Hi! We're program directors for the National Human Genome Research Institute's Ethical, Legal and Social Implications Research Program. We're here to answer your questions about how genomics impacts society (because it does)! Ask us anything!

NIH-NHGRI [1] and r/Science AMAs[1]

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April 17, 2023

Abstract

The reach of genomics is wide-ranging and can touch on many different aspects of society from forensics, to how we understand our ancestry, to the promise of precision medicine for all individuals and populations. When the Human Genome Project was launched in 1990, the Ethical, Legal and Social Implications Research Program at the National Human Genome Research Institute (NHGRI – we're one of the 27 institutes and centers that make up the NIH) was launched alongside it, with the anticipation that once we started generating massive amounts of human genomic data, there'd be lots of societal factors to consider. Now that the Human Genome Project has been completed and researchers and clinicians are sequencing human genomes faster than ever, considering the societal implications of genomic data and what we can learn from it is even more crucial. With great amounts of data comes great responsibility to use the data in an ethical and effective way. We're experts in these types of issues and we want to know what questions you have about how genomic data can impact your medical care, your interpretation of your ancestry, or just your everyday life. Our research program covers a range of issues, but here are some questions to jumpstart your curiousity and help you come up with your own! How do we incorporate race or ethnicity in genomics research, and how does self- reported race, ethnicity, or ancestry change how we are prescribed meds and cared for by our doctors? What ethical considerations do we need to think about in genomic testing of newborns? How should direct-to- consumer genomic tests, like 23andMe be regulated, used and marketed? What privacy protections are in place when sharing your genetic information? Can my genomic information be used to discriminate against me? What's the deal with CRISPR gene-editing system? What kinds of questions do new technologies like CRISPR raise? We want to know what you're curious about, so ask us anything! Your hosts today are: Lawrence Brody, Ph.D., division director in the Division of Genomics and Society at NHGRI Joy Boyer, B.A., program director in the Division of Genomics and Society at NHGRI Dave Kaufman, Ph.D., program director in the Division of Genomics and Society at NHGRI Nicole Lockhart, Ph.D., program director in the Division of Genomics and Society at NHGRI Cristina Kapustij, M.S., chief of the Policy and Program Analysis Branch in the Division of Policy, Communications and Education at NHGRI Sonya Jooma, M.A., health policy analyst in the Policy and Program Analysis Branch in the Division of Policy, Communications and Education at NHGRI Rebecca Hong, B.S., program analyst in the Policy and Program Analysis Branch in the Division of Policy, Communications and Education at NHGRI Relevant links: Learn more about the Ethical, Legal, and Social Implications (ELSI) Research Program: https://www.genome.gov/elsi/ And if you want more inspiration to come up with questions, here's a longer list of the types of research we support: https://www.genome.gov/27543732/elsi-research- domains/ UPDATE: Wow, thanks for all the really fantastic questions, Reddit-ers! We had so much fun answering them and are just wrapping up. Happy Monday, all!

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NIH-NHGRI R/SCIENCE

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How do we incorporate race or ethnicity in genomics research, and how does self- reported race, ethnicity, or ancestry change how we are prescribed meds and cared for by our doctors?

What ethical considerations do we need to think about in genomic testing of newborns?

How should direct-to- consumer genomic tests, like 23andMe be regulated, used and marketed?

What privacy protections are in place when sharing your genetic information?

Can my genomic information be used to discriminate against me?

What’s the deal with CRISPR gene-editing system? What kinds of questions do new technologies like CRISPR raise?

We want to know what you’re curious about, so ask us anything!

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Cristina Kapustij, M.S., chief of the Policy and Program Analysis Branch in the Division of Policy, Communications and Education at NHGRI

Sonya Jooma, M.A., health policy analyst in the Policy and Program Analysis Branch in the Division of Policy, Communications and Education at NHGRI

Rebecca Hong, B.S., program analyst in the Policy and Program Analysis Branch in the Division of Policy, Communications and Education at NHGRI

Relevant links:

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READ REVIEWS

WRITE A REVIEW

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How do you prevent ideological biases from influencing the (1) results and (2) interpretations of research funded by the NHGRI? In other words, if I were to receive a NHGRI grant, how can you reassure *me* that I can conduct my research without fear of political backlash? AND, what can you do to demonstrate to *the public* that my own political biases have not influenced my research?

I'm asking because the broader picture of the relationship between scientists and the public is somewhat dim from my perspective. For example, researchers who suggest that there are *inherent* differences in the career preferences of men and women face accusations of political bias from the political left whereas researchers who suggest that the aforementioned gender differences are *socialized* tend to face accusations of political bias from the political right. As an aspiring researcher myself, I can attest to the pressure from my colleagues to *avoid* certain research questions and to interpret my own findings through a particular political lens. How can you help shield researchers from this kind of external influence and how can you demonstrate the effectiveness of those efforts to the public?

