

Genetic Engineering, Stem Cell Research, and Human Cloning

Chapter 13

Learning Objectives

- After reading this chapter, you will be able to:
 - 13.1 Explain the difference between positive and negative genetic engineering.
 - 13.2 Evaluate the ethical issues involved in stem cell research.
 - 13.3 Evaluate the ethical issues involved in human cloning.

Bio-ethical Issues

- Some of the topics of **bioethics** may seem too technical (or too far-fetched to be discussed in a contemporary moral issue course); I, myself, thought this might be the case. I believed it might be too technical or simply too far removed from our everyday experiences to be pertinent to the students in the course. Many of the topics seemed like an episode of X-files as opposed to actual everyday life to be relevant to students. In hindsight (with the benefit of some research), I see that nothing could have been further from the truth. A little empirical investigation determined that scientists were genetically modifying food; screening the DNA of humans before birth; cloning animals, and creating plant/animal hybrids

Types of Genetic Engineering

- Negative-Correct a genetic defect
- Positive-Make a life-form better. AKA, Eugenics- make improvements upon organism.

Types of Genetic Therapy

- Somatic Therapy
- Germ line Therapy

Somatic Therapy

- Somatic therapy is a type of genetic therapy that only affects the individual.
- Changes are not passed on to any subsequent generations or off spring.

Germ Line Therapy

- Germ line therapy is a type of genetic therapy that not only affects the individual but also the off spring.
 - Changes are passed on to subsequent generations.

Splicing

- Splicing is a method where genes from one organism are "spliced" into the DNA of another organism. This is the most common method of genetic engineering.

Philosophical Views

- Conservative
 - Michael Ruse
"Can we do better than God?"
- Liberal
 - Jonathan Glover
"Decisions: the Genetic Supermarket"

Michael Ruse

- Argues that we cannot get it better than God. His main point is that if we make everyone with superhuman powers and abilities the world will become a dramatically different and radically worse place.
- The awe of human creation and achievement will be lost, with everyone excelling at everything.

Jonathan Glover

- Argues that both positive and negative genetic engineering are morally permissible.
- He employs the philosophical argument of Robert Nozick, a libertarian.
- Most libertarians are against any government interference in the private affairs of citizens, but Nozick recognizes the inherent dangers in genetic engineering and suggest a system of government regulation at the "genetic supermarket".

Genetic Supermarket

- In the genetic supermarket parents would have a limited voice in opting for genetic engineering of both positive and negative features.
- The government would simply ensure that no dangerous modifications were made.

The Council for Responsible Genetics (CRG)

- Opposes the use of germ-line therapy in humans. Further any changes made to an organism at an embryonic stage have the potential to be passed on to future generations, like Germ line therapy.
- The goal of cleansing the gene pool of recessive genes and to improve the human organism would take thousands of years. Further, such benefits would only be realized by families and not by the population as a whole.

Dolly the Sheep

- In 1997 Scientist in Scotland cloned the first mammal- Dolly the sheep. Not everyone was pleased.
- In 2003 Dolly passed away from complications related to her cloning.

\$50,000 to Clone Your Cat!

- In 2002 scientist cloned the worlds first cat.
- In 2004 a woman paid \$ 50,000 to have her dead cat cloned.

Choose The Sex of Your Baby!

- In vitro Fertilization has been used for years to help couples have babies.
- PGD- Pre-implantation Genetic Diagnosis can be used to sort embryos before they are implanted.

Choose Your Trait

- Eyes
- Skin Color
- Hair
- Weight
- Height
- Sex

Splicing

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Spliced Pigs

- **Gene splicing improves pork farm waste**
- In the last few years, scientists at Ontario's University of Guelph have created Enviropigs™, a line of transgenic pigs containing both mouse and bacterial chromosomes; the pigs cost less to feed and produce less noxious manure.

USDA Organic

- The USDA now certifies all food that has an organic label to be tested.
 - What it means: Organic food is produced without using most conventional pesticides
 - Fertilizers made with synthetic ingredients or sewage sludge;
 - Bioengineering; (genetic Engineering.)
 - Ionizing radiation.
 - Which means conventional foods may have all of these.

To get the seal...

