American Indian and Alaska Native Communities and Genetics Research

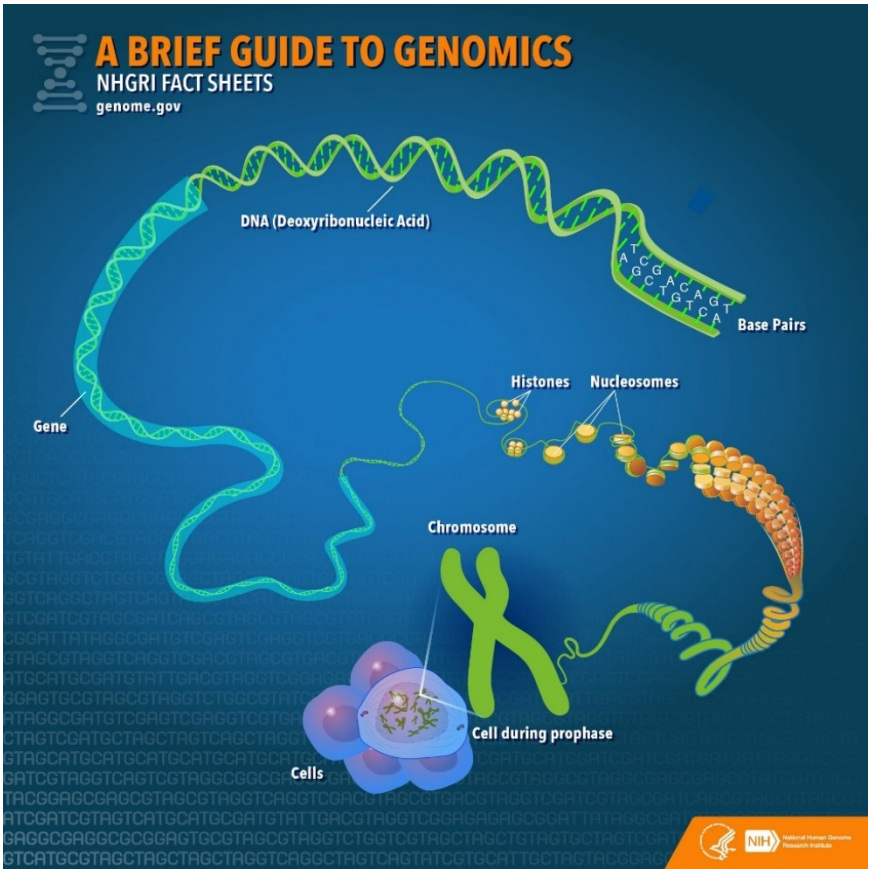


Image credit: Darryl Leja, NHGRI

What is the human genome and why is it important?

Genome is a fancy word for your DNA. Your genome contains all the instructions for you to grow throughout your lifetime. These instructions are passed down from your birth mom and dad. Half of your genome comes from your mom and half from your dad. These passed-down instructions influence traits such as height, eye color, and whether or not you are protected or at risk for some diseases, including some types of cancer.

Humans are very similar; we share 99.5 percent of DNA with each other. The differences, or genetic variants, are what result in the differences in our physical traits. They are what make you unique.

However, your genome is only one part of what determines your health and traits – your genome is not your destiny. Sometimes, changes in the genome will definitely result in a certain trait or disease. These include diseases such as Huntington's disease, cystic fibrosis, or sickle cell disease. Most of the time, many genes act together and can be influenced by the environment. These interactions can affect your traits and disease risks. For example, if a person is at higher risk than average for becoming diabetic because she has three or four gene variants that elevate her risk, it does not mean that she will definitely become diabetic. Instead, what she eats, how much she exercises, and other factors, influence her overall risk of becoming diabetic.

How do we learn about our individual genomes?

There are different ways to look at the genome, depending on what information you're seeking. Healthcare providers and researchers can perform genetic tests to learn a variety of things about your genome. In order to conduct these tests, DNA is collected from blood, saliva or tissue. Currently, in clinical care, health care providers use genetic tests to diagnose or assess genetic risk for specific diseases.

The genome can be read in its entirety or in parts. Reading an entire genome is a laboratory technique called whole genome sequencing. Right now, whole genome sequencing is usually used for research studies and not yet utilized in routine clinical care.

For more in depth information, please see Resources at the end of this booklet.