RGTP_314

Hello this is Joy with the ELSI Research program. Great questions! All funding decisions at NIH are made on the basis of peer review of grant applications. This review process is designed to insulate the research funding process from bias and to ensure that all decisions are made on the basis of what is the best science, not the most popular or politically correct. The reviewers are experts in the area of science being reviewed and always address questions of possible bias in their review. In addition, the process of identifying and setting research priorities involves substantial input from the research community--again, to ensure that these priorities are based on expert input and are driven by science, not politics. An additional layer of protection is, of course, provided by the tradition of academic freedom--the foundation on which our colleges and universities are built. There are always pressures to conform in any social setting, but I like to believe that these pressures are mitigated in academia, and particularly in the sciences, by the norms and traditions of the field.

Do I, as a natural person, actually own my DNA or the information stored in it? What is the legal status of ownership in regards to genetic information? With the right of ownership comes the right to sell it, license it or not?

reteipvb

Hi there, this is the Policy and Program Analysis Branch at NHGRI. Whether individuals own their DNA is an ongoing area of debate in the genomic and legal worlds. In the often-cited court case *Moore v. Regents of the University of California*, the Supreme Court of California was, in part, deciding on whether or not a person maintained ownership over his biological samples after it had been removed from his body (in this case, cells that were used to create a cell line). The court decided that a person did not maintain this right or the right to any profits that emerged from the use of their biological samples. However, they noted that individuals should be informed of intentions to use their samples and data for potential profit.

Many states, however, have created laws providing individuals with property rights to their biological materials and to their genetic information. Alaska's Genetic Privacy Act, for example, states that, "a DNA sample and the results of a DNA analysis performed on the sample are the exclusive property of the person sampled or analyzed." Florida, Colorado, and Georgia, and others also have laws that give individuals property rights to their genetic information.

As you can see, the law is not settled on whether individuals have ownership over their genetic information, and it will be interesting to see how the ethical and legal dimensions of this issue evolve.

With the ease of medical tourism, what would prevent middle-class Americans from CRISPRing their future kids in countries like Mexico/India/China with a completely different set of regulations and coming back to the US to have the child? How can a single country have comprehensive legislation about genome editing if couples can simply get it done in another country with perhaps less restrictive policies?

lifeistwisted

Hi, this is Cristina. Thank you for your question. The international community is working in good faith to establish standards throughout the world to prevent activities like the one you describe. As mentioned above, the National Academies of Sciences, Engineering, and Medicine hosted a summit in 2015 with the British Royal Society and the Chinese Academy of Sciences to discuss how and when genome editing should be used in humans. After this summit, the international committee of scientists published a report recommending cautious and limited applications of genome editing. For example, these scientists recommended against using genome editing 'for purposes other than treatment or prevention of disease and disability'. While it will never be entirely possible to police and prevent rogue actors from performing genome editing outside of the international norms that have been established, efforts such as these will establish standards that will make the potential medical tourism that you describe less likely.

I'd love to hear your thoughts on the direct to consumer marketplace for genomics which seem to range from benign to predatory. Few genetic tests have been considered useful for medical care (I think there are fewer than 50 considered medically relevant and covered by most insurers), and yet the marketing of many consumer platforms suggest they can tell you everything from your optimal nutrition profile to your metabolic fitness profile to chronic disease risk. Do you think this information is being responsibly marketed, and are there risks to patient health of individuals make personal medical and lifestyle decisions based on direct to consumer commercial products (or also worth considering, people making decisions for their children or other dependents)?

p1percub

This is Dave Kaufman from NHGRI. As you point out there are a wide variety of direct-to-consumer (DTC) products and vendors out there. They do not all sell information that is medically useful.

The question of what kind of information is useful is interesting, and one we like to think about. As you point out, there are currently a limited number of common genes that we know about that indicate a person should take action or seek care. It can be empowering and important for a person to learn that information about themselves. But once you have that information, the phrase "consult your physician" becomes pretty significant! In cases where DTC vendors are delivering medically relevant information, it needs to be done in responsible ways that clearly communicate the limits of the data and what a person's next steps ought to be.

The potential for misuse and misunderstanding does exist, The million dollar question(s) is/are, as you point out: Are these DTC tests marketed truthfully? Are the results clear, complete and honest? We still have work to do to ensure this is the case.

Which countries do you feel have the best genetics laws at the moment, in terms of preparation for the unprecedented possibilities technology will offer in the near future?

