Science AMA Series: I'm Bonnie Rochman, health/science journalist and author of the newly released The Gene Machine: How Genetic Technologies Are Changing the Way We Have Kids — And the Kids We Have. Go ahead—AMA!

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Is it possible to genetically engineer a child to have special traits, such as making their bodies more susceptible to cryofreezing for space travel, or to be totally immune to certain diseases?

frogloaf15

Right now, it's not possible to "build a baby" to have certain traits such as athleticism (a killer jump shot, for example) or musical aptitude (say, a mini-Yo-Yo Ma) or to be immune to certain diseases. I can't speak to cryofreezing for space travel but that sounds even more complicated! The reason we can't do that is because so many things factor into determining traits. There is no one single gene that codes for intelligence, no specific "Einstein gene" that will guarantee your infant will make it to Harvard.

What do you think is the next big genetic frontier? The human genome project seemed to have a huge media push in the 90s, then the chromosomal microarray and a steady stream of gene discovery with a few gene-targeted therapies.

What do you think will be the next big wave of discovery?

BlergenSchmergen

CRISPR, no doubt. CRISPR (short for Clustered Regularly Interspaced Short Palindromic Repeats) modifies genes, enlisting a protein called Cas9 to target an individual defective DNA sequence and fix it. CRISPR has the potential to repair genetic errors that cause disease. We're just now taking baby steps and don't yet know what range of diseases can be tackled using this approach.

As more options for genetic testing (and maybe eventually genetic manipulation) of embryos becomes available, how do you see this impacting socioeconomic classes? I assume that it will, at least initially,

be very expensive and only available to wealthy people. Will a insurmountable genetic gap be created between wealthy and less wealthy people, or will the technology become so ubiquitous that all infants will have the ability to undergo testing and potentially modification (to either correct defects or enhance traits)?

kerovon

There's already a health care gap between those who have access to great docs and meds and high-quality health insurance and those who don't. Although we are far away from actually being able to genetically manipulate embryos to be super-smart or breathtakingly beautiful — and who knows if this could ever come to pass due to the multifactorial nature of genes and what they determine — continued advances in genetic technology will certainly widen the socioeconomic gap. Take, for instance, preimplantation genetic diagnosis (PGD) in which embryos are created via IVF then analyzed for the presence of a specific genetic mutation that is associated with a specific, typically severe or fatal, disease. It costs several thousand dollars, in addition to the significant expense of IVF. Only well-off people can afford to pay for this. So there is already inequity! In other words, well-to-do parents can afford to do PGD and avoid having a child with a particular disease. But less well-off people can't. They have to cross their fingers and hope their baby is not affected (depending on the disease, there's a 25-50% chance of a mutation leading to disease) or they must choose not to have kids or to adopt, etc. In a med school class, I heard a heartbreaking story of a mother whose child had been diagnosed with a severe genetic disorder. She desperately wants another child but is not willing to take a chance of having another baby with the disease. And she can't afford to do PGD.

Thank you for doing this AMA!

Scientists who advocate for GMOs often point out that genetic modification is not so different in nature from the genetic changes that result from mutation+artificial selection, a process that many people are far more comfortable with. Is there an analogy to be drawn to "designer babies"? How do you think about culturally acceptable dating and family planning practices as ways that humans already influence the genetic makeup of their children?

neurobeegirl

You are spot on that humans already are influencing the genetic makeup of their children. We do this every day, in every country, by falling in love -- for the most part -- with people who are like us. That is, it's not often that a high school dropout will marry an MD/PhD. Why? Presumably because they don't have as much in common. But we are already creating "designer babies" in the world of assisted reproduction. A prospective parent who is selecting an egg or sperm donor is not going to pick someone who attends community college if there is another available donor who is enrolled at an Ivy League school. So kids conceived through donor gametes, it can be argued, are "designer babies." As I say in my book: "Rather than picking and choosing particular genes to try to make a child smarter, more beautiful, and a terror on the basketball court, the best way we know to have a smart, good-looking, athletic child is to procreate with someone who is smart, good-looking, and athletic."

What's the most fascinating thing that you've personally discovered about genetics?

LusciousLettuce

What's most intrigued me about my research is learning more about how genes are not necessarily destiny. There is a cultural misconception that this is the case — you know, nature vs. nurture, writ large within our own bodies. But just because you have a genetic variant, or mutation, doesn't mean in many cases that it's a sure bet. There's a whole complicated mix of environment and epigenetic -- the

flipping on and off of genes -- that has to be factored in as well.