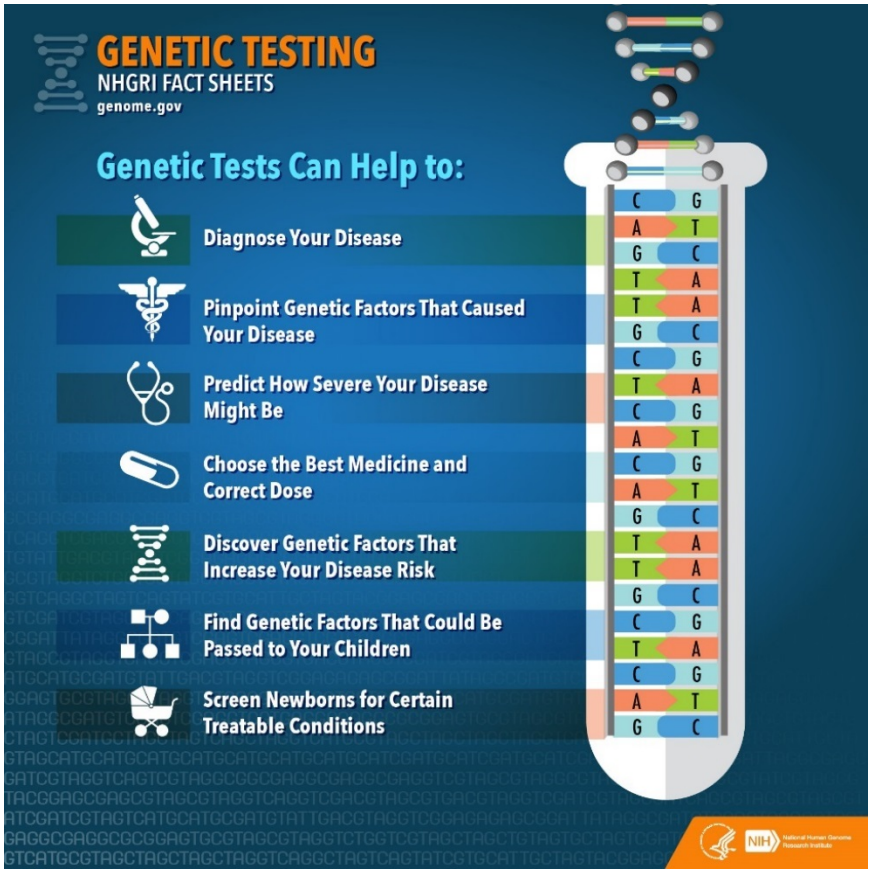


Image credit: Darryl Leja, NHGRI

What role can genetic tests play in medical diagnosis and care?

Genetic tests may be used to identify increased risks of health problems, to choose treatments or to assess responses to treatments.

Our genes influence our risks for developing different diseases. Better understanding of the role our genes and genome play in health and disease can enable us to better understand, prevent, diagnose and treat illness.

Once scientists have a more precise understanding of the role that genetic variants play in health and disease, doctors may be able to develop and use genetic tests to care for their patients, helping them diagnose diseases, choose the most effective medicines, assess risk for a disease for preventive purposes or assess the risk of passing specific variants on to children.

One example of when genetic testing can provide helpful information is in the case of hereditary breast cancer. Women who have variants in the BRCA1 or BRCA2 genes are at a much higher lifetime risk for getting breast and ovarian cancer. If a woman tests positive for these variants, she can take steps to lower her risk of getting breast cancer. Currently, there are little data about how often American Indians or Alaska Natives have harmful variants in these genes or in other genes that can increase a woman's chance of developing breast cancer.[1]

While understanding the genetics of health and disease can be very useful, genetic testing in the clinic has its limitations. Our genes are one piece of a larger puzzle in human health. Research in genomics can help advance health, but there are many non-genetic factors to address as well. These include lifestyle and environmental factors and existing health disparities caused by social, economic, and geographic differences in the United States that affect access to health care and other resources that would improve health.

Information on the human genome and its importance adapted from Genome: Unlocking Life's Code https://unlockinglifescode.org/ and https://genome.gov/

[1] Kaur, J. S., Vierkant, R. A., Hobday, T., & Visscher, D. (2014). Regional differences in breast cancer biomarkers in American Indian and Alaska Native women. *Cancer Epidemiology, Biomarkers & Prevention: A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology*, *23*(3), 409–415. http://doi.org/10.1158/1055-9965.EPI-13-0738

How can genomics be used to diagnose, prevent and treat cancer?

Cancer is a disease of the genome and, the more we learn, the more we are finding that each cancer is the result of genetic changes. Understanding the genetic changes that are in cancer cells is leading to more effective treatment strategies that are tailored to the genetic profile of each patient's cancer.

In cancer cells, small changes in the genetic letters or sequence can change what a genomic word or sentence means. A changed letter can cause the cell to make a protein that doesn't allow the cell to work as it should. These proteins can make cells grow quickly and damage neighboring cells. In other cases, changes can also cause the cell to stop making certain proteins which can result in increased cell growth and damage to neighboring cells.