Edit: Also, I teach a unit on genetic ethics in one of my high school English courses. I'd love any recommendations you or the community can offer in terms of interesting/insightful articles or content related to genetics.

true_spokes

Hi, this is Rebecca, Sonya, and Dave. It depends on what you mean by genetics laws. In the U.S. and in Canada, there are laws protecting genetic privacy. In the U.S., this is the Genetic Information Nondiscrimination Act (or GINA, more info here: http://ginahelp.org/), which prevents health insurers and employers from discriminating against individuals based on the results of genetic tests. In Canada, there is a similar law called the Genetic Non-discrimination Act.

Scientists in many countries are also engaging in dialogue about other ethical questions brought on by improving technologies, such as for the use of genome editing for research or therapy. The National Academies of Sciences, Engineering, and Medicine hosted a summit in 2015 with the British Royal Society and the Chinese Academy of Sciences to discuss how and when genome editing should be used in humans. After this summit, the international committee of scientists published a report recommending cautious and limited applications of genome editing. For example, these scientists recommended against using genome editing 'for purposes other than treatment or prevention of disease and disability.'

We are excited to hear that you are teaching genetic ethics as a part of your English class! As for resources or content, some vignettes and discussion questions for high school students can be found at this link: https://www.genome.gov/25019880/ethical-legal-and-social-implications-of-genetic-knowledge/ We also have links available to video recordings from our Genomics and Health Disparities Lecture Series that might be of interest to you and your students: https://www.genome.gov/27561525/genomics-and-health-disparities-lecture-series/

Another possible source of content might be the Genomics Law Report blog. While it has become less active in recent years, the blog posts often contain links to original articles on all sorts of topics, while the blog itself contains analysis of the issues as they emerged. https://www.genomicslawreport.com/

Do you think having your genome sequenced will have a positive or negative effect on a person's life?

Positive - Identify potential mutations which could lead to the development of a disease in the person's lifetime, thus encouraging them to life a healthier life.

Negative - Finding out you have a high predisposition (80% of developing it) for something like cancer, and the person ends up worrying about it for the rest of their life.

I am still undecided, as to whether having the knowledge re: your own genome, is a good thing. Hopefully you can help me decide!

drmikeographer

Hello this is Joy. Excellent question. Like most complicated personal information, the impact genomic information has will vary among individuals and will depend on a number of psychosocial and environmental factors. The difficulty with genomic information is that it can be interpreted as being more predictive than it actually is, and individuals can lose sight of their own role in shaping their future health and happiness. Having your genome sequenced is a very personal decision, and, as you've pointed out, it can have many long term consequences--both positive and negative---for not only you, but potentially for your family as well. The good news is that you are already thinking about these issues and seem well on your way to coming to a decision that meets your needs and expectations. To help in your decision making, you may want to consider contacting a genetic professional. The National Society of Genetic Counselors has a website that will help you find a genetic counselor in your area: https://www.nsgc.org/page/find-a-genetic-counselor.

I notice the chinese are rushing ahead to take advantage of CAS9 Gene Editing. I have concerns that because they aren't doing controlled trials and reporting statistics/outcomes that these "modified people" might become agents/carriers of genetic malware that if transmitted to children or others could create unforeseen problems. What is the US government doing specifically to manage this? I think the US approach is safer in the long run but the chinese desperation to be first means they are throwing commonsense to the wind. Would the US consider tagging or banning genetically modified people unless we could examine the treatments to really understand what has occurred?

residentx10

Hi, this is Rebecca from the policy branch. CRISPR/Cas9 genome editing technology really is taking the world by storm, and the potential of this technology definitely raises questions about regulation and ethical use in the US and in other countries. Chinese researchers have published several examples of how they've used genome editing to create extra-muscular dogs and to modify non-viable human embryos (embryos that cannot result in a live birth). But, US researchers have embarked on similar efforts -- last July, scientists at the Oregon Health and Science University also announced successful modification in human embryos. Both Chinese and US researchers are currently pursuing CRISPR gene editing therapies to treat various forms of cancer.

The US government is not taking action to directly influence Chinese regulations of genome editing, but there is ongoing, international dialogue to establish some international norms. In December 2015, the US National Academies of Sciences/National Academy of Medicine partnered with the Chinese Academy of Sciences (CAS) and UK Royal Society to hold the International Summit on Human Gene Editing. After this summit, an international committee of scientists published a report recommending cautious and limited applications of genome editing For example, these scientists recommended against using genome editing 'for purposes other than treatment or prevention of disease and disability.'

As for your question about genetically-modified individuals - there are several proposals on how to track multi-generational effects of genome editing in humans, but the scientific community has not settled on any one model.

