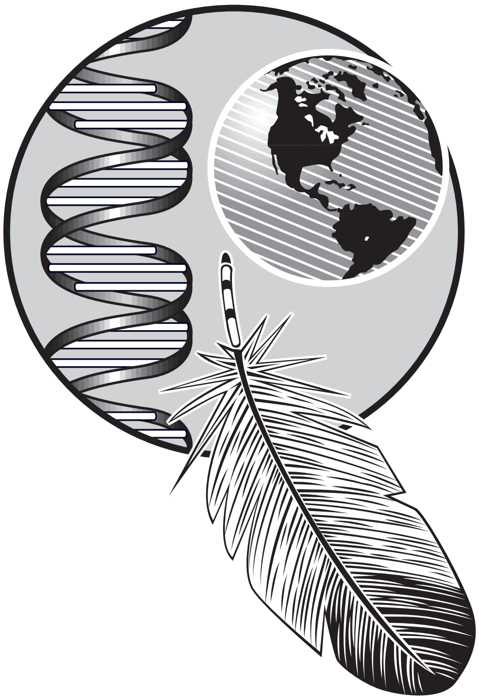
Indigenous Peoples,
Genes and Genetics
What Indigenous People Should Know About Biocolonialism



A Primer and Resource Guide

INDIGENOUS PEOPLES COUNCIL
ON BIOCOLONIALISM

Indigenous People,
Genes and Genetics

What Indigenous People Should Know About Biocolonialism

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Indigenous Peoples Council on Biocolonialism
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In Memory of
Dr. Frank Dukepoo
1943-1999

This publication is dedicated to **Dr. Frank Dukepoo**, a geneticist of Hopi and Laguna ancestry, who set his own research aside in order to insure that indigenous peoples' human rights and interests would be protected in the face of the new biotechnologies. Dr. Dukepoo was a founding member of the board of directors of the IPCB, and a treasured mentor and friend. He was the co-author of the original version of *Indians, Genes and Genetics: What Indians Should Know About the New Biotechnology*, the publication on which this booklet is based. Dr. Dukepoo's dedication and commitment to insure that the treatment of indigenous peoples in research is ethical, responsible, and respectful has been a continuing source of inspiration and a guiding light to our ongoing efforts.

"**To us, any part of ourselves is sacred. Scientists say it's just DNA. For an Indian, it is not just DNA, it's part of a person, it is sacred, with deep religious significance. It is part of the essence of a person.**"
Dr. Frank Dukepoo, Interview, San Francisco Chronicle, 1998

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Introduction

Indigenous peoples of the world are unique groups who are widely known by our diverse cultures, customs, and languages. Despite our differences, however, we share many similarities. Our early ancestors made significant contributions to astronomy, arts, architecture, agriculture, mathematics, ecology, social science, political science, and genetics. The results of our contributions are evident throughout the world. How far we would have gone in these areas is unknown because our recent ancestors put them aside as they were forced to contend with colonization.

In former times our ancestors fought their battles on land and in courtrooms. Today some of the battles have moved to scientific laboratories and patent offices. Our weapons are awareness, knowledge, and choices, rather than arrows, guns, and treaties. Call it "the new wave of colonialism," "the new biotechnology," "the bio-revolution," or "bio-colonialism," it is here and will be with us for a long time. In a very broad sense, what we are talking about is "biotechnology." It is an area that we dare not ignore.

When we hear the word "biotechnology," many of us turn away our minds, thinking that this field of science seems too hard to understand or that it is "not Indian." Until recently, very few of us had heard about the science of genetics. But we cannot afford to ignore this field of science any longer, because the genomics industry, both public and private, wants and needs the genetic resources that exist within the biodiversity of indigenous peoples' lands and that flows in our veins. The immense resources of technology-rich countries are being pooled in worldwide collaborations in order to carry out genetic research. Also, numerous researchers are funded by both public and private funds to carry out their own independent research activities. These efforts, combined with increased technological capabilities for genetic sequencing, are fueling a worldwide effort to collect genetic samples, from plants that produce foods or medicines, from animals, and from diverse human populations. The genetic resources that have nurtured the lives of indigenous societies for centuries are at risk of genetic theft.

The field of molecular biology is moving ahead extremely fast. In fact, the field has outpaced the development of new policies and laws that can effectively address the legal, social, and ethical concerns that genetic research raises for society. Scientists and bioethicists regularly have conferences to discuss ethical issues such as genetic discrimination in the workplace or in insurance coverage. Or they may be concerned about the dilemma parents face when genetic screening of unborn children indicates a predisposition for a disease, but offers no cure for that disease. Others debate the ethics of altering genes in unborn fetuses, human cloning, and animal organ transplants into humans despite the risks of transferring viruses between species. They also often meet to discuss the unique questions raised when they would like to do genetic research on indigenous peoples, but indigenous peoples are rarely at the table to represent our own views.

Call it "the new wave of colonialism," "the new biotechnology," "the bio-revolution," or "bio-colonialism," it is here and will be with us for a long time.

As Indigenous people have taken a more critical look at genetics, many have voiced their concern and have started to speak out against some of the negative aspects of biotechnology. In fact, a widespread movement against genetic theft, or biopiracy, has started to build around the world. Many of the protestors at the World Trade Organization meeting in late 1999 in Seattle were opposed to the negative impacts biotechnology can have when the interests of corporations are favored over societal needs. Those opposed to the control corporations have over science and genetic resources include a broad range of people, from indigenous peoples to shareholder activists, from students to tenured professors.

The purpose of this booklet is to provide you with a "primer" to help you build a foundation and have a better understanding of the complex subject of genetics. This essential knowledge will enable you to better understand the issues and make more informed decisions regarding yourself, your people, and your environment.

Before we begin, we want to emphasize that we do not intend to tell you what to do or make decisions for you, be they pro or con. Our intent is to present the subject and the issues so that you can make intelligent, well thought-out and informed decisions about genetic research in indigenous communities. We present a broad perspective on the concerns and potential negative aspects of genetic research. We can't expect or rely upon the researchers, corporations, media, or government officials to present all of the information we need to know. It is possible they may be more interested in protecting their own interests rather than ours, or they simply may not know what information is important to us. To make a good decision, you need to have the opportunity to be fully informed of every aspect of the research, and to weigh the potential benefits with the risks. The final decisions are, of course, yours to make. We want to provide you with the whole picture because your decisions are important and they will affect all of us.

Genetics is concerned with studying the genetic composition of life forms at the cellular level, be it viruses, bacteria, plants, animals, or human. The genetic material, or DNA, is found within the cells and contains the hereditary information passed on through reproduction from generation to generation. DNA contains certain biological/chemical instructions that, when combined with environmental influences, result in the biological (physical) development of the organism. Scientists are concerned with understanding the structure and sequences of genes, identifying genes associated with various physical conditions, and they sometimes attempt to change the genetic structure of organisms through genetic manipulations. Genetics, as a discipline, has little regard for the life forms it manipulates. Their interventions—inserting foreign genetic material into an organism, adding or deleting genes— can permanently alter life forms that have evolved naturally over thousands of years.

This contrasts sharply with an indigenous worldview. For us, all life is sacred—it is a gift from the Creator. As indigenous peoples, we carry the responsibility of insuring a healthy future for our children and unborn generations yet to come. This includes a responsibility to respect, protect, and nurture all life. Life is sustained by a healthy environment. In order to carry out our responsibilities to future generations and our environments, we need to understand the nature of the problems we face. Once fully aware, then we are prepared to take action in order to carry out our responsibilities.

The issue of biocolonialism has come knocking at our doors. Like all other unwanted advances of colonization within our lives and territories, genetic prospecting is a reality and is here to stay. Much of life's genetic diversity exists among our peoples and in our territories. Genetic diversity flourishes where lands have not been clear-cut to make way for the expansion of cities, farming, or ranching activities, and where small scale crop diversity is the norm rather than large-scale mono-cropping. Researchers know full well that this is where they will find the genetic diversity, human, animal and plant, needed for their research projects. As an indigenous person you should be concerned, since you might have an unusual genetic makeup—you might possess a rare gene or suffer from an "important" disease or medical condition, thereby making you a prime candidate in some research project. If you choose to participate in studies involving genetics, that is your choice, but we urge you to consider the following:

- Am I fully aware of the research I am getting into?
- Do I really understand what is going on?
- Am I aware of the short and long-term effects of such research?
- Have I weighed the positive as well as negative outcomes?
- Does this violate or go against my religion, my culture or my personal code of ethics?
- Do I really know what is in the "consent form"?
- Have I given my true consent?
- Do I know what will be done with my blood, tissue, hair or other samples?
- What use will be made of our tribal knowledge, or of samples removed from our territory?
- How will the research results affect me, my family, or my people?
- Who really benefits from the research, and how much?

