Inheritable characteristics are passed from one generation to the next through DNA, a molecule that is present in all of our cells. Scientists think of DNA as being divided into genes, or units of genetic information. In the past three decades, scientists have learned how to mix and match characteristics among unrelated creatures by moving genes from one creature to another. This is called "genetic engineering."

Cloning: Cloning uses the DNA of an existing individual to create a new individual. The best-known example is Dolly, a sheep that was cloned using DNA from a sheep that had been dead for six years. A human has not yet been cloned, but a team of researchers including an American and an Italian recently announced they are going to attempt it.[1]

Somatic cell manipulation: Somatic cells are all the cells of the body that do not pass DNA on to the next generation. Somatic cell manipulation is currently practiced in some medical research centers under the name "gene therapy." For example, researchers are experimenting with ways to introduce genes into the blood cells of patients with hemophilia (a blood disorder), and into cells of the immune system in patients with Severe Combined Immune Deficiency (SCID), a rare inherited disorder of the immune system. The idea is to "correct" the genetic component of the disease instead of, or in addition to, treating the disease with drugs. Hundreds of trials have been carried out, but in most cases the patients have not been cured.[2]

Germline manipulation: Germ cells (sperm and eggs) do pass DNA from one generation to the next. Germline manipulation refers to changes in the germ cells changes which will be inherited by successive generations. Designing future generations through germline manipulation is still in the realm of science fiction, but just barely: some influential scientists are arguing that it should be attempted.

Why are scientists pursuing these techniques? Some researchers see somatic cell manipulation as a promising way to treat serious diseases, such as cystic fibrosis. Other genetic engineers may have less idealistic motives. Engineering human cells is technically appealing, and the mere fact that we possess this technology is, for some people, sufficient reason to use it. Some technological optimists are fascinated by the idea of germline engineering as a way to "take evolution into our own hands" by redesigning the genetic information in our children's cells.

Engineering human cells could also be a big money-maker. For example, one company hopes to create a market in "organ repair" generating cloned cells and tissues to insert into existing people's organs.[3, pg. 18] Other companies and researchers simply want to keep open the option to engineer human cells because it could be profitable in the future, even if they have not made investments in doing it right now.[3]

Cloning

There are two main applications of cloning. One is "embryo cloning," which could be used to create new human parts. For example, some scientists are working on methods to produce a new embryo from an existing person's cells and then use the cells from that embryo to produce replacements for failing body parts in the original person.[4] An embryo develops about a week after conception, and in its early stages consists of a few identical cells.

"Reproductive cloning" would produce complete cloned individuals, like Dolly the sheep. Genetic engineers are now able to clone mice and cattle as well as sheep.[5, pg. 45] Human cloning would produce a new person who is a near genetic copy of another person. He or she would, however, be different from the original person because he or she would develop in a different environment and have different experiences.

Many people think both "reproductive cloning" and "embryo cloning" are repugnant and unethical. Other people think embryo cloning could be acceptable in some cases to treat disease but think reproductive cloning is wholly unnecessary and never justifiable.

In the U.S., federal funds cannot be used for reproductive cloning experiments and some states have outlawed it, but there is no federal law against it.[5, pg. 4] A team of researchers recently announced they are going to attempt human cloning in an "unidentified Mediterranean country."[1] These researchers have been widely condemned, but some of their colleagues are primarily concerned that this early attempt at cloning could give the technology a bad name and reduce the public's willingness to allow further cloning research.

Somatic cell manipulation

Somatic cell manipulation adds genes to existing cells in some part of the human body, such as the lungs or the blood. Somatic cell manipulation is only supposed to affect the DNA of the person undergoing the treatment. In theory, it does not produce changes that could be passed on to that person's children and grandchildren.

Somatic cell manipulation was first attempted on humans in 1990.[6, pg. 110] The mechanisms of somatic cell manipulation are poorly understood, and the effects can be lethal. In one case, a teenager died after researchers at the University of Pennsylvania tried to introduce genes into his liver cells, using a modified virus to carry the genes to their destination. The idea was that the virus would "infect" the target cells and insert the desired genes, without being dangerous itself. The researchers are still not certain how they killed their patient, but evidence suggests the virus invaded many organs besides the liver and triggered a severe immune reaction.[7]

According to the U.S. Food and Drug Administration (FDA), somatic cell manipulation also poses the threat of insertional mutagenesis, in which inserting new DNA changes or disrupts the functioning of existing DNA. (See REHN #716.) FDA also says researchers attempting to alter somatic cells could inadvertently introduce foreign genes into the patient's sperm or egg cells.[8, pg. 4689] If this happened, researchers could accidentally change the genetic information passed from parent to child.

Researchers are required to submit data to FDA and the National Institutes of Health (NIH) on any adverse effects that occur during somatic cell manipulation trials. After the teenager's death at the University of Pennsylvania, an investigation revealed that many researchers were not reporting adverse effects to NIH, which can make the information public. Some researchers say it would "confuse people" to report every death that occurs during these trials because many participants are seriously ill and could die for reasons unrelated to the treatment.[9]

Right now, most information that researchers submit to FDA on somatic cell manipulation experiments is kept secret.[8, pg. 4688] The agency has issued proposed regulations under which information about somatic cell manipulation trials will be made available to the public, and is accepting comments on the proposed regulations until April 18, 2001.[10]
Germline manipulation permanently changes the inheritable characteristics passed from one generation to the next. This can be done by altering sperm or egg cells or by altering an embryo. If an engineered embryo survives and develops into a baby, the changes introduced by germline manipulation will be present in every cell of that baby. If the baby survives to adulthood and has children, the changes will be passed on to future generations, through that person's sperm or egg cells.

Some researchers try to justify germline manipulation by saying it could remove or replace DNA associated with an inherited disease. This is a far-fetched idea and unnecessary; even if both members of a couple have the genes for a hereditary disease, there are other ways to produce a child without the disease, including using donated sperm or eggs. Other researchers say they want to use germline engineering to give a baby new genetic features it could not have gotten from its parents. This goal cannot be achieved through any technology. It is also a goal that, by definition, could never be medically necessary because it would not serve to relieve sickness in an existing person. Instead, it would aim to “improve” future generations of human beings.[6, pg. 113]

The attempt to “improve” the human race genetically – as one might create a specialized breed of horses or dogs -- is known as eugenics. In the early decades of the 20th century, eugenics projects in the U.S. led to forced sterilization of some people who were considered to have undesirable traits. This included prison inmates who were considered to be “hereditary criminals.” One forced sterilization was justified by describing a man as “subnormal mentally,” with “every appearance and indication of immorality.”[6, pgs. 20-21] In Nazi Germany, the systematic extermination of Jews and other people was one part of a eugenic project to breed a “superior race.”[6, pg. 17]

Some prominent scientists hope to achieve eugenic goals through genetic engineering instead of through breeding. Molecular biologist Daniel Koshland, formerly the editor of SCIENCE magazine, argues that “if a child destined to have a permanently low IQ could be cured by replacing a gene, would anyone really argue against that?” He continues, “It is a short step from that decision to improving a normal IQ. Is there an argument against making superior individuals?... As society gets more complex, perhaps it must select for individuals more capable of coping with its complex problems.”[4, pgs. 115-116]

To be continued.

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