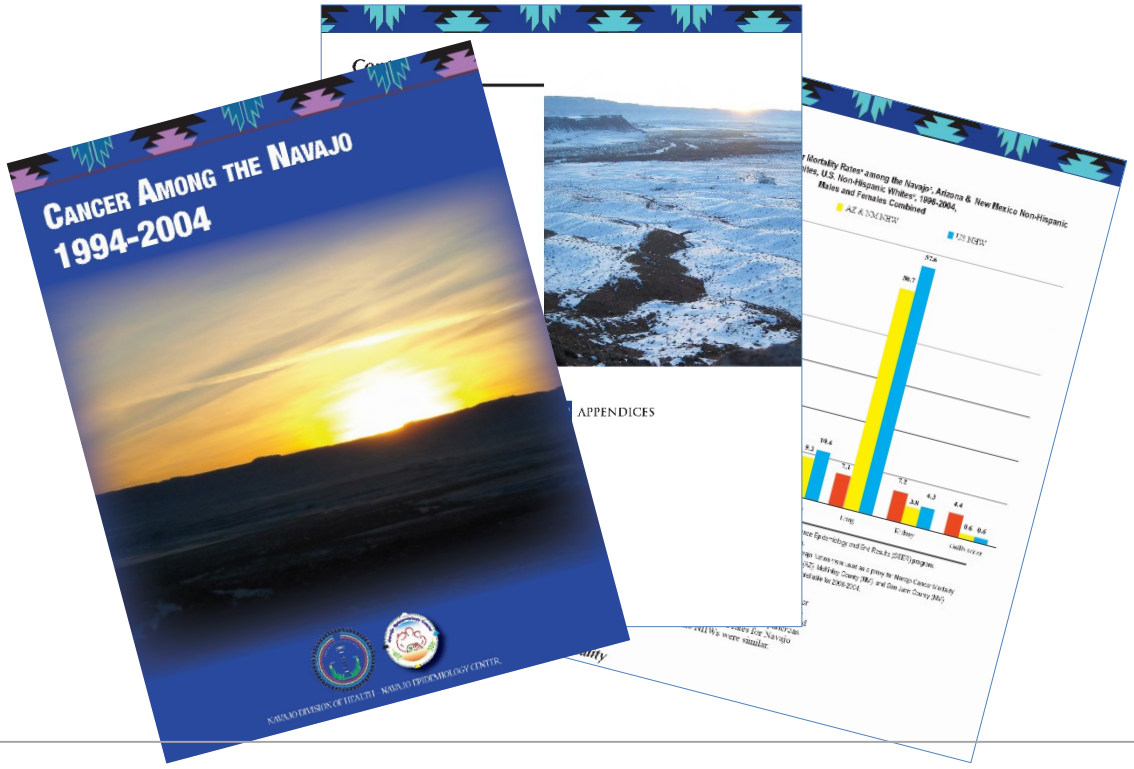
These cancer-causing changes in DNA can be inherited, but most are acquired throughout life and are not passed on to children. They may be caused by environmental factors, such as chemicals, or from lifestyle choices, such as smoking. It generally takes the buildup of several different changes to the DNA to result in cancer. Research projects will look for and identify all the changes in cancer cells to better understand different forms of cancer and new ways to control them.

By studying the cancer genome, scientists can discover what letter changes are causing a cell to become cancerous. The genome of a cancer cell can also be used to tell one type of cancer from another.

In some cases, studying the genomes of cancer cells can help identify a subtype of cancer within that type, such as aggressive forms of breast cancer. Understanding the cancer genome may also help a doctor select the best treatment for each patient.[2]

Cancer rates vary by tribe, location and type. However, American Indians and Alaska Natives generally experience higher rates and worse outcomes from cancer than many other communities. Recognizing regional differences in cancer incidence can help prevention, diagnosis and treatment efforts.

2. Adapted from National Cancer Institute and National Human Genome Research Institute's The Cancer Genome Atlas: https://cancergenome.nih.gov/cancergenomics/whatisgenomics/whatis



American Indian and Alaska Native Communities and Genomic Research

Past experience with some genetic research has undermined the trust between American Indian and Alaska Native communities and researchers. Many communities have interacted with researchers who sought research participants for their studies, but did not communicate the objectives of the research or subsequent research; did not discuss with the community how the research would benefit the health of the community; and did not discuss the research findings prior to publication and presentation. Unethical and harmful practices such as these have been imprinted into the fabric of tribal communities and, therefore, many communities are not eager to engage in relationships with the biomedical community.

This reality has contributed to the low representation of American Indian and Alaska Natives in genomics research, and raises a number of distinctive issues for tribal communities that are essential to understand and address in the development of tribal genetic research codes and policies.

Underrepresentation in Genomic Studies

So far, a majority of genomic research studies have utilized samples from individuals of European ancestry. An analysis from 2016 showed that 81 percentof genome-wide association studies to date had been conducted in people of European ancestry[2].

This is a problem because people of different ancestral backgrounds have unique genetic characteristics that can be informative for genomic medicine, especially when it comes to rare variants that are found in only a small number of people. It is also important to make sure that populations that experience significant health disparities are able to receive the benefits of genetic research. Excluding or limiting genomic research in diverse populations may increase health disparities by delaying the discovery of important genetic variants that have health implications in specific populations.

[2] Popejoy, A. B. and S. M. Fullerton (2016). "Genomics is failing on diversity." Nature 538(7624): 161-164.