These are extremely important questions. They are questions and issues that all of us must face as we enter the "bio-revolution." They will help you evaluate research proposals and take control over how this revolution will affect you. Collectively, as tribal peoples, we can also play a role in determining how this revolution moves forward and how we may choose to participate, or not.

In addition to human research, we also know there is an increased interest in plant or botanical research, as seed and pharmaceutical companies seek to "discover" and patent the agricultural and medicinal properties of our native plants, and the knowledge of our elders and medicine people.

In the next section we will provide an overview of the science of genetics. Then we will discuss some of the areas of specific concern to indigenous peoples. Finally, we will provide some ideas about what you can do, and some resources for you to learn more if you would like to do so.

Essentials of Genetics

Genetics Then and Now

Genetics is the study of the structure and function of genes and of the transmission of genes between generations. Knowledge of genetic phenomena has a history that is thousands of years old and probably began when humans first noticed similarities between parents and offspring, or that certain traits or characteristics "run" in families. Ancient civilizations, including the Chinese, Romans, and Egyptians, applied this knowledge to "develop" many different domesticated animals. Throughout the centuries, indigenous peoples in the Western Hemisphere have developed many varieties of plants such as corn, potatoes, beans, squash, and other edibles. Present-day indigenous peoples still maintain different strains of plants, developed over generations of cultivation.

The incredibly fast growth of the "new genetics" is another story altogether. It started when it was found that humans could move portions of DNA (genes) between organisms (human and other life forms), and so the genetic engineering revolution began. And that "revolution" marches on at breakneck speed. Almost daily there are new developments in the "discovery" of "new" genes. Molecular biological techniques have found their way into the courtroom, as documented by the well-publicized trial of O. J. Simpson. In

The incredibly fast growth of the "new genetics" is another story altogether. It started when it was found that humans could move portions of DNA (genes) between organisms (human and other life forms), and so the genetic engineering revolution began.

1997 the world was stunned by the news of "Dolly," the cloned sheep, and two weeks later news coverage featured cloned Rhesus monkeys from a University of Oregon lab. In January of 1998, we learned that longevity might be extended by manipulating certain parts of the chromosome and that a scientist in Chicago (Richard Seed) was proposing to clone humans. In the year 2000, the UK has proposed to lift its ban on human cloning.

Genetic research in the agricultural world, though less susceptible to sensation in the press, is moving equally fast as scientists are attempting to identify the genes that produce commercially valuable properties by studying plant and animal genetic material. "Traitor Technologies", that engineer seeds to infertile after planting, captured the attention of the press and the public. Further concerns were raised when researchers found that genetically engineered crops were killing the Monarch butterfly.

Genetic Engineering

Genetic engineering is an aspect of genetics that attempts to make changes in the DNA of an organism. Typically, this is done by putting pieces of DNA from another source into a life form. When this is done to nonreproductive ("somatic") tissues the changes only remain in effect during the lifetime of the altered individual. However, when this type of manipulation is done during early embryonic stages, the changes can be incorporated into the developing eggs or sperm ("germ cells"), and may therefore be passed on to offspring of the manipulated organism. Genetic alteration of somatic tissues is sometimes called "somatic gene therapy" or "somatic gene engineering", but because of the inexact nature of the science it is more proper just to call it "somatic gene manipulation". Similarly, genetic alterations that

Genes, DNA, and Reductionism

Genes are molecular entities which can be inherited, and they specify how proteins are built in the body. The molecules which contain genes are called DNA (deoxyribose nucleic acid). DNA is made of long strings of molecules, which under a microscope takes on the shape of a twisting ladder (often called a "double helix"). A portion of a strand of DNA can function as a gene - meaning that this portion carries the relevant code for production of a particular protein.

Of course, proteins are important for every cell in the body. But to think that genes provide all of the instructions for life by providing instructions for how proteins are built is to ignore many other factors that influence an individual - even an individual's body. Genes, and difference in genes, may explain some of the differences between people, but other factors also contribute to differences between people. Many other factors, including environment, nutrition, and the family and culture in which a person is raised and lives can be at least as important to what makes up a person as the way their proteins are constructed, but genetic studies tend to make people believe there is a genetic "cause" for everything - this tendency is sometimes called "genetic reductionism."

Human Genetics. *A more detailed look...*

The science of human genetics can focus on a broad variety of topics. Some geneticists study traits we inherit from our parents, some study similar traits within a population and differences between populations, some are looking at genetics from a historical perspective to study the history of populations, their relationships with others, while others are looking at current health-related questions.

People inherit a mix of genes from each of their parents. Each of your genes is present in two copies. One copy comes from your mother, and the other copy from your father, but the two copies do not always have an equal impact on your biology. This can contribute to your being more like your father in some ways and more like your mother in other ways. The genes you inherit from your parents they inherited from their parents, and so on. Surprisingly, the version of a gene you get from one of your parents may have been silent in their own bodies, but simply passed on from one of their own parents. This is why in certain respects you can resemble your grandparents more than your parents. If you have children, you will pass some of the ancestral genetic information you received on to them.

Since DNA is in every cell of the body, scientists can obtain a sample of a person's genes from virtually any tissue sample, like blood, hair, or bones. Once they obtain a sample, they can perform procedures that cause the genes to be copied over and over. Therefore, just one small sample is enough to create a supply of a person's genetic samples that is never-ending. The cells become "immortalized."

The Basics of Human Genetics

This section provides an introduction to some of the more technical scientific background about genetics. It will help explain some of the technical language used by scientists, and will provide some of the essential details about what genes are and how they work.

After fertilization has occurred, a single cell called a zygote is formed. The zygote contains all of the genetic material necessary for an individual to grow and develop. This cell divides rapidly and becomes an embryo, then a fetus, and eventually a baby is born. By adulthood, a human is composed of trillions of cells—all from one initial cell. Each of these cells, except for red blood cells, contains a full set of human genetic material.
A typical cell has two major areas, called the "cytoplasm" and the "nucleus." Within the cytoplasm are found organelles, which keep the cell functioning. Also enclosed within the cytoplasm is the membrane-bound nucleus, which contains the genetic material. At certain times this material is diffuse, not easily seen, and is known as chromatin. At other times the

chromatin condenses into visible chromosomes. Embedded in the chromosomes are genes which occupy specific sites called loci.

Chromosomes come in pairs as do their accompanying genes. For each species, the total number of chromosomes is constant. Fruitflies, for example, have 4 pairs of chromosomes. Each human cell contains 46 total chromosomes (23 from the mother and 23 from the father). The 23 pairs of chromosomes are made up of 22 pairs of autosomes and 1 pair of sex chromosomes. Males have an X and a Y sex chromosome, while females have two X sex chromosomes.The total genetic material, all the chromosomes together, is known as the "genome."

Chromosomes are visible because they are tightly coiled. However, if we were to unwind a chromosome, we would discover that it is bound with histone proteins. If we continue to unwind, we find the structure of the DNA molecule as postulated by James Watson and Francis Crick in 1953: the "double helix."

Chemically, DNA is composed of common elements including carbon, hydrogen, oxygen, nitrogen and phosphorus arranged somewhat like a twisted ladder. In this "double helix" the outer supports of the "ladder" are composed of deoxyribose sugar alternating with phosphorus. The connections between the supports are like rungs on the ladder and contain two types of paired bases. One pair is adenine and thymine (A and T); the other is guanine and cytosine (G and C). A gene might be visualized as a certain length of the ladder (which may be large or small) and may contain hundreds of bases which may be present in any order.

At the molecular level, the DNA bases are read three at a time. These sets of three bases are "translated" into amino acids. A sequence of bases in the DNA somehow determines how other proteins in the body are to be formed. There are many different proteins in the body, and some of them help sythesize DNA and other proteins. Proteins in the body serve either a structural function (such as bones or cartilage) or as enzymes which are necessary for the chemical workings of cells. Some proteins, called enzymes additionally are responsible for the chemical workings of cells. The chemical workings include out metabolism, i.e. the ability to breakdown and use food for energy, our growth and development, our ability to combat diseases, etc. DNA thus controls the visible expression of a gene (otherwise known as a "phenotype") by providing instructions for making protein in the body-somewhat like a cookbook for the different proteins in the body. Different phenotypes therefore, can reflect different genetic instructions for building proteins-that is, different phenotypes can reflect genetic variation.

can be passed on to future generations should be indentified as “germline manipulation”.

