fact in humans/other animals. Epigenetic reprogramming eliminates or alters almost the entire human embryo’s epigenome. No one has shown how epigenetic modifications withstand that process. Plus these markings are so transient it seems unlikely a modification would stick around long enough to be passed on directly for hundreds of generations. All the studies that show epigenetic inheritance over generations deal with static environment (see unrealistic), a recent study similar to the rat licking one tried exposing these rodents to a more dynamic environment and those modifications associated with stress disappeared quickly.

TLDR Don’t change a thing and let the science become more settled before altering your course.

For more epigenetics news—as well as background about the microbiome and endocrine disruptors—check out the Epigenetics Literacy Project, a sister-site to the GLP. Or follow ELP on Twitter and like our Facebook page.

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