Some states currently require the mandatory screening of newborns for certain diseases (in the interests of the infant and public health). As the genetic causes of more and more diseases are determined, do you think we'll eventually switch to mandatory sequencing of every infant at birth? Would this information be made available to law enforcement, etc. in the future? Basically, in the interests of public health, do you think it is inevitable that everyone will have their DNA put into a database?

terekkincaid

Hi, this is Cristina with the Policy and Program Analysis Branch. Very interesting question, and one NHGRI has been thinking about. Together with the National Institute of Child Health and Human Development, we currently fund the NSIGHT (**N**ewborn **S**equencing **I**n **G**enomic medicine and public **H**eal**T**h) consortium. This research program explores the implications, challenges and opportunities associated with the possible use of genomic sequence information in the newborn period. Some of the funds will be used for research related to analysis of genomic datasets that expand considerably the scale of data available for analysis in the newborn period as well as research related to the ethical, legal and social implications (ELSI) of the possible implementation of genomic sequencing of newborns.

The potential to switch to sequencing of every newborn at birth has multiple challenges to overcome before it could be considered as a viable alternative to the tests available today. This includes the fact that current technologies designed to measure the presence of a condition are extremely efficient, economical and accurate. Methods such as tandem mass spectrometry are far better than what sequencing technology can do right now - so before we can even consider the possibility of sequencing all children at birth we would have to make sure sequencing is as good or better than what is currently available. The research we are funding should help inform that decision.

A public health database could come in two forms: your own personal medical records which are private unless you choose to release them, or a research database designed to help us improve healthcare. Participation in research is never mandatory and in most countries, participants are informed about what the research entails. In many cases you would need to "opt in" to have your information placed in such a repository. In the US, research data can be protected so that it is highly unlikely the information in such a database would be accessible to law enforcement. In fact, the 21st Century Cures Act makes certificates of confidentiality (CoC) mandatory for all research. These CoCs prevent researchers and institutions from being compelled to disclose information in response to legal demands that would identify research subjects.

Do you fear the rise of genomic discrimination? Or do you see it as a force for good against bigotry due to the sometimes shocking truths it can reveal about our heritage?

BONUS: In the foreseeable future, do you see our genomic information playing any role in the sports or dance industries, with ballet for example holding a particular standard of discrimination against dancers of particular height and proportions?

TheLowry

Great question! This is Nicole from NHGRI. Like any information about an individual, genomic information can be used in both positive and negative ways. How an individual uses and incorporates genomic information into the understanding of their identity will depend on their own experience and views. Also, it is important to keep in mind that genetic influence on many traits is small and the vast array of factors outside of genetics which can affect traits. Using genomics to discriminate will be far more complicated than using other, more readily available, types of personal information - like medical history or even zip code. However, you correctly point out that as genomics becomes easier to access through services such as ancestry testing, the public's views may shift. These are important questions that require ongoing research - and that is what we're all about!

For your bonus question, discrimination in some areas is already practiced based on factors like height, weight etc. In my mind, it is unlikely that genomics will be used discriminate in this way in the near future, since these attributes are genetically complex and the genetic basis for many physical attributes is not well understood. For example, variation in human height--a trait that you might guess would be determined by a single or a few genes--we now know that it is influenced by hundreds of genes. And both height and weight are heavily influenced by external and environmental factors.

[deleted]

[deleted]

Hello, this is the NHGRI Policy and Program Analysis Branch. You bring up some good points about direct-to-consumer (DTC) testing and the privacy concerns that customers should be thinking about before they send their spit off for testing. As you point out, even though companies say in their consent or user agreement forms that your genetic information may be sold to third-parties, it is really important for consumers to actually understand what those consent forms mean. It would be great if they did not write these as page after page of fine print. We hope that DTC companies, and genomics researchers in general, get better at communicating genomics with patients/customers/research participants. NHGRI currently funds work to improve informed consent processes and communicate with people about their research and the risks/benefits of genetic testing.

And you're correct that the Genetic Information Nondiscrimination Act, or GINA, protects Americans from discrimination by health insurers and employers but does not cover life, long-term, or disability insurance. However, these industries are regulated by state governments so that if they choose to use genetic information to make coverage decisions, they would be subject to scrutiny by their regulators in the same way that electric utilities companies, for example, are subject to oversight by the utility commission and cannot triple prices at will.

When humanity is finally able to write DNA code such that diseases are edited out and traits for better gene expression are possible (smarter, taller, stronger, beautiful, disease resistant / better healing ability) are we then going to become a subset of homo sapiens sapiens? Is that going to create a rift between the 'improved' genes and the people who did not get the benefit of augmented genetics, and how is that going to impact society at large?