In agriculture, a range of genetic engineering techniques has been developed to manipulate the genes or the genetic makeup of living beings to produce a desired commercial result. These technologies are being used in many areas of production, such as pharmaceuticals, industrial raw materials, and food. (For an example of how a plant may be genetically engineered, see the highlight “How a Transgenic Plant is Made” below). While proponents of genetic engineering claim that it is precise and safe, there is a great deal of controversy around these claims.

While the term “genetic engineering” sounds like an exact science, in reality it is far from being precise in any predictable manner.

While the term “genetic engineering” sounds like an exact science, in reality it is far from being precise in any predictable manner. Critics of the technology, many of them scientists themselves, emphasize the unpredictability of genetic manipulation as a primary reason for caution. Critics say that the discipline lacks adequate knowledge of the many dynamic processes that contribute to the development and diversity of different plants and animal species in our world. They observe that the science is being developed and commercialized with too little concern for the risks of not knowing all of the consequences. Among the primary areas of concern, these scientists warn that:

- Transgenic techniques are imprecise. Currently, genetic engineers are not able to fully control where the foreign DNA is inserted into the host organism. This control is important because it is believed that the position of genes can determine what they do. Genetic engineers are not being mindful of the environment of the gene, and the dynamic role that all the other processes and forces in a living being have in shaping the activities of genes.

- Genes can perform more than one function, depending on their environment and the influence of other factors. These multiple functions are not understood, but they are also being ignored. So scientists focusing on the ‘growth genes’ to make salmon grow bigger were surprised to find that the young fish also turned pale green. U.S. Department of Agriculture animal genetic engineers using foreign growth hormones to make pigs grow bigger produced pigs with severe arthritis, lethargy, and other disorders. Some of these multiple effects caused by foreign genes may not be so obvious at first, but instead may reveal themselves over time in as yet unimagined ways.

- Projects for the development of genetically engineered plants and animals typically do not try to understand the way that the transgenic organism will interact with other species once released into the world.

How a transgenic plant is made

Once genetic engineers have identified the genes that they want to introduce to the agricultural crop, they construct a kind of package that will be introduced to the host agricultural plant. This package is made up of:

- The **desired DNA (genetic material)** extracted from the isolated cell of the living being from which it is taken. (This is extracted using enzymes, proteins that function like scissors.)

- A **promoter** , a stretch of DNA, that acts as a switch, ensuring that the foreign DNA is recognised and 'expressed' (employed to make the desired protein) by the host organism's cells.

- Finally, a **marker gene** is included, so that genetic engineers can tell if the foreign DNA has been successfully introduced into the host's cells. This gene most commonly is resistant to antibiotics.

To actually introduce this package into the targeted agricultural plant, two methods are commonly used:

1. A **vector** is used to force the gene into the desired organism. Vectors are most commonly viruses, or bits of short segments of bacterial DNA called plasmids, because they function by breaking down the defenses in the host cells, and slipping into the cell's DNA.

or

2. A **gene gun** is used. The gene construct is placed on large numbers of tiny gold (or tungsten) bullets and fired into a plate of target plant cells

To make sure that the foreign gene has been taken up by the target organism, the cells are flushed with **antibiotics**. The cells that are carrying the 'package' with the antibiotic resistance marker genes will survive. Those cells that do not have the package will not have resistance to the antibiotics, and will die. The surviving (transgenic) cells that are left will be cultured, and grown into mature plants.

The Current Status of Human Genetic Research

Genetic studies are currently trying to identify and map out the long strings of molecules which make up the entire genetic code, or "genome", of humans. Currently the federally-funded Human Genome Project (HGP) is attempting to sequence all the estimated 3 billion bases in humans to arrive at a prototype or "generic" sequence using mainly Northern European families. Of course, since every person's genetic makeup is different, what is really being mapped out is supposed to be an "average" genome.

Although the HGP is one major project sequencing genes, there are a host of researchers doing human genetic research. These projects may or may not be affiliated with the HGP. These research projects are conducted by corporations, universities, and governmental agencies, and they are sometimes conducted in cooperation with public health entities like the American Red Cross and others. Corporations are also trying to map out portions of the "average" genome, and obtain patents over the parts they map out.

While some people are studying the "average" or "standard" genome, others are studying variations within and between populations. An increasing number of projects now focus more directly on human variation and diversity by sequencing the DNA of select, and supposedly more genetically "pure" or "distinct," indigenous populations. Detecting genetic variation among indigenous populations becomes easier if there is a "generic" sequence for comparison. As the HGP completes the "map" of the "average" human genome, there will be increased interest in sampling indigenous populations in order to study human diversity.

Variations in genes contribute to differences between people. It is believed that identifying differences in genetic sequences between people may help determine what makes people different from one another, or what makes groups of people different from other groups. Of course many other different factors also contribute to differences, such as culture, language, environment, and lived experience. Genetics ignores these other factors.

Some people believe that if scientists can identify a variation, or difference, in genes that equates to a significant difference in people (such as a different gene sequence that apparently causes immunity to a disease), the discovery may have value—human and economic. This perceived value in the variation creates an incentive to study people whom it is believed have a large amount of variation in their genetic makeup. The result is a new "gold rush" where universities, governments, corporations, and private researchers are all seeking to identify human genetic variation.

The actual focus of genetic studies varies widely. Some geneticists study traits we inherit from our parents, some study similar traits within a population and differences between populations, some are looking at genetics from a historical perspective to study the history of populations and their relationships with others, while others are looking at current health-related questions. Among scientists interested in genetic engineering, some are seeking to make changes in the genes of unborn fetuses, others are attempting to cause genetic changes in an individual, others are attempting changes to the reproductive cells (which affects future generations of the human species), and still others are experimenting with cloning techniques.

The Current Status of Agricultural Genetics

Traditionally, farmers have diversified plant and animal breeds with selective breeding by crossing different varieties from the same species to achieve desired characteristics such as taller plants or sweeter fruits. Nowadays, however, the genetic engineering industry is using approaches that depart radically from traditional agricultural breeding practices.

In agriculture, the most common genetic engineering techniques are transgenics and cloning. Transgenics involves the deliberate breaking down of nature's borders, by crossing species that would normally not interbreed. Transgenics works on the assumption that certain genes associated with the performance of certain tasks can be successfully transferred into other life forms, where they will continue to perform the same function. Genetic engineers identify genes that they *believe* perform a particular function and then introduce them into the agricultural plant or animal in the hope that these genes will continue to work in the same way in this totally new environment. Examples of transgenic crop and animal experiments that have been attempted include introducing fish genes into tomatoes, petunia flower genes into soybeans, bacteria genes into corn, cow growth hormones into chickens, and human genes into tobacco, kiwifruit, mice, and sheep. Cloning techniques, based on the experiments that produced the cloned sheep Dolly – will be used increasingly to mass produce livestock. It is estimated that within 15 years, 85% of livestock in Great Britain will be cloned.

Every living species has suddenly become a reservoir of potentially useful genes, or the possible host for the cultivation of interesting genes or substances that can be later extracted.

Genetic engineering is being increasingly promoted in agriculture because of the backing of large seed, agrochemical, and livestock companies that are investing billions into the new technologies. Food pro-

"A cow is nothing but cells on hooves"

Thomas Wagner, animal genetic engineer. Fortune Magazine October 1987

cessing companies are also encouraging this development, because they see that the new technologies can be used to create raw materials better suited to their manufacturing processes.

Largely, genetic engineering is being developed to be able to maintain industrial agricultural practices such as the use of intensive agrochemical and large-scale monocultural (one crop) plantations. So plants and animals are engineered to cope better with the chemical and biological stresses that intensive farming places on them and their environment. According to the companies, the most common aims of genetic engineering techniques are:

- to make plants resistant to agrochemical inputs such as herbicides
- to make plants resistant to pests
- to make plants that can withstand drought conditions
- to make plants and animals "resistant" to diseases and viruses

This genetic research has to be constantly updated because weeds, pests, bacteria and viruses will continue to develop resistance to the conditions designed to control them.

In addition, genetic engineering in agriculture is being used to push plants and animals beyond their natural limits by

- increasing the productivity of each individual animal (more meat, more milk, more wool, for example)
- creating plants that produce raw materials better suited to the processing industry (e.g., trees better suited to the needs of paper and pulp companies)
- creating plants and animals that produce pharmaceuticals or "human" substances

In the last decade, genetic engineering in agriculture has boomed. The fascination of the Western scientific community with the technologies and the promises by the genetic engineering companies of better agriculture have encouraged billions in investment and an extremely cooperative attitude by governments worldwide. Hundreds of thousands of genetically engineered organisms have been released into the environment for field trials. Every living species has suddenly become a reservoir of potentially useful genes, or the possible host for the cultivation of interesting genes or substances that can be later extracted.