- Before a product can be labeled "organic," a Government-approved certifier inspects the farm where the food is grown to make sure the farmer is following all the rules necessary to meet USDA organic standards.

Organic Food Contaminated

- A variety of foods marked 'organic' or 'GM-free' sold in the United Kingdom have been found to contain genetically modified (GM) ingredients. Researchers found that out of 25 organic or health food products that should have been GM-free, 10 contained GM soy.

Mix and Match Crops

- The United States and Argentina, two of the largest soy producers in the world, produce mostly GM soy, and GM-free crops are often mixed with GM crops after harvesting. Further, seeds that are supposed to be GM-free can contain from 1 percent to 2 percent GM varieties. \ Over 60 percent of processed foods sold in supermarkets contain soy ingredients.
- Researchers suggest that it will become increasingly difficult to keep organic products GM-free and even say that the problem will be 10 times worse in just one year.

Two Types

- **Embryonic** - created by means of in vitro fertilization. They are harvested after 5-6 days from a cell known as a **blastocyst**. ***They do not come from aborted fetuses.*** They have the potential to change into any type of cell found in body.
- **Adult** - found in bone marrow. Harvested at any time in a adult person's life. Potential to become only a limited number of specialized cells.

Stem Cells

- **Embryonic Stem cells** the potential to develop into many different cell types in the body.
 - Theoretically divide without limit to replenish other cells as long as the person or animal is still alive.
 - Each new cell has the potential to either remain a stem cell or become another type of cell with a more specialized function, such as a muscle cell, a red blood cell, or a brain cell.

Two Important Traits

- Stem cells have two important characteristics that distinguish them from other types of cells.
 - They are unspecialized cells that renew themselves for long periods through cell division.
 - They can become cells with special functions such as the beating cells of the heart

For Over 20 Years

- Scientists discovered ways to obtain or derive stem cells from early mouse embryos more than 20 years ago.
- In 1998, they discovered how to isolate stem cells from human embryos and grow the cells in the laboratory.
 - These are called human embryonic stem cells

Embryonic Stem Cells (continued)

- Embryonic Stem Cells, are derived from embryos that develop from eggs that have been fertilized in vitro- in an in vitro fertilization clinic—and then donated for research purposes with informed consent of the donors.
- They are *not* derived from eggs fertilized in a woman's body.

Blastocyst

- The embryos from which human embryonic stem cells are derived are typically five or six days old and are a hollow microscopic ball of cells called the **blastocyst**.

Adult Stem Cell

- An undifferentiated cell found in a differentiated tissue that can renew itself and (with certain limitations) differentiate to yield all the specialized cell types of the tissue from which it originated.
- For example, an adult stem cell found in the liver could become any type of cell found in the organ.

In All Parts of Our Body

- Adult tissues, such as bone marrow, muscle, and brain, contain adult stem cells that can generate replacements for cells that are lost through normal wear and tear, injury, or disease.
- Recently a comatose patient regenerated neural tissue. This was documented in the by scientist.
- This could be a result of stem cells.

Adult Stem Cells (continued)

- The primary roles of adult stem cell in a living organism are to maintain and repair the tissue in which they are found.
- Some scientists now use the term somatic stem cell instead of adult stem cell.
- Unlike embryonic stem cells, which are defined by their origin (the inner cell mass of the blastocyst), the origin of adult stem cells in mature tissues is **unknown**.

History of Adult Stem Cells

- In the 1960s, researchers discovered that the bone marrow contains at least two kinds of stem cells.
 - Hematopoietic stem cells form all the types of blood cells in the body.
 - Bone marrow stromal cells were discovered a few years later. Stromal cells are a mixed cell population that generates bone, cartilage, fat, and fibrous connective tissue.

Adult Stem Cells in The Body

- Adult stem cells have been identified in many organs and tissues. There are a very small number of stem cells in each tissue.
- Stem cells are thought to reside in a specific area of each tissue where they may remain (non-dividing) for many years until they are activated by disease or tissue injury.
- The adult tissues reported to contain stem cells include brain, bone marrow, peripheral blood, blood vessels, skeletal muscle, skin and liver.

The Promise of Stem Cells

- Some of the most serious medical conditions, such as cancer and birth defects, are due to problems that occur somewhere in this process.
- A better understanding of normal cell development will allow us to understand and perhaps correct the errors that cause these medical conditions.