Collaborations between Tribal Communities and Genetics Researchers

The National Congress of American Indians' (NCAI) web-based American Indian and Alaska Native Genetics Resource Center provides several examples of positive collaborations between tribes and genetics researchers. Many of the studies incorporate a community-based, participatory research (CBPR) practice, which engages communities from research concept, to results, to implementation. Examples provided in the NCAI Resource Center include:

- In 2003, the Salt River Pima-Maricopa Indian Community (SRPMIC) contributed $5 million to a genetics research institute, the Translational Genomics Research Institute (TGen) in Arizona. The tribe and TGen have formed a partnership for conducting medical genetics research on diabetes and other diseases (TGen 2003). The partnership created an environment in which tribal members and researchers can work together to address research questions.

- In Mexico, the National Institute for Genomic Medicine (INMEGEN) was established in 2004 to "carry out disease-related genomic studies that will address national health problems" and to study the genomic diversity of the Mexican population (Seguin et al., 2008). Researchers at INMEGEN have also been involved in community engagement with indigenous communities in Mexico to educate people about genetic research, answer questions, and carry out discussions with community members and leaders. Through these engagement efforts, researchers have trained local university students to collect samples and worked with people to translate the research goals into the local Indigenous languages.

- The Walking Forward program in South Dakota aims to help Native American cancer patients better understand cancer treatment options and to educate the community about cancer screening to reduce cancer disparities in Native Americans. A component of the Walking Forward program incorporates a genetic research study on a gene thought to be associated with response to radiation therapy.

- More recently, the Alaska Area Specimen Bank and the Northwest-Alaska Pharmacogenetic Research Network have described their efforts to establish collaborative partnerships between the federal government and tribal communities, including discussions about data sharing expectations and ensuring that the benefits of research involving these resources would be realized by the communities involved.

Appendix of NHGRI-Funded Education and Research Projects with American Indians and Alaska Natives

**studies with an asterisk have a training component*

Native American Research Centers for Health (NARCH)*
National Institute of General Medical Sciences
National Institutes of Health
Project Code: Y01HG006057
Dates: 2017

The Native American Research Centers for Health is a set of partnerships of American Indian and Alaskan Native (AIAN) tribes, tribal organizations, or non-profit national or area Indian Health Boards. This initiative will encourage research to reduce health disparities, train AIAN scientists and health professionals that conduct biomedical and behavioral research, and encourage partnerships with research-intensive Institutions and AIAN organizations to increase trust by AIAN communities and people toward research.

Genomics and Native Communities: Perspectives, Ethics, and Engagement
Garrison, Nanibaa', Seattle Children's Hospital
Project Code: K01HG008818
Dates: 2016-2021

This is a 5-year career development award for Dr. Garrison. She has a focus on community-engaged research with American Indian groups and aims to help develop guidelines and policies for tribes to engage in genetic research, based on the views and opinions of American Indian, Alaskan Native, and Native Hawaiian stakeholders (which will be characterized through interviews and surveys with tribal leaders and other stakeholders).

Center on American Indian and Alaska Native Genomic Research
Paul G. Spicer, University of Oklahoma, Norman
Project Code: RM1HG009042
Dates: 2016-2020

This center intends to build a consortium of tribal and community sites that cater to the needs of American Indian and Alaska Native (AIAN) communities. They seek to support research that explores the ethical, legal, and social implications (ELSI) of genomics for AIAN communities and creates an educational program on ELSI of genomic research in AIAN communities, among other goals. The center is partnering with tribal health systems--Chickasaw Nation in Oklahoma and Southcentral Foundation in Alaska—as well as federal systems of care to explore how/if genomic knowledge should play a role in these health systems.

Symposium: A Spectrum of Perspectives: Native Peoples and Genetic Research
National Congress of American Indians (NCAI) and the National Museum of the American Indian (NMAI)
Date: June 23, 2014

NCAI, NHGRI, and NMAI held a one-day symposium to discuss the range of perspectives in Native communities on genomic research. Discussion focused on the possibilities for genetics research to improve the health of Native communities, the need for cultural considerations in biomedical research, genomics, and ancestry, and the importance of creating and improving training pathways for Native researchers. Learn more at: https://www.genome.gov/27558499

Increasing AIAN research engagement through a culturally adapted ethics training
Cynthia Renee Pearson, University of Washington
Project Code: R01HD082181
Dates: 2014-2018

This project aims to create a culturally adapted training module for the Collaborative IRB Training Initiative (CITI) in order to promote community-engaged research and build trust with American Indians and Alaska Natives (AIAN). The module will be designed through consultation with a national expert panel of AIAN community leaders and researchers and ethicists with expertise in AIAN research. The project seeks to serve the overall goal of increasing AIAN participation in research (including in design and implantation) to improve the health and welfare of these communities.

Summer Internship for Native Americans in Genomics (SING)*

Ripan S. Malhi, University of Illinois Urbana-Champaign

Project Code: R25HG007158

Dates: 2013-2019

This project establishes a six-day summer course on genomics for Native American college and university students with an interest in genomics. The goal of the program is to build capacity for scientific research among the students, especially for research with Native American communities.