Meanwhile, commercial cultivation is growing rapidly, due largely to the global reach of the large multinational companies, which have been able to introduce their products almost simultaneously around the world. In 1999, 100 million acres of genetically engineered crops were cultivated commercially worldwide - a 44% increase from 1998. Over 50% of the US soybean crop and 62% of the Canadian canola harvest in 1999 were genetically engineered.

Some Implications of Genetic Research for Indigenous Peoples

Genetic research in general raises a complex range of legal, ethical, social, spiritual, and political issues which concern indigenous peoples, and society at large. Indigenous peoples, and our territories, are at the forefront of genetic research worldwide. We are immersed in genetic diversity—both in human and environmental (biodiversity) terms. Lands that remain in the control of people indigenous to the area contain the majority of the biodiversity that remains in the world. Our traditional knowledge about our surroundings, as well as many of the members of our own ecosystems, is seen as the "new gold" in a rush to gain commercial benefit from nature. Since indigenous populations represent a significant percentage of the world's human diversity, we are the subjects of scientific curiosity. Indigenous knowledge systems and biological resources are therefore extremely threatened by appropriation.

Indigenous people and nations must prepare themselves to critically evaluate proposals for research involving their people and their territories. Policies which recognize and protect the collective rights of indigenous peoples are lacking. We must accept the responsibility to put into place policies that protect our interests, and we must come to understand the issues so that we can make fully informed decisions.

The following sections will highlight some of the areas of potential concern regarding genetic research and indigenous peoples.

Genetic Research Ethics Fail to Address Concerns of Indigenous Peoples

Initially, indigenous peoples were primarily concerned with the Human Genome Diversity Project (HGDP), a worldwide research project initiated in 1992. Today, human genetic diversity research seems to be an aspect of every major genetic research agenda, including the Human Genome Project. Indigenous peoples are the subjects of evolutionary genetic research, genetic research to study differences in how populations react to various pharmaceutical products (pharmacogenetics), and in single nucleotide polymorphism (SNPs) research, to name a few.

Despite these efforts, indigenous peoples are largely unaware of the scale and potential impacts of human genetic research on their communities. The typical human genetic research paradigm treats indigenous peoples as objects of curiosity, rather than partners in research. The research is designed, funded, and implemented without true and meaningful consultation of the studied group.

It has become evident that this new area of science and technology poses new challenges with regard to existing ethical practices. Current bioethical protocols fail to address the unique conditions raised by population-based research, in particular with respect to processes for group decision-making and cultural world views. Genetic variation research is population-based research, but most ethical guidelines do not address group rights. In this context, one of the challenges of ethical research is to include respect for collective review and decision making, while also upholding the traditional model of individual rights. Indigenous communities are further disadvantaged in this paradigm by being dependent solely on the researcher for information explaining the benefits and risks of the research.

Basic standards in research involving human subjects require that the benefits of the research at least equal the risk. Most population-based genetic research cannot meet this requirement because indigenous peoples are not the intended beneficiaries of the research. As a result, researchers often offer other benefits unrelated to the genetic research such as some short-term medical attention, technology transfer, training opportunities for students, or promises of royalties for any commercial products developed.

Conditions of research designed to protect and benefit the subjects could be formalized in research agreements. But indigenous peoples must be able to monitor and enforce these agreements. But how does one monitor the world-wide exchange of genetic materials and data? What happens when agreements are violated? Who is responsible for the costs associated with enforcement and monitoring agreements? Is money compensation (the only available remedy) the appropriate form of restitution and remediation for broken agreements? These are questions indigenous peoples must take into consideration before entering into research agreements.

Bad Science

- Bad science is scientific research that harms people against their will.
- It imposes itself on the subjects; it operates against the notion of consent.
- It may be based on coerced consent, failing to reveal relevant information to secure consent.
- Research where the subjects do not stand to benefit.

Tribes can and must take control of any research activity that takes place within their territories and affects their people.

Conflict with Common Indigenous Principles and Ethics

Many indigenous peoples regard their bodies, hair, and blood as sacred elements, and consider scientific research on these materials a violation of their cultural and ethical mandates. Immortalization, cloning, or the introduction of genetic materials taken from a human being into another living being is also counter to many indigenous peoples cultural and ethical principles.
Indigenous peoples have frequently expressed criticism of Western science for failing to consider the inter-relatedness of holistic life systems, and for seeking to manipulate life forms using genetic technologies. Many indigenous people have grave concerns about the short and long-term impacts of introducing genetically-modified life forms into the environment.

Supplanting Worldviews

By focusing on reactions to changes in genetic materials in organisms (including humans), genetics takes a very mechanistic view of the world. Life forms are viewed as mere machines, in that the research tries to change one part of the "subject" organism in order to get different "output" in terms of, for example, disease resistance or food production. The view is that, with enough experimentation, eventually we will be able to design better "machines." This view is in conflict with a view that recognizes the interrelatedness and interdependence of all living things. Tampering with one aspect of creation necessarily has effects on all other aspects. Tampering with genetic materials in any life form, which developed over generations in response to years of environmental influence, creates a risk of throwing everything else out of balance as well. That life form had a place where it was specifically adapted to fit in. Tampering with the life form means changing the balance and interrelationships that influenced the development of the organism, which could have broad "ripple" effects.

Group View of Genetic Inheritance

Two basic tenets of Euro-american society are that all property should be alienable (for sale) and that all property should be owned by individuals. Current mainstream ethical protocols generally assume that individual consent is all that is necessary for a person to share something of theirs - such as genetic materials or knowledge about something. This is because the protocols, rooted in Euro-american thought, assume that the individual has the right to sell or give away anything that is their own. This thinking is in conflict with indigenous notions of group rights. For example, in many indigenous societies, people may not be free to sell their knowledge because either the knowledge cannot be sold according to the group's ethical principles, or because permission of a larger group is required first. Also, there may be responsibilities that go hand-in-hand with the holding of traditional knowledge, and that is not usually part of what the Western "purchaser" or researcher is concerned with at all—they just want the knowledge of how something works. Another example is that, if a person's genetic material is sought because they are a member of some indigenous nation, most indigenous people would think that the group ought to have a say in whether the individual's sample may be used as a representative of the nation. After all, it is because the individual is part of the nation that the individual's genetic material is sought at all, and all the members of the nation will be subject to the repercussions of any conclusions drawn from the research. Therefore, indigenous peoples have a notion of group "ownership" of some things that is in direct conflict with the Euro-american principles, and this means that in areas where we believe we have group rights, these rights are ignored by the mainstream ethical protocols.

Commercialization and Ownership of Life

Much of the current research in genetics is being driven by a strange twist in patent law. Patent laws grant a limited "intellectual property right" to someone who holds a patent. The property right usually lasts from 17 to 20 years. Patents are usually granted for new inventions, as a means of recognizing the inventor's innovation. Currently, the United States Patent Office is granting patents to people who claim to uncover genetic sequences. This means that once a valuable gene is located and isolated, it can be patented, and even mass-produced for commercial purposes.

Under the current law, patents are being granted for portions of all types of genes—human, animal, and plant. But many people are opposed to the idea of patenting genetic sequences, because genetic sequences are part of a life form—which nobody can claim to have invented. Patents were never intended to be granted for the "discovery" of life forms. They were intended to provide some benefit to inventors of things—like mousetraps or toasters. Under the current law, however, even your own genes can be patented, without you even knowing about it.

Often times indigenous peoples are not informed that their DNA can be commercialized through patents and used in the development of new products. The potential commercialization of unique human DNA seems to be a significant motivation behind many research projects. Three cases best exemplify the concern for patenting human genes. The U.S. Secretary of Commerce filed a patent claim on the cell line of 26-year Guaymi woman from Panama in 1993. A wave of international protest and action by the Guaymi General Congress led to the withdrawal of the patent claim in late 1993. The Department of Commerce also filed patent claims on the cell lines of an indigenous person from the Solomon Islands. This patent claim was also later abandoned. The U.S. Patent and Trademarks Office (PTO) actually approved patents on the cells lines of a Hagahai man from Papua New Guinea. The patents were granted to the U.S. Department of Health and Human Services and the National Institutes of Health (NIH) in March, 1994. Again the patent holders faced public outcry, and in late 1996 the NIH abandoned the patent. However, the Hagahai cell line is now available to the public at the American Type Culture Collection as ATCC Number: CRL-10528 Organism: Homo Sapiens (human) for $216 per sample.