AbulurdBoniface

Thanks for the question! This is Nicole. I'm seeing a lot of interest in issues related to fairness and access to new technologies, which is hugely important! First, it's important to consider where we currently are in the use of technologies like CRISPR for clinical use in humans. Before CRISPR can be used in humans, it must be proven safe and effective. Further, initial use of CRISPR will focus on clinical uses to eliminate severe disease - see the examples highlighted by several Reddit-ers throughout this thread. Enhancement, i.e. changing human function beyond what would be found naturally, would be a distinct use of the technology which many in society would likely find untenable. Issues of health disparities exist across biomedicine, and are not unique to CRISPR or any gene editing technology, for that matter. However, the vast potential of CRISPR has sparked the imagination of both the scientific community and the public at large. Hopefully this interest can be used to address both current issues related to disparities and access and anticipate potential future issues.

Is the research community considering the implications of providing genetic testing to children? Are there any concerns about releasing information about adult-onset diseases to children?

rdflme

Thanks for the thoughtful question! This is Nicole. You raise a challenging question where there has been a lot of debate within the clinical genomics, pediatric and bioethics communities. Traditionally, decisions related to genetic testing in children have been based on the “best interest of the child” standard. In general, most pediatric ethicists and pediatricians would likely argue that genetic or genomic information should not be returned to children unless there is an intervention that could be undertaken in childhood to reduce morbidity or mortality. Some would even argue that children have a “right to an open future” - basically the right to decide for themselves what information they would like to know or not know about themselves - and that return of genetic information about adult-onset conditions violates this right. This is an issue with a lot of nuance, particularly as genetic testing becomes more common and widespread, and an area of active research.

See the American Academy of Pediatrics take on this matter here:
http://pediatrics.aappublications.org/content/131/3/620

Have you put any thought into the ramifications of using things like CRISPR to enhance intelligence? It seems that this will become a huge issue in about ten years and might lead to major changes. Have you thought about how to deal with it if it becomes a fait accompli through, for example, medical tourism?

IndianSurveyDrone

Hello, this is Larry Brody. Geneticists have spent considerable time thinking (pun intended) about the genetics of intelligence. Unfortunately, intelligence is a very difficult trait to measure in any objective way. Specific elements of cognition, i.e., spatial manipulations, musical ability, reading comprehension, are a bit easier to study. When we look into the genetics of those specific elements, we find that many genes influence a person's ability in any one area. This makes it very difficult to predict what genes to engineer/edit and whether or not changes to these genes would also be associated with bad outcomes in other traits. The other layer of complexity is we are still not very good at getting CRISPR into specific cells in mature tissues like the brain. Given how little we know about the genetics of intelligence, I would **not** expect us to start these kinds of experiments in humans for a long time. It would worry me greatly if a company or clinic somewhere in the world was claiming that they can engineer your brain to increase your intelligence.

What are some of the more interesting findings or research projects that don't get the attention or funding they deserve because of "social implications"?

GentleInAndOutMotion

Hello, this is Dave Kaufman from NHGRI. Thanks for this thoughtful question. When applications for research grants come to NIH and NHGRI, they are reviewed by a set of outside experts who evaluate each application for its potential scientific impact, how innovative it is, and whether the team and methods proposed will accomplish the goals of the project. The primary goal is to advance our scientific knowledge in meaningful and creative ways, and not to restrict the work because a subject may be sensitive. In fact, in some cases NHGRI has begun to fund ethical, legal, and social research embedded within basic and medical genomic studies, in order to explore the implications as they emerge. One example of this is the ELSI research going on in the CSER consortium. https://cser-consortium.org/

Your field has progressed rapidly, and many of the discoveries have already found practical use. I want to know if any of the concerns about ethical, social, and legal implications have been put to rest, or conversely, been shown to be accurate. To whoever answers this question, what is your biggest worry or fear at this stage.

craftsroom

This is Dave Kaufman. Thanks for this thoughtful question. One issue that we are beginning to feel settled about is whether people can cope with genetic test results showing they are at increased risk for a serious disease. Several studies of healthy people who receive results about serious diseases like cancer and Alzheimer's have shown that, at least in the near term, most people do not become depressed or anxious.

One concern that stands out to me is that genomic research and medicine need to be made accessible and useful to all socio-demographic groups.

A couple related questions, feel free to self select: How will genomics be integrated into our daily lives in the future? What is the full potential of technology like Whole Genome Sequencing? What is the 'ideal' outcome of integrating genomics technology in society? What are the potential pitfalls of having this kind of knowledge about our own health?