Diversity action plan: UW GenOM Project*

Willie J. Swanson, University of Washington

Project Code: R25HG007153

Dates: 2013-2020

This project aimed to develop a comprehensive program to coordinate the recruitment, retention and training of groups that are significantly underrepresented in genomic science, including African Americans, Hispanic Americans, Native Americans, Alaska Natives, Filipino Americans, Native Hawaiians and Pacific Islanders. The goal is to guide these students into graduate programs that will enable them to become principle investigators in academia or senior scientists in industry.

PAGE study: Exonic variants and their relation to complex traits in minorities of the WHI

Charles L. Kooperberg, Fred Hutchison Cancer Research Center

Project Code: U01HG007376

Dates: 2013-2017

This study aims to conduct genome-wide association studies (GWAS) in ancestrally diverse populations to identify as-yet undiscovered genetic variation that could be important for understanding health and disease. Most GWAS studies in the past have focused on populations with European-descent, but this project will include African Americans, Hispanics and Native Americans from the Women's Health Initiative. It will use a new GWAS ExomeChip designed for use with ancestrally diverse research populations.

The Flybase Diversity Action Plan*

Norbert Perrimon, Harvard University

Project Code: R25HG007630

Dates: 2015-2018

This project is a collaboration between the flybase database program at Harvard University and the University of New Mexico to train a diverse group of students, including Hispanic and American Indian students, in the biomedical science fields.

Diversity Action Plan for Mouse Genome Database*

Carol J. Bult; Janan T. Eppig, Jackson Laboratory

Project Code: R25HG007053

Dates: 2013-2016

This project aims to encourage underrepresented minority students, including Hispanic, African American, Native American and Pacific Islander/Hawaiian, to pursue genomics-related fields through a summer research internship with investigators that are part of the NHGRI-funded mouse genome database.

Ethics of Dissemination: Communicating with participants about genetics research

Bert Brandon Boyer and Wylie G. Burke, University of Alaska Fairbanks

Project Code: R01HG005221

Dates: 2010-2015

This study explored how best to communicate research results from routine clinical measures to genetic and genomic analyses for the Yup'ik Eskimos in Southwest Alaska. The study builds on an ongoing community-based participatory research project with the Yup'ik community. The investigators aimed to develop a framework to establish appropriate communication plans for returning findings to research participants.

Center for Native Population Health Disparities
Dedra S. Buchwald, University of Washington
Project Code: P50CA148110
Dates: 2010-2015

The University of Washington and the Black Hills Center for American Indian Health aim to create a Center for Native Population Health Disparities in order to improve cancer health outcomes among American Indian and Alaska Native communities. The center seeks to build upon existing research on health disparities and improve upon models for working with communities. The project parties already have strong connections with tribal communities and heavy representation from AIAN groups to pursue their work.

Online Genetics Resource Guide
National Congress of American Indians (NCAI)
Project code: N02HG000000
Dates: 2010-2012

NCAI and NHGRI collaborated to create an online genetics resource guide for American Indians and Alaska Natives that provides tribal leaders and American Indian and Alaska Native peoples with the tools and information to make their own informed decisions about genetics research. This resource can be found here: http://genetics.ncai.org/.

Genetic Research and the Navajo Nation: Context of and Attitudes to the Moratorium
Nanibaa' Garrison, Stanford University
Project Code: F32HG005931
Dates: 2010-2013

The investigator set out to understand the moratorium on genetic research put in place by the Navajo Nation in 2002. She engaged with community members to understand how they perceive genetics research and if perceptions have changed since the moratorium began. She gauged their interest in pursuing genetic research to address health concerns in the community and possible ways forward.

Indigenous Communities and Human Microbiome Research
Paul Spicer, University of Oklahoma
Project Code: R01HG005172
Dates: 2009-2013

This project engaged communities in the U.S. Southern Plains (Apache, Caddo, and Kiowa nations) and in the Andean region of Peru (Aymara, Quechua and Uros-descended communities) in focus groups, interviews and public meetings, to discuss how to conduct ethically and culturally appropriate microbiome research.

Engaging Tribal Participation in Research through Priority Setting and Regulation
Ron Whitener, University of Washington
Project Code: RC1HG005788
Dates: 2009-2013

This project took place from 2009 to 2011 and aimed to increase tribal participation in research by working with tribal communities to identify health research priorities. This involved communicating with community members to discuss willingness to participate in research and developing a process for oversight and regulations. From these discussions, the researchers created tool kits that outline the steps for successful collaboration and setting of health priorities and steps for the process of developing oversight and policies.

Ethical and Cultural Implications of Specimen Banking Among Alaska Native People
Ruth Etzel, Southcentral Foundation
Project Code: S06GM077993
Dates: 2006-2009

This project, conducted from 2006 to 2009, aims to understand the use of tissue from Alaska Native people stored in aspecimen bank, such as whether adequate informed consent was obtained and whether its use was consistent with consent. It further aimed to understand how Alaska Native people view the use of stored tissue specimens and develop methods for the operation and management of this tissue through a community-based, participatory research model. This project aimed to help in the foundation's larger goal of increasing partnerships with Alaska Native and American Indian communities to reduce distrust and conduct research that can improve the health of these communities.