At the present time, the US Patents and Trademark Office maintains a policy of granting patents for human genes, and the genetic materials of other life forms. The USPTO is the prevailing model for the protection of intellectual and property rights worldwide, and is currently advocated in international agreements such as the World Trade Organization. Patents on life forms are likely to be a problem for the foreseeable future, unless and until citizens groups and other public advocates are successful in securing legislation that prohibits patents on life.

Gene Banking and Immortalized DNA

Genetic samples are frequently "immortalized" for future study utilizing a technique of cell transformation which keeps cells viable for several years. Through immortalization, a single sample is all scientists need to generate unlimited amounts of DNA for future research.

The immortalized cell lines can be stored in various gene banks around the world. Control and monitoring of samples is a critical issue, and it is very difficult to prevent abuses such as samples being used beyond the original intent. It is almost impossible to tell who is using them and for what purpose.

Additionally, DNA can be extracted from tissues and blood. Once the DNA is extracted, it is frozen and is stored for years. Again, these samples can be transported to several different labs without the consent of the donor and used for studies beyond their original intent.

Sanctity of Our Ancestors

Collections of biological materials are taken not just from the living, but also from the deceased. For most indigenous peoples this represents a serious violation of the sanctity of our deceased ancestors. In a recent highly-publicized example, the Department of the Interior has approved a plan for taking 10-20 samples from the remains of the Ancient One found at Kennewick, Washington, in order to determine which part of the remains will be the best place to obtain further samples for DNA analysis. These studies are being conducted despite protests from area indigenous peoples.

Euro-centric Scientific Theory and Discrimination

Expressing a sense of urgency, the Human Genome Diversity Project (HGDP) proposes to collect the DNA samples of indigenous peoples and store the collections in gene banks in order to "avoid the irreversible loss of precious genetic information." Referring to indigenous populations as "isolates of historic interest (IHI's)" the HGDP plans to immortalize the DNA of disappearing populations for future study. The initial conceptualization of the HGDP has been widely criticized for its consideration of indigenous peoples as mere research subjects, with little regard for the continued livelihood of the targeted populations. The HGDP has also been sharply criticized for failing to consult with indigenous peoples throughout its planning processes.

Scientists expect to reconstruct the history of the world's populations by studying genetic variation to determine patterns of human migration. In North America, this research is focused on validation of the Bering Strait theory. It is possible these new "scientific findings" concerning our origins can be used to challenge aboriginal rights to territory, resources, and self-determination. Indeed, many governments have sanctioned the use of genomic archetypes to help resolve land conflicts and ancestral ownership claims among Tibetans and Chinese, Azeris and Armenians, and Serbs and Croats, as well as those in Poland, Russia, and the Ukraine who claim German citizenship on the grounds that they are ethnic Germans. The secular law in many nations including the United States has long recognized genetic archetypal matching as a legitimate technique for establishing individual identity.

Genetic Discrimination

The ability to screen a person's genetic material could lead to genetic discrimination. Corporations, for example, may someday demand genetic testing and refuse to hire individuals who carry certain genes. Insurance companies may raise the premiums, or refuse to cover individuals who have been "genetically identified" as having a predisposition for some disease. Already some genetic studies have sought to reinforce social stereotypes and stigmatization in ways such as searching for "the binge drinking gene." Whether the intentions behind the design of such research projects are innocent or not, it remains clear that indigenous peoples must face the real possibility of discrimination and stigmatization in this area as in many other areas of life.

Eugenics and Genocidal Practices

Eugenics is an attempt to "improve" the genetic composition of individuals or entire peoples. Genocide is an attempt to eliminate whole peoples from existence. Many people are concerned that genetics may entail forced sterilization or abortion of those found to possess "undesirable" genetic sequences. Some geneticists already talk of attempting genetic manipulation on fetuses, in order to "fix" potential genetic problems found in them.

Upon learning about the basics of genetics, some people fear the specter of genetically specific warfare—weapons designed only to impact individuals with certain genetic traits. Until now, biological warfare has been "sloppy"—along the lines of just introducing a virus in an area where it infects a lot of people. Genetically-based biowarfare would target individuals within a population with specific genetic traits, and not affect other people directly. There are three basic requirements for genetic biowarfare to be possible: (1) a good understanding of the basic, average human genome (the same goal as that of the HGP); (2) identification of how different populations differ in their genetic material (the same goal of SNPs (single nucleotide polymorphism) research and human genetic diversity research currently being conducted); and (3) research discovering how to take advantage of the differences among populations in order to "target" weapons based on genetic differences. While we are not there yet, all of the human genetic research currently being conducted takes us closer to the possibility of genetically-based biowarfare.

Funding Priorities and "Techno-Fixes"

Currently, millions of dollars in the federal budget are being spent to support genetic research. You might question whether this is an appropriate use of federal funds. For example, many public health advocates would like to see federal money currently spent to discover genes associated with diabetes redirected to more practical solutions, like education and other strategies to encourage exercise and dietary changes, as well as providing nourishing foods to people who can't afford to buy food at market prices.

Serious questions should be directed at policies whereby vast resources are spent in the search for genetic causes of diseases, and these expenditures are followed by more expenditures, this time for research into how to "fix" people who have "flawed" genetic material (assuming this can even be done!). Public health advocates make a good argument that even to view the problem as a "flaw" in genetic makeup is wrong, and to view the solution as a technological one is wasteful. In many cases, preventative measures would help people deal with their problems in a quicker, more effective, and less costly way. But those interested in conducting genetic research—researchers and bioscience corporations—are not likely to point out that there are more effective uses of public money than finding "techno-fixes." It is up to us to say so if we don't want our tax money spent to support genetic research.

Some Problems with Genetics in Agriculture

Colonizing and Owning Life

Intensive agriculture, mineral exploitation, and industrial production have led to massive and rapid genetic erosion and loss of agricultural biodiversity. The United Nations Food and Agriculture Organization estimates that 75% of agricultural species have been lost over the last hundred years, largely as a result of industrial farming practices. Genetic engineering is being developed and mass-marketed by transnational agribusiness. Where the trend is to develop broad international markets for a single product, genetic uniformity through large, monocultural (single crop) rural landscapes is likely to continue.

Where these trends threaten indigenous peoples and small-scale farmers is that genetic engineering companies are now increasingly interested in reaching out to the small farmers and rural peasant communities, in the hope of replacing diverse agricultural crops with their genetically engineered seeds. The seed companies are moving into centers of diversity and origin: Monsanto potatoes are being introduced into the Andes, origin of the potato. Genetically engineered corn is being introduced to Mexico, where thousands of years ago, the Mayan people domesticated and diversified maize.

Many indigenous peoples are concerned about the theft of plant and animal species by the genetic engineering companies. Since 90% of the diversity of life forms is in developing countries, largely under the protection of indigenous and peasant rural communities, plant genetics companies have been prospecting in these territories. They are interested in the plant and animal species, and in the indigenous knowledge of the properties of these species for food and medicinal purposes. In many cases, the companies are taking species without the knowledge or consent of the local indigenous people, and then illegitimately claiming legally–enforceable ownership over these plants and animals. They are applying for and receiving patents on plants and animals. The patents define the company as the inventor and exclusive owner of the living being. As a result of patenting life forms, all genetically engineered seed that is being tested and planted in the fields, and all genetically engineered foods in shops, restaurants, and supermarkets is under the patent control of the genetic engineering companies.

In addition to the idea of owning life, many people object to patenting plants because the patents give seed companies monopolies over plants. Farming organizations in particular are concerned about this development, in light of the rapid consolidation of the seed and agrochemical industries that has taken place in the last few years.

Introducing New Species

The introduction of any new species will impact the existing life in that territory.

The new species may compete with indigenous or other species for water, food, or sunlight, or it may change the nature of the food chain (such as the nutrients in the soils), threatening the survival of species that depend upon the relative stability in the ecosystem. In the last decade, a number of ecological risks have been discovered after genetically engineered organisms were released into the environment. These risks have become the subject of intense debate among the seed companies, academic and corporate scientists, and concerned public interest groups.

The main concern is that genetically engineered plants are exchanging their genetic material with other species, and creating new species and new ecological problems affecting the web of life well beyond the human food web. In many cases, the risks are not being discovered until after the release and mass commercialization of genetically engineered organisms. The risks are therefore not potential but actual, because genetically engineered organisms have already been introduced into thousands of places around the world.

This genetic contamination is a particular threat to indigenous peoples and their territories, which have become havens of biodiversity in the world.