Thanks for your time!

jlove857

This is Joy. All good questions, but difficult to answer. I'm not sure we know what the full potential of Whole Genome Sequencing is, or how it ultimately will be integrated into society. We have some idea about potential risks and benefits of genomic knowledge, but these change as the technology continues to evolve. The founders of the Human Genome Project recognized this and created the Ethical, Legal and Social Implications (ELSI) Research program (https://www.genome.gov/elsi/) to fund research that would help to anticipate and address these and other questions, with the goal of maximizing the benefits of genomic information and technology and minimizing potential harms.

As a physician and a genealogist active in Direct-to-Consumer (DTC) testing, I would like your thoughts on whether enough research has been done on the positive aspects of genetic genealogy and ancestry testing? Many of us consider ourselves citizen scientists and enjoy the reconstruction of our ancestral haplotype blocks from the raw data downloaded from the various test companies including AncestryDNA, Family Tree DNA, 23andMe. Most of the time the information is used to successfully build our family trees through the identification of cousins. We also are actively searching for novel variants in our Y-DNA and mtDNA tests to contribute to the phylogenetic tree of mankind; such endeavors have been going on for over a decade with very few adverse events. Social science academicians often are not familiar with the newer autosomal tests and how these are actually being used in pedigree building. My observation has been that there has not been adequate scientific studies done on the risks vs. benefits by those who are actually familiar with these tests, for example, by the end-users. Autosomal tests have now approached 10 million fueled in large part by ancestry-oriented companies. Should there be another division within the National Institutes of Health that addresses this field because most people ordering these tests are not necessarily doing so for medical purposes?

kjgeneticgenie

This is Nicole Lockhart and Dave Kaufman of NHGRI. We appreciate the contributions that end-users of ancestry tests have made to the study of the human phylogenetic tree. The scientific importance of the community's expertise and data are impressive! In terms of whether another Division (or perhaps Institute or Center at the National Institutes of Health) is needed to address these issues, I think we want to carefully consider whether that might led to silo-ing or considering issues related to ancestry in isolation. The National Human Genome Research Institute does fund research related to non-medical uses of genetics, including ancestry testing. In particular, we fund research related to how ancestry testing may influence how users understand their own identity and their sense of family and community.

How does the field of epigenetics change how you approach studying large amounts of genomic data? Maybe put another way, what genetic information is missing in genome sequencing? By epigenetics, I mean things like methyl tags on nucleotides or non-sequence factors that affect how the genome is read. This might be a little too simplistic of a view of epigenetics, so please feel free to clarify. I'd be interested to know how epigenetics affects the interpretation of genomic libraries.

hzeiger

Hello this is Larry Brody at NHGRI. The study of epigenetics (stable changes in DNA or the proteins that bind that without changing the underlying genetic sequence) has the potential to help us how the genome reacts to the world around it. As you suggest this means the genome is more complex than just a stretch of A, C, T and G. We have developed a number ways to read this changes. Many of these can be done at the genome level. These marks are now added to the genome sequence datasets and tag with the conditions under which they were measured. For example, the marks found on a cell in the liver can tell us about how genes are regulated in that tissue. Of course, we'd also want to know what the epigenetics of a liver cell looks like after exposure to alcohol or a viral infection, or what a liver cell looks like in the morning compared to the evening or how a liver cell compares to a kidney cell. As you can see, these questions (and the associated data) can multiply quickly. The sequence of the genome provides an excellent coordinate system on to which these data can be "attached." The tools developed for big data can then be used to find these patterns. NHGRI funds a large amount of research in this area. The ENCODE project is a great place to examine some of these datasets.

Like dentistry and other types of operations/procedures, genomic editing has the potential to be categorized as "essential" or "cosmetic". When it comes to insurance policies and the potential for a whole new industry in "genomic protection", is there any evidence of corporate interest? If so, what can an ethics board do to mitigate the ability of an interested party to steer an industry in a financially beneficial and potentially dangerous direction?

Ar_Oh_Blender

This is Cristina from the NHGRI Policy and Program Analysis Branch - I'm not exactly sure what you are trying to ask, but I'm going to try to attempt to address some facets of your question. If you are referring to reimbursement for genetic tests - this is a complicated field that intersects with policy, legislation, economics, and more. Regarding questionable reimbursement policies, there are some instances where professional organizations can work to set standards to avoid the misuse of scientifically dubious tests. For instance, the American Dental Association recently adopted a policy on genetic testing. This policy called for insurers to:

- demonstrate that genetic tests used to determine eligibility for benefit coverage of specific oral health services are scientifically valid
- disclose financial relationships between manufacturer and payer
- be transparent about conflicts of interest between the test manufacturer, payer and study investigators
- provide independent third party agency confirmation of test validity and reliability for the intended purpose
- and an analysis of how utilization of the test will affect health outcomes and plan costs. Additionally, this policy states, “Health professions will experience a growth of such products and tests in the coming years and [dentists] will need a mechanism to assess the claims and counter claims so that we may best serve our patients and advocate for the needs of the public.”