Trust and Genetics Research in Diverse US Communities

Paul Spicer and Tim Byers, University of Colorado at Denver and Health Sciences Center

Project Code: R01HG003891

Dates: 2005-2010

This project focused on exploring perceptions of cancer genetics research among American Indian and Alaska Native communities and having discussions to build trust with community members. The project takes a step away from more controversial research done in the past on the genetic bases of diabetes and alcohol dependence that have proved difficult to discern and derive benefit from. Cancer genetics has greater potential to be realized in the near future for precision medicine and was thus chosen as a jumping off point for discussion. After identifying attitudes towards genetics, research and healthcare, the investigators wanted to work with community members to identify ways to strengthen relationships and trust in future genetic research.

Center for Genomics and Healthcare Equality*

Wylie Burke, University of Washington

Project Code: P50HG003374

Dates: 2004-2016

The Center for Genomics and Healthcare Equality has been receiving funding from NHGRI since 2004 and aims to continue building on the work it has done thus far. Specifically, it aims to 1) understand the challenges and opportunities for translating genomic research for use in medical care with attention to promoting health benefits for underserved populations, 2) develop methods for building community-university partnerships, 3) develop tools to help with the use of genomic health technologies in medicine and reimbursement of these services, 4) provide training opportunities for scientists from underrepresented minorities, and 5) develop partnerships to conduct more research in the area.

Community Consultation as an Ethics Method

Pilar Ossorio, University of Wisconsin-Madison

Project Code: R01HG003042

Dates: 2004-2007

In the study, investigators note the increase in use of community consultations with minority and indigenous populations in order to minimize harms for these communities and incorporate feedback from its members. Because there is little guidance on best practices for community consultation, the project brought together 18 scholars to propose guidelines that research oversight committees can use to determine when a project requires a consultation and methods for the consultation.

SACNAS for Increasing Diversity in Genomic Research

Marigold L. Linton, Society for Advancement of Chicano and Native Americans in Science

Project Code: R25HG003200

Dates: 2004-2007

The Society for Advancement of Chicano and Native Americans in Science (SACNAS) has extensive success and experience in increasing minority participation in science. The long-term objective of this proposal was to increase the number of Chicanos/Latinos and Native Americans engaged in genomic research.

Genetics Testing in Midwest American Indians

Joycelyn Dorscher, University of Minnesota Duluth

Project Code: R21DK066142

Dates: 2003-2006

This project took place from 2003-2005 to uncover concerns and issues related to genetic testing among American Indian communities in the Midwest. The project used a combination of qualitative research about ethical, legal and social issues, and the tradition of storytelling, to discuss genetics research with community elders. They hoped to understand concerns as well as gain an understanding of the ways to respectfully interact with communities.

American Indian and Alaska Native Genetics Research Policy Formulation Meeting

Francine Romero, Northwest Portland Area Indian Health Board

Project Code: Y01HG001004

Date: 2001

NHGRI and the National Institute of General Medical Sciences (NIGMS) funded a meeting of 29 individuals to create a policy document that could aid tribal communities and researchers in conducting genetics research.

The Promise and Pitfalls of Native Genetic Research

Paul Spicer, University of Colorado Health Sciences Center

Project Code: R01ES010830

Dates: 2000-2004

This project explored the range of ethical, legal and social (ELSI) issues for genetic research and health services with Indian and Native peoples. It aimed to convene a conference with representatives from diverse Indian communities and subsequently conduct community consultations in five communities to discuss areas of common ground and compromise between researchers and tribal communities. Ultimately, the researchers wanted to create guidelines for conducting research and delivering genetic health services to the communities.

Genetic Education for Native Americans

Linda Burhansstipanov, Native American Cancer Initiative, Inc.

Project Code: R25HG001866

Dates: 1998-2001

This project aimed to modify genetics education curricula for use by Native American university students and educators. The modified curricula were to be culturally competent and relevant to allow students to make informed decisions about genetic issues and to pursue careers in genetics. It also aimed to create a database of researchers willing to provide mentorship to Native American students.

ELSI Research in Two Native American Communities

Morris Foster, University of Oklahoma

Project Code: R01HG001302

Dates: 1995-1999

This project aimed to understand the ethical, legal and social implications (ELSI) of the Human Genome Project (HGP) for the Plains Apache and Euchee communities. The study strove to understand privacy issues for the community and construct models for ELSI research and possible participation in the HGP.

Twelve Important Terms for Understanding Genetics & Genomics [3]

1. **Genome**
   The genome is the entire set of genetic instructions found in a cell. In humans, the genome consists of 23 pairs of chromosomes, found in the nucleus, as well as a small chromosome found in the cell's mitochondria. These chromosomes, taken together, contain approximately 3.1 billion bases of DNA sequence.

2. **Chromosome**
   A chromosome is an organized package of DNA found in the nucleus of the cell. Different organisms have different numbers of chromosomes. Humans have 23 pairs of chromosomes--22 pairs of numbered chromosomes, called autosomes, and one pair of sex chromosomes, called X and Y. Each parent contributes one chromosome to each pair so that offspring get half of their chromosomes from their mother and half from their father.