Herbicide and Pesticide Resistance

The most widely commercialized genetically engineered crops so far are **herbicide resistant** and **pest-resistant** plants. In 1999, 71% of genetically engineered crops planted worldwide were herbicide resistant, while 22% were pest-resistant.

Herbicide resistant crops are engineered to survive application of herbicides. In most cases, companies are making plants resistant to their own herbicides, and require farmers to use only the company's herbicide with the plant. While companies such as Monsanto and AgrEvo claim that farmers need to apply herbicides less frequently, and use less herbicide overall, there is evidence that points to the contrary. Meanwhile, companies are increasing their herbicide production capacity to meet the growing demand.

Pest-resistant plants are engineered to produce toxins that will kill pests. The most common insect resistance has been developed using a soil bacterium called *bacillus thuringiensis* or **Bt.** Bt has been used as a spray for decades by organic farmers as a form of biological pest control. Whereas organic farmers spray the Bt pesticide periodically, the Bt-plant produces the toxin constantly. Bt plants approved for consumption include cotton, corn and potato.

How genetically modified organisms can become 'pollution'

- **Carried by the wind, by riverways or animal-born,** the pollen or seeds of genetically modified plants and trees is transported across distances, cross fertilizing, cross-pollinating or germinating as life forms tend to do.

- **Streams, rivers, lakes, oceans: genetically engineered fish** may escape from their captive breeding places and into the wilds. It is currently estimated that even a few genetically engineered fish could replace an entire population of wild fish, due to natural spreading of their introduced traits.

- **Genetically modified crops** that have been approved by the federal agencies enter into a wide range of processed foods. Living food entities like potatoes can reseed, if composted before use, while foods such as tomatoes, corn kernels and cereal grains that are still viable seeds can pass intact through digestive systems and then out again into the earth.

- **New bacteria and viruses** that result from the processes of genetic engineering, and from the new life forms that they create may enter into diverse ecosystems with the force of epidemics.

- **Animal feed** that is bought to supplement diets of domestic livestock could contain genetically engineered ingredients.

- **Wild honeybees, butterflies and other insects** may take pollen from genetically engineered crops, those that are directly cultivated or those that have escaped from the fields.

- **Wild animals that are hunted for food** may have consumed genetically engineered crops from cultivated fields. Birds, for example, may have eaten seed from cultivated genetically engineered crops or escaped genetically modified plants.

- **Birds of prey** that eat small wild animals that have fed on genetically modified crops will also be vulnerable to the unknown effects.

- Genetically engineered crops cultivated in or near regions where there are **domesticated and wild related varieties** (i.e., that are **centers of origin or centers of diversity** for that crop) are likely to exchange their genetic material, including the genetically engineered traits, and thus become part of the wider environment.

Superweeds and Superpests: Related varieties of plants commonly interbreed naturally. This is called "outcrossing". There is evidence that points to the transfer of herbicide and pest-resistance from genetically engineered varieties to agricultural or wild relatives. This is most likely to happen in centers of origin or diversity of plants, where there are a wide variety of relatives in farming and the wild. Mexico, for example, is the center of diversity and origin of corn, while the Andes are the center of origin and diversity of potatoes. When the genetically engineered traits are passed on to wild relatives, new varieties are created that may have a fitness advantage over the indigenous plants and threaten their survival. In the case of herbicide resistance and pest-resistance, there are two broad areas of concern: *superweeds and superbugs.*

- Wild and weedy relatives that receive the capacity for herbicide resistance may create superweeds that survive herbicides farmers usually apply, forcing them to buy additional and possibly more intensive weed-killers that are more harmful to farmers, their families and the environment.

- Pest populations are known to develop resistance to pesticides. This process is accelerated with plants genetically engineered to produce pest-toxins on a constant basis, since pests are under increased pressure to develop resistance for their own survival. The U.S. Environmental Protection Agency estimates that insects could develop full resistance to the widely cultivated Bt-crops (crops engineered to produce a pesticide) within 3-5 years.

In addition, crops engineered to produce toxins to kill insects that usually harm the harvest of that plant are also killing non-target insects that do not harm the harvest, but help farmers. The Scottish Crop Institute found that pest-resistant potatoes were not only killing the targeted aphids (potato pests), but insects further up the food chain. Ladybugs – insects that help farmers by feeding on aphids – were affected when they ate aphids that had eaten the pest-resistant potatoes. The ladybugs' life span was halved and they laid fewer eggs than ladybugs that fed on a normal diet. Meanwhile, Cornell University researchers found that Monarch butterfly caterpillars suffered high mortality rates when pollen from the insect-resistant corn blew onto milkweed – the food of the Monarch and a common border neighbor of corn.

Bad for Farmers and Farming Communities

Genetic engineering is jeopardizing farmers livelihoods in a number of ways:

- Currently, insurance companies are not insuring farmers for loss of markets and market premiums due to contamination of their conventional or organically grown produce by neighboring genetically engineered crops.

- At the same time, the seed companies are actively fighting legislation that will make them liable for environmental or health damages resulting from their products. In this vacuum of responsibility, farmers are among the first victims.

- Farmers are being prosecuted for theft and illegal use of patented seed when they may have been innocent victims of outcrossing of genetically engineered crops onto their farm.

- Export markets are lost through the market advantages that patents on plants provide to seed companies. For example, basmati rice, a highly prized rice variety developed and cultivated for centuries by Indian and Pakistani farmers, was pirated and patented by Ricetec, a Texas-based company. Under Ricetec's patent rights, Indian and Pakistani farmers can no longer export their basmati rice to the U.S., where the Ricetec patent applies.

"Terminator" and "Traitor" Seeds

Small-scale farmers who rely upon seed-saving and informal seed exchange number about 1.4 billion across the world. Interested in their business but concerned by their seed-saving practices, several companies have developed seed sterilization techniques that put chemical or biological locks on seeds. These techniques destroy the ability of the plants to produce their own viable seeds. In this way, the seed companies seek to ensure that farmers have to return to the seed market each planting season. It is feared that outcrossing, through processes such as cross-pollination, could spread genetically engineered seed sterility into other species. Appropriately labeled "Terminator" technologies, they have been widely opposed and are the subject of bans in India, and in states such as Maryland. In spite of sustained condemnation, the U.S. Department of Agriculture and Delta and Pine Land Co. continue to develop them.

A related, but younger, plant technology is "Traitor" technology. This technology involves using an external chemical to "turn on or off" genetic traits in plants. As an example, companies may try to "turn off" a plant's natural defense mechanisms, and thus make use of pesticides necessary to successfully grow the plant. The most obvious implication of this technology is an increased dependence on chemicals for agriculture. Other frightening implications also loom—like the possibility for applications in biowarfare. The Terminator and some Traitor traits are carried in the pollen of the plants containing them, so the possibility of outcrossing into nonintended species is a real danger.

Health

We are exposed to risks when genetically modified organisms are released and

Plants genetically engineered today

Alfalfa
Apple
Asparagus
Barley
Beet
Belladonna
Bermudagrass
Carrot
Chicory
Chrysanthemum
Coffee
Corn
Cotton
Cranberry
Creeping bentgrass
Cucumber
Eggplant
Grape
Grapefruit
Kentucky bluegrass
Lettuce
Melon
Oat
Onion
Papaya
Pea
Pear
Peanut
Pelargonium
Pepper
Petunia
Persimmon
Perennial rye grass
Pine
Pineapple
Plum
Poplar
Potato
Rapeseed
Rice
Soybean
Spruce
Squash
Strawberry
Sugarcane
Sunflower
Sweetgum
Sweet Potato
Tobacco
Tomato
Walnut
Wheat

interact with the living world and the web of life. Following are some ways in which human health is threatened by genetic engineering.

Scientists critical of the speed and lack of adequate regulation around genetic engineering are concerned about the possibility of new viruses and diseases that could result from transgenics. In particular, the widespread use of viruses and bacteria is a cause for concern, because of the ability of viral and bacterial strains to exchange and absorb new genetic material.

"Xenotransplantation", for example, is a technology in which animals, such as pigs, are bred as organ-donors for human patients. Xenotransplantation involves, for example, the introduction of human genes to the pig to reduce the likelihood of a pig organ being rejected when transplanted into a human patient. There is great concern among critics of this technology that it will expose humans to new viruses that, until now, have affected animals alone. This means that humans could be exposed to pig viruses that may not only affect the human patient, but may be passed on to countless other humans. So we need to compare the potentially huge risk to human populations with the supposed benefits: it is estimated that if it worked *perfectly*, xenotransplantation would increase life expectancy across the human population by only about 0.02%.