It seems inevitable that we start inserting genes into our offspring the way we do to GMO crops and animals. This idea of designer babies scares lots of people. How do you feel?

Jobediah

I'm not in favor of it. And I have to say, we're not really on the cusp of doing that. Crops and even animals are very different in moral terms than humans. A carrot is a carrot; a newborn baby is an entirely different ball of genetic wax, so to speak. Can you imagine how our world would change if every single baby were bred to be an astrophysicist?

1. When do you think genetic testing will become readily available at an affordable price?
2. Do you think it will become a standard procedure for hospitals to screen newborns for genetic predispositions to diseases in the future?

-LifeOnHardMode-

1. That's a really broad question. Genetic testing can range from a targeted test of a single gene (we have more than 20,000!) to a comprehensive genome sequencing, or "decoding," of a person's DNA in its entirety. Newborn screening, which tests infants for severe, treatable disorders, is quite cost-effective already. And carrier screening, which checks parents-to-be (or pregnant women and their partners) to see if they're both carriers for a mutation that could cause disease in their baby, is often covered by insurance. Genome sequencing, meanwhile, is available for a couple thousand dollars, perhaps less, though no insurers I'm aware of would pay for it for "recreational" reasons — that is, because you're just curious to know more about your genes.

Eventually would scientists be able to eradicate hereditary diseases/issues without disrupting other parental likeness features of the child?

Also, from previous studies, it seems we are on a trend towards designing our babies almost like we could design a video game character. What traits have we not yet unlocked? (To change that is)

hAVARTI_pARTI

We have yet to unlock most traits precisely most traits are not the result of the influence of an individual gene; they are the result of multiple genes, plus the effect of environment (your health, where you live, where you go to school, who your parents are and how they raise you, etc.). Currently the most straightforward way to eradicate hereditary disease is to do preimplantation genetic diagnosis, which is explained above. That way, you're not tinkering with an embryo; you're just selecting an embryo that has not inherited a particular mutation associated with a particular disease.

The idea of heavily editing the human genome is explored in various sci-fi series such as Iain Banks' *Culture*. Do you read a lot of sci-fi and, if so, what's your take on the ideas put forth by such authors?

halborn

I'm not a huge sci-fi reader, but culturally speaking, the film Gattaca certainly articulated much of what we're talking about today in terms of designer babies -- and it was released 20 years ago!

not that i can for morals too much but i am sure that people like you get a lot of hate from people worried about morals in genetically changing babies, what is your response to this? and where do you believe the line of moral and not moral stands?

Novaraa

I think that morals are in a state of flux when it comes to genetic tech and babies. For a very long time, the status quo has been to disapprove of editing embryos. But in February, two eminent panels of scientists said that in certain limited circumstances (to avoid severe disease in a couple who has no other option to have a genetically related child), it could be okay to edit eggs, sperm or embryos. So it's a moving target.

Hi Dr. Rochman,

Thanks for doing the AMA!

My question is: What is the most interesting part of your area of research to you? In other words, if you were talking to a university student, what aspect of your research would you most want to tell them about the most?

ZentrixJC

First, a clarification: I'm not a doctor (though my father is!). I'm a science writer. The most fascinating bit of genetics to me, right now, is the struggle to make sense of tiny deletions and duplications of DNA that can be detected in a fetus. In so many instances, we don't know what, if anything, they mean. So how to stay calm when a degree of uncertainty underpins a pregnancy?

Hi Bonnie Rochman, thank you for doing this AMA!

I'm someone who has never wanted children ever. I also am a carrier for many health problems, including a gene for major cardiac problems (heart attacks in 30s and instant death kind of thing).

But I've been told that I'm being "pessimistic" and practically encouraging eugenics by choosing not to have children because I do not want to pass these genes along (even if I did want kids).

What are your thoughts on childfree people choosing to refrain from having children for medical reasons? Should we push forward instead, hoping on new medical technologies to cure these illnesses?

ZineKitten

Many people in your circumstance have made similar choices regarding child-bearing. The critical difference between the choice you are making and the tenets of eugenics is that eugenics was state-sponsored. You, on the other hand, are making a personal decision.

Do you think that civilization will reach the genetic bias level as the one in Black Mirror's "Men Against Fire"?

If so, how can we prevent this?

animalshavefeelings

In "Men Against Fire," so-called roaches, or humans thought to be genetically inferior, are subject to

ethnic cleansing. I can't envision a world where the majority of us would embrace that approach. (That would entail, I suppose, the elimination of all people with special needs or disabilities, or perhaps even those who don't perform very well in school.) I fervently hope that my hunch is right.