3. **Gene**
   The gene is the basic physical unit of inheritance. Genes are passed from parents to offspring and contain the information needed to specify traits. Genes are arranged, one after another, on structures called chromosomes. A chromosome contains a single, long DNA molecule, only a portion of which corresponds to a single gene. Humans have approximately 20,000 genes arranged on their chromosomes.

4. **DNA**
   DNA is the chemical name for the molecule that carries genetic instructions in all living things. The DNA molecule consists of two strands that wind around one another to form a shape known as a double helix. Each strand has a backbone made of alternating sugar (deoxyribose) and phosphate groups. Attached to each sugar is one of four bases--adenine (A), cytosine (C), guanine (G) and thymine (T). The two strands are held together by bonds between the bases; adenine bonds with thymine, and cytosine bonds with guanine. The sequence of the bases along the backbones serves as instructions for assembling protein and RNA molecules.

5. **Epigenetics**
   Epigenetics is an emerging field of science that studies heritable changes caused by the activation and deactivation of genes without any change in the underlying DNA sequence of the organism. The word epigenetics is of Greek origin and literally means over and above (epi) the genome.

6. **Trait**
   A trait is a specific characteristic of an organism. Traits can be determined by genes or the environment, or more commonly by interactions between them. The genetic contribution to a trait is called the genotype. The outward expression of the genotype is called the phenotype.

[3] Adapted from *The Talking Glossary of Genetics* https://www.genome.gov/glossary/index.cfm

7. ## Phenotype

A phenotype is an individual's observable traits, such as height, eye color and blood type. The genetic contribution to the phenotype is called the genotype. Some traits are largely determined by the genotype, while other traits are largely determined by environmental factors.

8. ## Sequencing

DNA sequencing is a laboratory technique used to determine the exact sequence of bases (A, C, G and T) in a DNA molecule. The DNA base sequence carries the information a cell needs to assemble protein and RNA molecules. DNA sequence information is important to scientists investigating the functions of genes. The technology of DNA sequencing was made faster and less expensive as a part of the Human Genome Project.

9. ## Variant

A variant is a change in a DNA sequence. Variants can result from DNA copying mistakes made during cell division, exposure to ionizing radiation, exposure to chemicals called mutagens, or infection by viruses. Germ line variants occur in the eggs and sperm and can be passed on to offspring, while somatic variants occur in body cells and are not passed on.

10. ## Nucleotide

A nucleotide is the basic building block of nucleic acids. RNA and DNA are polymers made of long chains of nucleotides. A nucleotide consists of a sugar molecule (either ribose in RNA or deoxyribose in DNA) attached to a phosphate group and a nitrogen-containing base. The bases used in DNA are adenine (A), cytosine (C), guanine (G) and thymine (T). In RNA, the base uracil (U) takes the place of thymine.

11. ## Protein

Proteins are an important class of molecules found in all living cells. A protein is composed of one or more long chains of amino acids, the sequence of which corresponds to the DNA sequence of the gene that encodes it. Proteins play a variety of roles in the cell, including structural (cytoskeleton), mechanical (muscle), biochemical (enzymes) and cell signaling (hormones). Proteins are also an essential part of diet.

12. ## Pharmacogenetics

Pharmacogenomics uses information about a person's genetic makeup, or genome, to choose the drugs and drug doses that are likely to work best for that particular person. This new field combines the science of how drugs work, called pharmacology, with the science of the human genome, called genomics.

In-Depth Resources

The resources below include peer-reviewed research, online resources and news articles that give examples and explore genomics research in tribal communities in greater detail.

2010 Presidential Address: Culture: The Silent Language Geneticists Must Learn—Genetic Research with Indigenous Populations.
Transcript of the 2010 Presidential Address at the 60th annual meeting of the American Society of Human Genetics by Roderick R. McInnes; addresses the issue of cultural misunderstandings during genetic research.

A Framework to Examine the Role of Epigenetics in Health Disparities among Native Americans.
Scholarly study on the correlation between the changes in genes and adverse childhood experiences (ACEs) in Native Americans; concludes that more research is required to understand how ACEs contribute to the health and well-being of Native Americans and to understand how interventions can promote their welfare.

Awareness and Acceptable Practices: IRB and Researcher Reflections on the Havasupai Lawsuit.
Study that examines the perceptions of the Institutional Review Board (IRB) chairpersons and human genetic researcher involved in the Havasupai tribe lawsuit of 2003. Explores how consent issues are understood by members of the IRB and human genetic researchers, and how this understanding impacts research ethics education.

Bridging the Divide between Genomic Science and Indigenous Peoples.
Article that explores the issues surrounding the advancement of genomic science and disparities in indigenous communities; calls for innovation in translational research methods for crossing the divide between genomic researchers and indigenous communities.

Bringing Indigenous Researchers to the Forefront of Genomics.
Article by AIAN researchers encouraging the study of STEM and genomics by AIAN students.