We are also exposed to risks when we eat genetically modified organisms.

We may be eating genetically engineered foods directly either as whole foods, such as corn, potatoes, tomatoes, and soybeans, or as ingredients in processed foods, such as vegetable oils and fats, corn or potato starch, and additives such as soy-based lecitin. Many of these foods are incorporated into thousands of processed foods. Soy, for example, is said to be used in over 60-70% of processed foods.

When we eat animal products such as meat and dairy products, we may also be exposed to genetically modified organisms. This is because a great deal of animal feed is made from crops now widely genetically engineered. It is estimated that around 90-95 per cent of soybean harvests and 60 per cent of traded corn are genetically engineered.

Some of the main concerns with eating genetically engineered foods include:

- **New toxins** resulting from the genetic engineering process and the presence of foreign genes and viruses. Traces of some toxins are enough to cause severe harm, yet are easily missed in tests, especially if they are only present at certain times (for example, weather conditions, stress). Genetic engineering is more likely to produce new toxins than traditional plant breeding, because it introduces genes that produce toxins that are new to the host plants. While acute toxicity is immediately noticeable, chronic toxicity may only take effect over time, through constant exposure—symptoms may not show up for years. Most genetically engineered foods currently on the market are staple foods eaten on a daily basis, so our exposure can be very high and constant.

- **Antibiotic resistance** genes (used to indicate whether the transfer of foreign genes has been successful) could integrate with beneficial bacteria in the human digestive system. These in turn could combine with pathogenic (dangerous) bacteria, to develop new virulent strains of harmful bacteria that are resistant to antibiotics. In this way, we would be faced with serious infections that we can not treat with traditional antibiotics. For this reason, countries such as Norway have banned the import or cultivation of all crops with antibiotic resistance genes.

- **Exposure to agrochemical and pesticidal toxins** is dramatically increased with the production of herbicide-resistant and pesticide producing food crops. Monsanto's widely commercialized herbicide-resistant soybeans were safety–approved on the basis of tests that did not apply herbicide to the soybeans. Yet there have been a number of studies linking exposure of farm workers to Monsanto's RoundUp herbicide with illness and cancers. For example, one of the most rapidly increasing strains of cancer in the Western world – non-Hodgkins lymphoma – is linked with exposure to the active ingredient of RoundUp – glyphosate, as well as another common herbicide, MCPA.

Genetically engineered foods approved for consumption in the U.S.

Canola
Chicory
Corn
Cotton
Flax
Papaya
Potato
Soybean
Squash
Sugarbeet
Tomato

In the case of the Bt pest-resistant crops, there are no clear, independent studies on the effects of eating foods with the pesticide in them. The bacterium in isolation, not the Bt-bacterium produced *in the* plant, has been safety tested, without confirmation that the two forms of Bt are the same.

Technical Solutions Cannot Fix Policy Problems

Genetic engineering in agriculture is receiving huge financial support from governments around the world because of its attractive promise of solutions to agronomic, farming, and food security problems. This represents an important decision-making issue for communities on how problems are to be addressed, and who will provide the solutions.

Currently, there is a tendency among governments and the seed companies to present genetic engineering as a miraculous solution for problems that cannot be solved by laboratory techniques. Seed cannot be genetically engineered to restore fairness to markets that currently squeeze out small farmers with low commodity prices, nor can it be engineered to deal with distribution inequities that contribute to famine and malnutrition. Does it make sense to create, and even support, all the risks to health that genetic engineering creates, when there are other— proven and safer— methods for addressing hunger?

Moreover, the over-emphasis on genetic engineering is a problem because resources are being diverted into solutions that set up distant company headquarters as the problem-solvers, rather than the communities or groups that should be empowered to develop solutions for their own people. Rice is currently being genetically engineered to provide higher levels of vitamin A where malnutrition and starvation is high. Critics argue that this approach is a high-risk, techno-fix that is diverting millions of dollars towards a program that does not involve local communities in the process. Moreover, the project has focused on only one of the nutrient deficiencies in communities where famine exists—a lot more than vitamin A is lacking in starving peoples' diets. And it will take considerable money and efforts to educate the local people to grow and eat the rice, which is yellow rather than white. People critical of this scheme note that working with local communities to diversify farming to include the growing of leafy green vegetables would better address the wider nutritional problems facing areas of famine.

What Can Indigenous People Do?

Genetic research is a given. It will continue. The potential problems are also a given. We must address them. This does not mean that we must just come to terms with the problems, and be prepared for the worst case scenario. Rather, the challenge we face is to ensure that the research will be conducted under the utmost ethical standards and that genetic information will be used wisely. There are many things that people, including indigenous people, can do to this end. There are also many things that indigenous people specifically, because of our world view and because of our unique political situations, can and must do.

First and foremost, indigenous peoples must ***regulate any activity that potentially may result in the extraction of genetic resources from their people or their territories.*** This places a burden on indigenous peoples, probably heaviest on tribal leadership, to be informed about the issues and to be prepared to control and manage research activity within their jurisdictions. Since there are no special laws (only ethical guidelines not backed by legal control) to regulate the activities of scientific researchers in the field, tribes must exercise their own sovereign power to regulate these activities in order to protect themselves and their people. This can be done by enacting local laws (ordinances, tribal codes) which regulate every aspect of research within tribal jurisdictions to ensure that community interests are protected. A model tribal ordinance is available on the IPCB website at www.ipcb.org.

A critical aspect of successful tribal control of research is a commitment to ***train local community members who can take responsibility*** for review, oversight, and recommendations concerning research proposals to the governing authority. Tribes should not have to bear the financial burden of training and technical assistance alone, especially when the research is initiated by outside interests.

Tribal leaders can also ***demand that federal spending priorities be shifted away from genomic research in favor of funding programs and services that produce real outcomes and benefits for the community.*** For instance, instead of allocating federal funding for non-beneficial research such as the search for the "binge-drinking" gene, funding should be spent on proven strategies, such as treatment programs. Instead of diverting precious resources to a search for "the diabetes gene(s)," funding should be allocated to programs that provide direct benefits in improving diets, exercise, and lifestyles.

Tribal leadership can ***advocate at the federal level for improvements in policies regulating the framework in which funding decisions and research projects are carried out.*** For instance, genetic researchers and their funders frequently fail to consult with tribal governments, assuming instead that individual informed consent is all that is necessary to carry out their research in an ethical manner. When the research impacts the entire community, which is always the case if the research is "population" or "race-based" research, this is a real problem. Tribal leaders can and should demand ethical protocols that respect tribal rights to consultation and sovereign authority. Such protocols should be adopted, and enforced, by the federal agencies carrying out or providing the funds for research on tribal communities or their territories.

Education of tribal community members should be a priority for Indigenous people concerned about biocolonialism, because until community members are aware of the issues, they are vulnerable to abuses from unethical research practices. Community education can be accomplished by organizing forums and workshops on the topics of genetic research or biocolonialism. ***Anyone who has read this book already knows enough to start sharing their knowledge in a way that will help others.*** IPCB and other interested organizations can make available resource persons and educational materials to support such forums. Community radio programming is also an excellent outreach tool. The topic of biocolonialism should also become a regular topic of discussion on the agendas of on-going regional conferences, because it impacts so many important areas of Indigenous peoples lives, such as education, the environment, cultural resources, natural resources, and general sovereignty concerns.

In addition to regulating research, tribes can also develop and ***implement policies regulating or preventing the introduction of genetically altered organisms*** within tribal jurisdictions, including Indian-owned land and leased land. To augment this approach, tribes can also offer education about the issues of genetically engineered organisms to landowners and lessees in the area surrounding the tribal jurisdiction, in order to help prevent migration of genetic "pollution" onto tribal land.

Individuals concerned about the idea of allowing ***patents on life forms*** can take individual action by joining existing campaigns (like the No Patents on Life campaign headed by the Council for Responsible Genetics) and by encouraging local actions. Possible local actions include tribal declarations that tribal land and resources are patent-free zones, where no patents on life forms will be allowed. Another potential local action is for tribes themselves to take actions, on federal and international levels, declaring the entire tribe's opposition to the concept of patenting life forms.

Individuals concerned about ***genetically engineered foods*** can avoid highly processed and mass marketed foods, since these are more likely to contain genetically modified ingredients. Buying such foods encourages the marketing, and increases the profits of the corporations that promote genetically engineered foods. As an alternative, whenever possible people can buy locally produced foods, encourage local farming and seed-saving and exchange to promote diversity of local crops, and even promote revival of a more traditional diet.

