**Gene Therapy: A New Method to Fight Disease**

**1.1 Gene Therapy Overview**

Outline

* 1. Gene Therapy Overview
  2. The Uses of Gene Therapy
  3. How it Works
  4. Safety Risks
  5. Changes for the Future

Have you ever imagined that the best way to fight a disease, may just be by altering genes?Well this idea is starting to become a reality for some, all through the process of gene therapy. **Gene Therapy** is the insertion of (usually) genetically altered genes into cells. This is done typically done to replace defective genes in the treatment of genetic disorders, or to provide a specialized disease-fighting function. The idea of gene therapy was initially founded in the 1960’s and early 1970’s when researchers begin to grasp the ins and outs of genetics. **Genetics** is a branch of biology that deals with the heredity and variation of organisms. During that time frame, cloned genes were something that were starting to become available for researchers. Cloned genes were being used to show that foreign genes could actually correct genetic defects and disease phenotypes in mammalian cells. Another accomplishment was that researchers were also able to isolate genetically marked mammalian cells. From 1966-1970 arose the first discussions of ethical issues and public policy on the potential of applying genetics to the human disease. It wasn’t until 1989-1990 that the first human clinical marking, and possibly therapeutic studies, were first approved.

While gene therapy is still a relatively new procedure in the science field, it has been gaining a lot of attention due to the amazing effects it has been having on diseases, and the potential long-term effects it could have on modern medicine. Since it is only in the experimental stages, there are still a lot of modifications needed, but there has been vast improvement as well as many clinical successes. While gene therapy has been known to help fight diseases, this therapy comes with a lot if unpredictable side effects, as well as raise as a lot of ethical questions.

**1.2 The Uses of Gene Therapy**

There are three main uses for gene therapy:

1) To replace mutated genes with a healthy gene, 2) to inactivate or remove a mutated gene that is not functioning properly, and 3) to introduce a new gene to help fight a disease.

In order to perform any of the three methods listed above, scientist must first locate the particular gene that is causing the indicated diseases. This can be done through genetic testing. **Genetic testing** is a type of medical test the identifies changes in chromosomes, genes, or proteins. This test can help confirm or rule out a suspected genetic condition. These tests can also tell if someone has a chance of developing or passing down a genetic disorder to their children. Right now, gene therapy is focused on body cells, such as bone marrow or blood cells. It works best in diseases that are caused by faulty genes, like cystic fibrosis.

**1.3 How it Works**

Transportation Methods

Now that the area of mutation is recognized, the new functioning gene needs to be inserted into the target cells so that the mutation can be corrected. If the gene is inserted directly into the cell, then it will not function properly, and the procedure will fail. Researchers have recently been able to find safer and more successful ways to deliver genes. The two most current methods of delivery are:

1. Inside the body (**in vivo**).
2. Outside the body (**ex vivo**).

**In vivo delivery**

For in vivo gene therapy delivery, the vector is given by either IV or injection to the specific tissue that needs to be targeted. After being given, it is then picked up by individual cells.

**Ex vivo delivery**

For some patients their target cells may be removed and through lab work can be exposed to a vector. The cells are then returned to the patient, and if the treatment is successful, the new gene will make a functioning protein.

Both of these methods use vectors as the transportation vessel for these genes to enter the cell safely. A **vector** is an agent (such as a plasmid or virus) that contains or carries modified genetic material (such as recombinant DNA) and can be used to introduce different external genes into the genome of an organism. Vectors are able to insert the new gene into the cell by infecting it. Since it is a virus, scientist modify the vector so that it will not cause additional disease when used on people.

Cell Invasion

There are two ways that the vector can deliver the gene into the cell; this includes **retroviruses** and **adenovirus**. The retroviruses integrate the gene into the cell through the cell’s chromosome. The adenovirus integrates their DNA into the nucleus of the cell rather than the chromosome. For the adenovirus, it enters through the cell membrane and is packaged in a vesicle. The increasing acidity from the cell causes the release of a toxin. This toxin breaches the vesicle, and the virus attaches to the cell’s nuclease on a nuclear pore. The vector then disassembles and delivers the DNA into the nucleus. The genetic information from the new gene is transcribed into mRNA, and with then be translated into proteins that will no longer have the specified mutation.

**1.4 Safety Risks**

Since gene therapy is such a new technique, there are many unpredictable risks. Currently, there is ongoing research to try to make this treatment safer for mainstream medicine. Gene therapy, like most new treatments, has had studies that show some major health risks. These risks include inflammation, toxicity, and even cancer.

Now that this therapy has moved from testing on animals to people, there are more precautions that need to be taken. There is currently comprehensive federal laws, regulations, and guidelines to help keep the people who are participating in clinical trials (research studies) safe. All researchers who want to test their products have to first get U.S. Food and Drug Administration (FDA) approval before anything can be practiced. The FDA can suspend, as well as reject a trail, if they deem it to be unsafe. Lastly, the National Institute of Health (NIH) comes up with guidelines for the universities and hospitals that use gene therapy in their clinical trials.

The current type of gene therapy practiced does not allow the fixed gene to be passed down to children. If the therapy is targeted to egg and sperm cells, it would allow the genes to be passed on to future generations. This is known as **germline gene therapy.** Since this particular therapy is dealing with a fetus, it is a very controversial topic that faces a lot of ethical issues. Also, since it has not been practiced yet, there could be unforeseen long-term side effects to the fetus.

**1.5 Changes for the Future**

If gene therapy were to keep safely progressing forward, then it will allow people to be treated for diseases without the risk of surgery or drugs. All doctors will have to do is insert a gene into a cell. Still, many technical challenges need to be overcome before gene therapy will become a practical method of treatment. There is a big need to find better ways to deliver and target cells, ways to reduce the cost, as well as answer some of the ethical questions. Some of these questions may include: If the therapy has such high cost, will it only make it available to the wealthy? Would the use of gene therapy make people less likely to accept those that are different? Should people be allowed to use this therapy to enhance different human traits like athletic ability or eye color? All these questions need to be looked into before it can become a mainstream form of treatment.

For now, studies are just focusing on treating human diseases. Gene therapy studies are now even being conducted to try and link gene therapy to treat diseases like cancer and HIV/AIDS. In the future, there is hope that gene therapy will be the new method to fighting disease.

**Sources**

Burney, T., & Davies, J. (2012). Gene therapy for the treatment of cystic fibrosis. *The Application of Clinical Genetics,* *5*, 29-36.

Hacker. (2011) Merriam-Webster. Retrieved from <https://www.merriam-webster.com/dictionary/hacker>

Hardwood, J. & Wilkin, D. (2012). Gene Therapy. Retrieved March 7, 2019, from https://www.ck12.org

Theodore Friedmann. (1992). A brief history of gene therapy. *Nature Genetics,* *2*(2), 93-8.

U.S. Department of Health & Human Services (2019). Help Me Understand Genetics Gene

Therapy. *Genetics Home Reference-NHI,* 3-4.