DNA on loan: issues to consider when carrying out genetic research with aboriginal families and communities.
Scholarly article on the importance of the research relationship with the AIAN community. (Subscription required)

Ethical Issues in Developing Pharmacogenetic Research Partnerships American Indigenous Communities.
Article that examines that ethical issues around partnering with AIAN communities in pharmacogenetics research; concludes that newly generated knowledge should buttress the health goals of all communities involved.

Genomics for the World.

Article in *Nature* magazine that explores the potential benefits of including other ethnic groups in human genetic research.

Exploring Pathways to Trust: A Tribal Perspective on Data Sharing.

Scholarly article that reports on the tribal perspectives that emerged from a meeting between tribal representatives and the Northwest-Alaska Pharmacogenetic Research Network; indicates that there is strong support for an efficient research process that would expedite the benefits from collaborative research.

Genetics Research Policy Formulation Meeting - Summary Meeting Report.

Summary of the February 7-9, 2001 meeting on research policy formulation; covered issues such as tribal concerns and expectations regarding genetics research, how researchers see genetics research and the review board's perspectives on genetic research.

Genomic Justice for Native Americans: Impact of the Havasupai Case on Genetic Research.

An examination of the impact of the Havasupai case on view of genetic researchers; posits that many researchers may have learned the wrong lessons from the Havasupai case and unless there is a change in said perspectives, genetic research will suffer.

Perspectives on Research in American Indian Communities.

Scholarly article on tribal council responsibilities in regards to research review. (Subscription required)

Nuu-chah-nulth Blood Returns to West Coast.

Newspaper article on the return of blood samples to the Nuu-chah-nulth tribe in Canada, after fraudulent use of the blood samples by a genetic researcher;discusses many of the issues that surround the implications of research with first nation communities such as consent, the handling of genetic material, research oversight, and secondary use of genetic material.

Reflections on Partnering in Genetic Research.

One-page list of questions for tribal leaders and researchers to reflect upon when considering entering into a research relationship; focuses on questions related to communications, trust and control.

Sample Genetic Policy Language for Research Conducted with Native Communities.

Scholarly article that attempts to clarify several genetic issues that have cultural ramifications for Native communities; supplies draft language for study protocols, the support researchers and tribal nations when developing studies pertaining to genetic issues. (Subscription required)

Secondary uses and the Governance of De-identified Data: Lessons from the Human Genome Diversity Panel.

Scholarly article on the secondary uses of de-identified data in human subject research; concludes that the potential risks to research participants cannot be completely mitigated by de-identifying an individual's data and secondary use of research data still requires oversight.

The Alaska Area Specimen Bank: A Tribal–Federal Partnership to Maintain and Manage a Resource for Health Research.

Article that describes the history, purpose and cooperative management of the Alaska Area Specimen Bank (AASB).

The A's, G's, C's, and T's of Health Disparities.

Article that discusses the potential contributions that genomics can play in alleviating conditions that disparately affect certain ethnic groups. Describes how an understanding of our genetic makeup can contribute to a mutual biological understanding that transcends social divisions.

The Havasupai Indian Tribe Case — Lessons for Research Involving Stored Biologic Samples.

Study on the Havasupai Indian tribe case where researchers improperly used blood samples for secondary genetic research; discusses different approaches to informed consent, including tiered consent.

Views of Biobanking Research among Alaska Native People: The Role of Community Context.

Scholarly article that reflects on the views of the Alaska native (AN) people with regards to biobanking; the authors solicited feedback from tribal health organizations and uncovered five themes that contributed to AN view on the practice of biobanking: prior experiences with medical research and care, stigmatizations, governmental and cultural change, concerns about developing technologies, and the benefits of research to future generations. (Subscription required)

Transforming genetic research practices with marginalized communities: a case for responsive justice.

Scholarly article on the moral implications of research with AIAN communities; posits that researchers must make the AIAN community equal participants in decision-making about how research is conducted and how the results are utilized. (Subscription required)

Variation in Genes Controlling Warfarin Disposition and Response in American Indian and Alaska Native People: CYP2C9, VKORC1, CYP4F2, CYP4F11, GGCX.

Scholarly article on genetic testing and the potential benefits for including AIAN peoples in warfarin trials.

Warfarin Pharmacogenomics in Diverse Populations

Article from the journal *Pharmacotherapy* on genotype-guided warfarin dosing using algorithms to optimize dosing and potentially reduce adverse drug events;discusses that diverse populations, such as African Americans and Latinos, have greater variability in warfarin dose requirements and are at greater risk for experiencing warfarin-related adverse events compared with individuals of European ancestry. The vast majority of literature on genotype-guided warfarin dosing, including data from prospective randomized trials, is in populations of European ancestry, although data suggest that patients of diverse populations may benefit from improved warfarin dose estimation.

Additional Resources/Readings:

American Indian and Alaska Native Genetic Resource Center.

National Human Genome Research Institute (NHGRI) supported website that serves as a resource guide on genetic research for the AIAN community.

"Genetic Education for Native Americans" (GENA®) Tailored Workshops.

Link to information for educational courses on genetics offered by the Native American Cancer Initiatives (NACI).

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