Embryonic Stem Cell Therapies

- Scientists have been able to do experiments with human embryonic stem cells (hESC) only since 1998, when a group led by Dr. James Thompson at the University of Wisconsin developed a technique to isolate and grow the cells.
- Federal funds to support hESC research have been available since only August 9, 2001, when Former President Bush announced his decision on Federal funding for hESC research.

Former President Bush on Stem Cells

- "Research on embryonic stem cells raises profound ethical questions, because extracting the stem cell destroys the embryo, and thus destroys its potential for life. Like a snowflake, each of these embryos is unique, with the unique genetic potential of an individual human being."

Federal Funding for Existing Cells

- "As a result of private research, more than 60 genetically diverse stem cell lines already exist. They were created from embryos that have already been destroyed, and they have the ability to regenerate themselves indefinitely, creating ongoing opportunities for research. I have concluded that we should allow federal funds to be used for research on these existing stem cell lines, where the life and death decision has already been made." – Former President Bush
- The ban on Stem Cell funding was lifted by President Obama in 2009.

Michael J. Fox's View

- "Stem cell research is a critical pathway to a cure... Stem cells can be used for cell replacement therapy, to actually produce neurons that have been lost."
- "You can't do research on living human neurons. But you can use stem cells to create them and study how they work and the impact of various drugs. It's huge."

Stanford University Scientist Irving Weissman:

- Warns that the country risks falling behind South Korea, China, Britain and Colombia and other countries in biomedical research if the Bush administration and Congress continue to restrict embryonic stem cell research for philosophical and religious reasons.

Historically, Regulation . .

- In the past, the United States regulated, but never banned, controversial research. In contrast, Russia did ban research and fell decades behind in the 1930s when it banned genetics research.

Stem Cells, Promise and failure

- Results of stem cell transplants in rats have been mixed.
- So research appeared to show it was successful
- Scientists at the University of Rochester Medical Centre in New York experimented with rats which had a condition mimicking Parkinson's disease.
- When treated with mature neurons which had been created from human embryonic stem cells, they recovered all their lost motor function.

Cell Replacement in Rats

- Ten weeks after the transplant, the rats' brains were examined. To the dismay of the researchers, only about one-fifth of the transplanted cells were now producing dopamine (the chemical lacking in patients with Parkinson's).
- The rest had begun dividing uncontrollably into benign brain tumors.

Cell Replacement in Rats (2)

- "First, the number of neurons producing dopamine fell sharply after one month, even though they had been "highly enriched" and differentiated cells.
- Second, "their persistent, uncontrolled and grossly homogeneous expansion over a 10-week span before the animals were killed nonetheless suggested graft-associated tumorigenesis".
- And it seemed clear, too, that the problem was not contamination by undifferentiated embryonic stem cells. The very cells which were supposed to cure caused the tumours.

Cell Replacement in Rats (3)

- The experiment provokes many questions, as the researchers do not know what would happen to the cells after 10 days. But they urge caution for therapeutic applications, "given the phenotypic instability and potential for undifferentiated donor cell expansion". - Nature Medicine Sydney Morning Herald.

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Why Clone?

- "Cloning will help us put an end to so many diseases, give infertile men the chance to have children. We can't miss this opportunity"
- ~Doctor Severino Antinori

Doctor Severino Antinori

- An Italian gynecologist who runs a fertility clinic in Rome has announced plans to clone the first human being.

Cloner and Baby Maker

- Italian embryologist Dr Severino Antinori is at the center of the heated debate on human cloning.
- Three years ago, Dr Antinori announced plans to use cloning technology to help infertile couples have children. The technology had been pioneered by British scientists to produce Dolly the sheep, the world's first vertebrate clone made from an adult mammalian cell.

Clone is Coming

- Earlier in 2005, Dr Antinori predicted that he would complete the first human cloning operation within 18 months.
- The 55-year-old Dr Antinori was previously best known for his work in *in vitro* fertilization and, in particular, for enabling women in their 50s and 60s to give birth.

63 Year Old Mommy

- In 1994 he helped a 63-year-old woman to have a baby by implanting a donor's fertilized egg in her uterus, making her the oldest known woman in the world to give birth.
- Recently a different 60+ year old woman had her 4th child!