Closing

We hope that this publication has helped you. We will consider it a success if you feel more informed, and if it leads to your making decisions based on information we have provided or that we have helped you find. We hope that we have provided enough material to allow those who are interested to begin to address biocolonialism in their own communities. We encourage you to talk about these issues. We will all be affected by how we as indigenous peoples decide to deal with the issues. Talking about them is the first step towards protecting ourselves and our relations from abuses, and towards ensuring that the wisdom of our ancestors is brought to bear on something that is sure to impact our future.

Recommended Reading

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Genetic Engineering, Food and Our Environment, Luke Anderson. Chelsea Green Publishing Company, Vermont, 1999, 1-890132-55-1

Magazines and Newsletters

GeneWatch. Council for Responsible Genetics magazine (to subscribe, contact address below)

RAFI Communique. Rural Advancement Foundation International briefings (to subscribe, contact address below)

Biotechnology and Development Monitor. University of Amsterdam. Free subscription available from: University of Amsterdam, Department of Political Science, Oudezijds Achtervorburgwal 237, 1012 DL Amsterdam. The Netherlands. Email: monitor@pscw.uva.nl. Or download issues from their website: www.pscw.uva.nl/monitor

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Techno-Eugenics. Supporting genetic science in the public interest. Opposing the new techno-eugenics. Email newsletter. Subscribe by sending email to Marcy Darnovsky, at teel@adax.com.

Excellent web resources on genetic engineering in agriculture

www.biotech-info.net.
Major focus on genetic engineering in agriculture with the most up-to-date and useful political, lay scientific and expert analysis.

www.sustain.org/biotech
Large database with wide range of information sources on genetic engineering in agriculture, intellectual property and biopiracy issues.

Organizations

There are numerous organizations working on issues related to genetic engineering and biocolonialism. Here we list only a few of those organizations that currently have the capacity to provide quality resource materials and advocacy support for the public.

Council for Responsible Genetics
5 Upland Road, Suite 3, Cambridge, MA 02140
Tel: (617) 868-0870. E-mail: crg@gene-watch.org
Website: www.gene-watch.org (use Internet explorer)

Genetic Resources Action International (GRAIN)
Girona 25, pral., E-08010 Barcelona, Spain.
Tel: (34-93) 301 13 81. Email: grain@bcn.servicom.es.
Website: www.grain.org

Indigenous Peoples Council on Biocolonialism
P.O. Box 818, Wadsworth, Nevada, U.S.A. 89442
Tel: (775) 574-0248. Website: www.ipcb.org

International Center for Technology Assessment (ICTA)
666 Pennsylvania Ave. SE, Suite 302, Washington, DC 20003
Tel: (202)547-9359. E-mail: info@icta.org
Website: www.icta.org

Institute for Agriculture and Trade Policy (IATP)
2105 First Avenue South, Minneapolis, MN 55404
Tel: (612) 870-3410. E-mail: iatp@iatp.org
Website: www.iatp.org

Pesticide Action Network North America (PANNA)
49 Powell St. Suite 500, San Francisco California 94102
Tel: (415) 981-6205. E-mail: panna@panna.org
Website: www.panna.org

Rural Advancement Foundation International (RAFI)
110 Osborne St., Suite 202, Winnipeg MB R3L 1Y5, Canada
Tel: (204) 453-5259. E-mail: rafi@rafi.org
Website: www.rafi.org

Third World Network
228 Macalister Road, 10400 Penang, Malaysia
Fax: 604-2264 505. E-mail: twn@igc.apc.org
Website: www.twnside.org.sg

Union of Concerned Scientists (National Headquarters)
2 Brattle Square, Cambridge, MA 02238-9105
Tel: 617-547-5552. E-mail: ucs@ucsusa.org
Website: www.ucsusa.org

Via Campesina
Apdo Postal 3628 Tegucigalpa, MDC Honduras, C.A
Tel: 504 20 1218. E. mail : viacam@gbtm.hn or via@sdnhon.org.hn
Website: www.sdnhon.org.hn/miembros/via/

Glossary

alleles Alternative of a gene for a particular characteristic.

amino acids The building blocks of protein.

autosomes Chromosomes other than the X and Y. Chromosomes which are not involved in determining the sex of an individual.

bases of nucleic acids Organic bases found universally in DNA and RNA.

base pair A pair of hydrogen-bonded nitrogenous bases that join the component strands of the DNA double helix. Adenine pairs with thymine, guanine pairs with cytosine.

biology The science that deals with the study of life.

cell The basic structural unit that makes up all living organisms.

cell membrane The outer boundary of a cell also known as the plasma membrane.

chromatin Areas or structures within a nucleus of a cell composed of DNA and proteins.

chromosome Histone protein and DNA structure found inside the nucleus of a cell that contain the cell's genetic information.

clone An identical copy of an individual or a gene, or the totality of all the identical copies made from an individual or a gene. In genetics, the clone is identical in genetic make-up to the original.

cloning The practice of artificially producing two or more genetically identical organisms from the cells of another organism.

cytoplasm The more fluid portion of protoplasm inside cells.

deoxyribonucleic acid (DNA) A polymer of nucleotides that serves as genetic information. When combined with histone protein and tightly coiled, it is known as a chromosome.

diploid A cell that has two sets of chromosomes; one set from the father and one from the mother.

double helix The Watson-Crick model of DNA structure.

eugenics The effort to improve human beings by changing their hereditary characteristics, especially by means of selective reproduction.

gamete A sex cell; a sperm or egg which contains half the genetic information of the parent.

gene A unit of inheritance that, in the classic sense, occupies a specific site (locus) within the chromosome.

genetic determinism The theory that human character and behavior are determined by the genes that comprise the individual's genotype rather than shaped by culture, social environment, and individual choice.

genetic diversity Genotypic differences among individuals and among population groups.

genetic engineering The manipulation of genetic material in the laboratory. It includes isolating, copying, and multiplying genes, recombining genes or DNA from different species to another, bypassing reproductive processes.

genetic intervention General term for the modification of inheritable characteristics of individuals or populations through various social mechanisms and/or genetic technologies.

genetics The science of heredity. The study of genes, how genes produce characteristics and how the characteristics are inherited.

genome The total genetic makeup of an individual or organism. A set of all the genes of an organism.

germ cells Sperm or ova; in relation to species, the cells of the germ-line (unlike somatic cells) bridge the gap between generations.

germ-line gene therapy Genetic manipulation that changes the germ cells of an organism, as well as of her or his biological descendants.

haploid A single set of chromosomes. Sperm and egg contain a haploid set of chromosomes.

heredity The familial phenomenon where biological traits are passed from parent to offspring.

Human Genome Organization (HUGO) The international organization of scientists involved in the Human Genome Project (HGP), the global initiative to map and sequence the human genome.

Human Genome Project (HGP) A 15-year, 3 billion dollar project conducted under the auspices of the National Institutes of Healthand Department of Energy to map and sequence all the DNA of a human prototype.

Human Genome Diversity Project (HGDP) A project designed to study human diversity that will involve a worldwide collection of genetic material from select indigenous people.

karyotype The chromosomal complement of a cell, individual or species often shown as a picture of chromosomes arranged in order from largest to smallest.

locus The spot or position on a chromosome where an allele is located.

mitochondria Organized structures in the cell's cytoplasm involved in the process by which cells transform food stuffs to generate energy. Mitochondria contain their own complement of DNA which is distinct from the DNA from the chromosomes of the cell nucleus, or nuclear DNA.

mitochonrial DNA The DNA in the mitochondrial choromosomes.

nucleus The membrane-bounded structure found in a cell which contains the genetic material.

nuclear membrane The structure surrounding the nucleus that separates the nucleoplasm from the cytoplasm.

nucleoplasm The liquid matrix of the nucleus.

polymerase chain reaction (PCR) A laboratory procedure in which enzymes are used to copy a tiny amount of DNA over and over until the sample is sufficiently large for chemical analysis or experimentation.

polymorphism Different forms of the same trait or organism.

protein Macromolecules made up of amino acids.

protoplasm The living portion of a cell as opposed to the non-living cell wall.

reductionism The philosophical belief that phenomena or organisms are best understood by breaking them up into smaller parts. For instance, the belief that an organism is to be completely understood by its genes, a society in terms of its individuals, and so on.

stem cells Relatively undifferentiated cells that have the ability to give rise to more differentiated or specialized cells.

transgenic organism An organism created by genetic engineering in which one or more foreign genes from other species have been incorporated into its genome.

X chromosome Female mammals have two X chromosomesin their cells.

Y chromosome Male mammals have an X and a Y chromosome in their cells.

zygote The cell or entity resulting from the union of sperm and egg.

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