Also, the FDA works to ensure that tests are marketed to the public are safe and effective, so this is one fail safe in place to prevent dangerous tests from coming to market. Hope this answer got to some of what you were trying to figure out!

Hi! I'm worried that a large online retailer (say, Amazon) will one day purchase a direct-to-consumer genomic testing company (say, 23andMe) and we'll enter an era of advertising and consumption based on genetic indicators, and also of companies having access to our genetic profiles. What's the likelihood of this happening?

dimsunshine

Hello, this is Dave Kaufman from NHGRI. Your question speaks to the evolving culture of Big Data, which is pretty exciting, and a little disquieting.
I don’t think the scenario you lay out is a stretch. For example, 23andMe is already monetizing their customers’ data, by selling it to biomedical research companies. To our knowledge they have not sold data to groups for marketing purposes, but it seems plausible. Should a company market cigarettes or alcohol to people shown to be predisposed to addictive behavior? No. Could they….? Looking carefully at the user agreements of DTC companies may shed light on what is legally in bounds, and what is not.

When will "live" genome editing (after birth) be available to cure auto-immune diseases or permanently change your ADN sequence (actually, add or remove genes) to control variable things such as melanin production, blood pH, hormone production, with minimum risk of mutations and tumors?

FlyInSpace

Thanks for the question! This is Nicole. This is a question that is on a lot of people’s minds given all the attention and promise of CRISPR gene editing technology. It’s important to keep in mind that before CRISPR can be used clinically, it must be proven safe and effective in humans with minimal risks. The initial diseases that are treated with CRISPR will need to be well-understood both scientifically (we know what function a broken disease-causing gene has, for example) and medically. Treatment will likely will be focused on diseases caused by mutations in a single gene.

For more detail, you might be interested in this AMA a few weeks ago featuring researchers from Jennifer Doudna’s lab which included lots of responses to a similar question as you asked:

https://www.reddit.com/r/science/comments/7r9pgw/hi_were_here_to_talk_about_all_things_crispr_and/dsvnscd/

So is gene therapy possible for issues like balding or arthritis?

Manapauze

This is Nicole. Thanks for the question - I bet there are a lot of people with interest in this topic! Gene therapy is currently only used for diseases that are well-understood both scientifically and medically, most often where mutations in a single gene are involved. Issues like balding or arthritis that are more complex cannot currently be treated with gene therapy. For a condition that many would consider a more "cosmetic" condition like balding, there would be additional concerns about the relative risk vs. benefit since gene therapy is currently used only for treatment of severe conditions.

Whee! I'm early, how exciting! I'm sadly not scientifically woke but I will try and ask a question that is relevant to me.

Is it ethically viable to use CRISPR to cure genetic diseases? Putting enhancement and cosmetic enhancements aside, would it be acceptable to cure genetic diseases such as (but not limited to) Machado-Joseph's Disease (aka' SCA Type 3)?

I apologize if this isn't the right place to ask this question, thank you for reading!

Hiti-

This is Nicole and I hope this AMA is helping you wake up (scientifically)… :)

Thanks for the thoughtful question! There is a lot of debate in both the scientific and bioethics communities about what would constitute ethical use of CRISPR in humans. (e.g. see: http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12032015a)

The growing consensus is that therapeutic use to cure or stop severe disease may eventually be ethically permissible. First, it's important to consider where we currently are in the use of technologies like CRISPR for clinical use in humans. Before CRISPR can be used in humans, it must be proven safe and effective. However, there will still be a lot of difficult decisions as to what types of diseases may be sufficiently severe to warrant use of technologies like CRISPR. In addition there is also debate about whether such changes should only be made in somatic (i.e. non-inherited) cells OR whether germline (i.e. those that would impact offspring or be inherited) changes should be allowed.

How unethical would it be for me a engineer a baby to have super powers?

VIIX

Thanks for the question - this is Nicole. There are both practical and ethical concerns related to genetic engineering that affects future generations. From a practical standpoint, you would need to be careful about what superpowers you engineered - you don't want to end up with super-sonic crying! From an ethical perspective, initial use of CRISPR will focus on clinical uses to eliminate severe disease - see the examples highlighted by several Reddit-ers. Enhancement, i.e. changing human function beyond what would be found naturally, would be a distinct use of the technology which many in society would likely find unethical. Uses for enhancement that also affect the germline (i.e. that would be inherited by future generations) are particularly concerning. Traditionally, pediatric ethicists have used the "best interest of the child" standard to make decisions related to the health of children. There is a possible case to be made for genetic engineering for therapeutic use under this standard, but superhero powers would be much harder to argue. Some ethicists would also argue that children have a "right to an open future" - basically the right to decide for themselves what information they would like to know or not know about themselves - and that genetic engineering without their consent may violate this right.