"I will make a human clone!"

- Dr Antinori, who runs a fertility clinic in Rome, plans to make his method of human cloning available to couples who cannot have children by any other means - for example, when test tube fertilization is impossible because the man produces no sperm.

Cloning Daddy

- Genetic material from the father would be injected into an egg, which would then be implanted into the woman's womb to grow.
- The resulting child would, in theory, have exactly the same physical characteristics as the father.
 - Example: Boba Fett of Star Wars

1 500 Volunteers

- Dr Antinori told an Italian newspaper recently that more than 1,500 couples had volunteered as candidates for his research program and that he planned to start producing embryo clones in November 2005.
- He is working in close co-operation with Dr Panos Zavos, an American fertility expert.

Banned in EU and US

- The practice of human cloning is banned in Europe and formal legislation is now going through Congress in the United States.

A Hidden Lab

- Dr Antinori has proposed carrying out the procedure in an unnamed Mediterranean country or on a boat in international waters.

It's the media's fault.

- In 1998, Dr Antinori told the BBC it would be immoral to try to clone humans just for the sake of it, but he justified his work as an attempt to help infertile couples.

Dr Antinori

- "Generally, people are against human cloning, and I blame the media for pre-judging it. I want to bring society with me, and persuade people that it is right in rare cases to help infertile couples."

Doctor defends IVF for Woman, 63 Years Old!

- A controversial fertility doctor has defended his decision to give IVF to a 63-year-old woman who is set to become Britain's oldest mother.
- Dr Antinori is her doctor; he has said age 62 or 63 was the upper limit for IVF in healthy women.

Doctor Severino Antinori Said

- He said he would only consider couples with at least 20 years' life expectancy left for fertility treatment but argued that older people made better parents.
- He said Patricia and her husband John Farrant had come to him at his clinic in Rome, where he specializes in treating older women, three years ago and informed him about their wish to have a baby.

Doctor Severino Antinori said:

- "When the couple love each other they naturally want to have a baby."
- "Age isn't important in this decision - what's important is the physical condition of the mother."

Researchers in South Korea

- Claimed to have cloned embryos in order to attain embryonic stem cells. Those embryos could have been implanted in a woman to create the first human clones. In other words, the cloning technology already exist.. The question is whether or not it should ever be used.

Hwang Woo-suk

- Korean scientist, Hwang Woo-suk, the lead researcher in Korea's stem cell research has been accused of several ethical violations and has also been accused of falsifying research.

Want a job, give me your eggs .

- Hwang Woo-suk is accused of pressuring several female co-workers into "donating" their ovum for research!

Send in The Clones?

- Dr Hwang stepped down as professor at Seoul National University (SNU) after an investigating panel said a key paper on custom stem cells was, in large part, fabricated.
- Now, the panel has concluded that his landmark claim in 2004 to have produced the first stem cell line from a cloned human embryo was also false.

Dr. Hwang Woo-suk

- In 2006 Dr. Hwang Woo-suk announced that he is back in business and has decided he will continue research on stem cells and clones.

Sexual Reproduction is Obsolete

- Scientists have now made sexual reproduction obsolete! Now, strictly speaking, sexual reproduction has been unnecessary for over 20 years- since the advent of successful *in vitro* fertilization. p. 137

Some Think This Is a Good Thing

- *In vitro* fertilization is a method where sperm and egg are united to form a single cell zygote outside of the human body- within a laboratory setting. This zygote is then implanted into a woman's womb with the hopes of producing a viable pregnancy. Although some philosophers, such as Andrea Dworkin^[1] have argued that this is a good thing- since heterosexual sex is immoral, most people do not agree.
^[1] Intercourse; New York: The Free Press, 1987

Parthenogenesis

- Scientists have used a technique called parthenogenesis - a form of reproduction in which the egg develops without fertilization - on human cells.

Parthenogenesis (2)

- The phenomenon has been observed to occur naturally in many insects, and artificial parthenogenesis has been achieved in almost all groups of animals, but it usually results in abnormal development and embryos that die after a few days.

Parthenogenesis (3)

- Amazons created in lab!
- This process can be used to create a baby without sperm.
- It only creates female off-spring.