Besides, any parent can tell you that all babies are born with super-powers. And lots of super-heroes don't have super powers and rely on their own natural intellect and abilities (e.g. Iron Man, Hawkeye, Batman, etc.)

Salutations, it is great to know this is available for inquiry.

First question: I have a cousin that is afflicted with Wolf-Hirschhorn syndrome, a rare genetic disorder caused by a partial deletion of the short arm of chromosome 4. I figured since researchers and clinicians are sequencing human genomes faster than ever, they could also find ways for repairing genetic disorders as well. Is there anything present in genomic data at this point that could provide insight on how to decrease the occurrence of this kind of condition in the future?

Second Question: What would be some obstacles and ethical considerations all of you might foresee when it comes to research focused on rectifying genomic errors leading to genetic disorders?

Third question: What are some pointers that you have for someone such as myself who is interested in studying the occurrence and possible curtailing of genetic disorders, as well as genomics? Such as how to obtain more lab experience, hands-on understanding in the field, who I should try to get in contact with, what programs I should be looking to join, etc. Based on any of your experiences.

PurveyorOfKnowledge0

Hi, this is Larry Brody from NHGRI. Thank you for your questions. I am sorry to hear that your cousin was born with a genetic disease. Geneticists are working very hard to figure out how to diagnose, treat and prevent genetic diseases. Some, such as Wolf-Hirschhorn syndrome, are very difficult as they are extremely rare and affect how a person develops. You are correct, we are getting much better at repairing DNA in the lab. It seems to work well in experimental systems when trying to fix very small changes. However, it will be sometime before we know how to repair large changes such as big deletions, like those found in Wolf-Hirschhorn syndrome. The other complicating factor is that we are still not very good at fixing DNA in the body, and we would be uncertain as to which tissues you might want to fix to help relieve symptoms.

As far as obstacles to repairing genetic defects (your second question), safety and efficacy will always be a factor. The last thing we want to do is make things worse. The ethical issues of repairing DNA can be lumped into two broad categories. One: most people are okay with research into trying to fix DNA in the cells of the body. An example of this might be trying to restore a missing enzyme in a person's liver. Research in this area is moving quickly. And, the second category is making changes in DNA that will be passed onto future generations. The pros, cons and ethical concerns over this have been discussed for a long time and conclusions about whether this is a good idea varies by person, community and country. Even research in this area is illegal in many countries.

It is great that you have an interest in genetics and genomics. The traditional route to explore and develop this interest to pursue formal training in the sciences. You can enter via majoring in college in biology, molecular biology, chemistry, physics and, even, computer science and math. Some postgraduate education would also be required. Along the way, it would be important to seek out research internships. These can be at research institutions or science focused companies. In college, professors often take students to work on independent study or senior thesis projects. This type of exposure will help you decide which areas you like the best.

Hi and thanks for the AMA!

What are you thoughts on people such as "Biohacker Josiah Zayner" running renegade with CRISPR science in the pursuit of profit and making CRISPR available to the public? For instance, Zayner wants to make DIY gene editing kits available for purchase with the claim that injecting yourself with a CRISPR-edited-plasmid will alter the user's somatic genes to promote something like muscle growth.

The legal, ethical, and health issues with this run deep and I'd love to hear what insight you all might have.

raiden3212

This is Nicole - thanks for the question. DIY and Citizen Science has been growing in popularity over recent years and in many instances it is a positive development which helps the public embrace and understand science. However, self-injection with CRISPR or any other non-medical grade product, poses serious risks to both the individual (i.e., infection at the injection site, immune reaction to the injection itself, possibly induced tumors). Such uncontrolled studies are also bad for the research community as a whole. A bad outcome could influence how people think about this type of research.

Worse still, a false positive result could encourage other people to try dangerous self experimentation. In fact, the odds of CRISPR components successfully entering a cell and editing DNA is relatively low without the use of more sophisticated equipment and reagents. However, if there are bad outcomes from DIY uses of CRISPR, that could potentially set back legitimate research and slow overall progress.

Will this human genome project published and released for public consumption?

Marshal91

It already has been! A reference map and sequence of the genome is freely available to anyone in the world with an internet connection. This is a composite map derived from sequencing several individuals.. A search for “genome browser” will return many places where you can look at the human genome (and the genomes of many additional species). Here are links to the two most popular sites: https://genome.ucsc.edu and https://useast.ensembl.org/index.html.

In addition, many individuals have posted their own genome online. You can see some of those here: http://www.personalgenomes.org/us