# Human Cloning and Genetic Modification: The Basic Science You Need to Know

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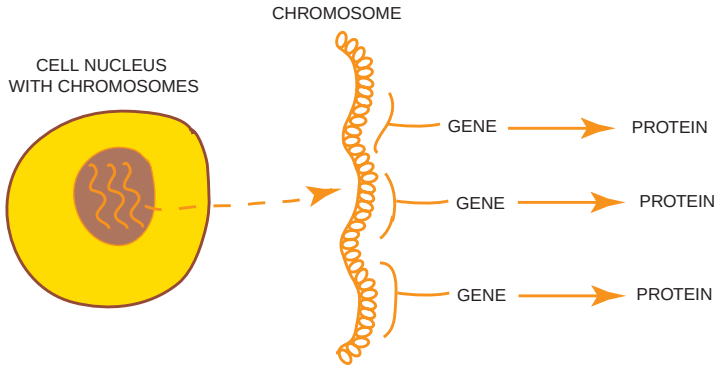
ASSOCIATION OF REPRODUCTIVE HEALTH PROFESSIONALS

ARHP is a nonprofit, national medical organization that has been educating front line providers and their patients since 1963. The organization and its members are dedicated to educating physicians and other health care providers, their patients, and the public about important reproductive health issues including contraception, sexually transmitted diseases, HIV/AIDS, menopause, urogenital infections, cancer prevention and detection, abortion, sexuality, and infertility. ARHP members are highly-respected national and international leaders in research and clinical care. These members are tapped to develop ARHP's clinical and patient education programs.

ARHP educates health care professionals, policy makers and the public.
The organization fosters research and advocacy to improve reproductive health.
For updated news stories and additional resources on genetic engineering, visit
http://www.arhp.org/genetics/

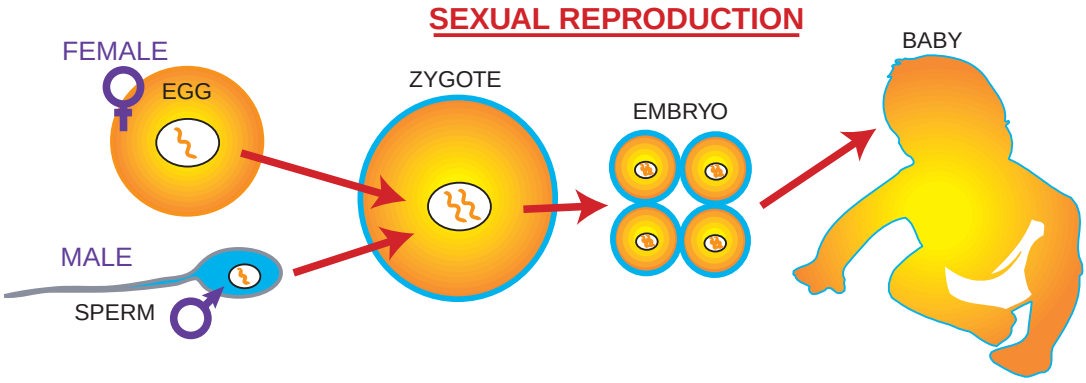
## I. GENES

Genes are strings of chemicals that help create the proteins that make up your body. Genes are found in long coiled chains called chromosomes. They are located in the nuclei of the cells in your body:




## II. "THREE WAYS TO MAKE AN EMBRYO"

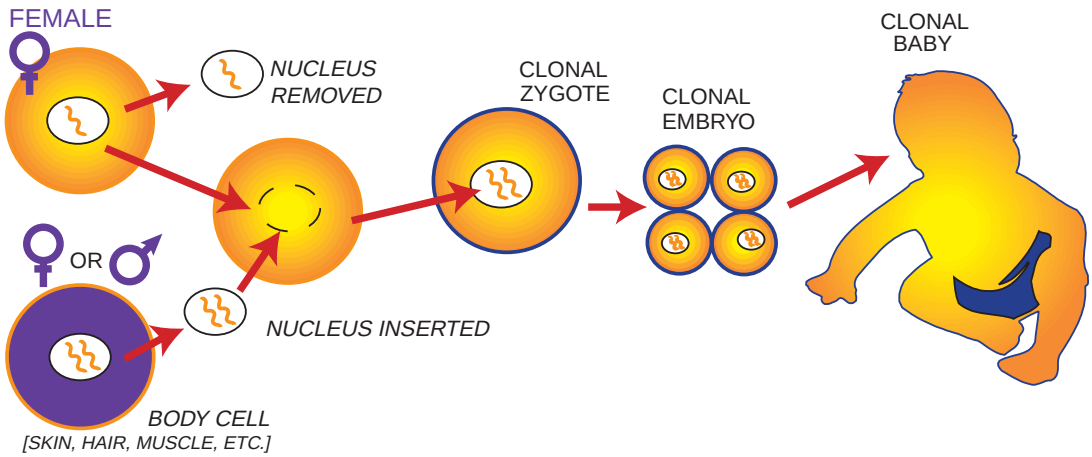
In sexual reproduction a child gets half its genes from its mother (in her egg) and half from its father (in his sperm):



## II. "THREE WAYS TO MAKE AN EMBRYO" (cont'd)

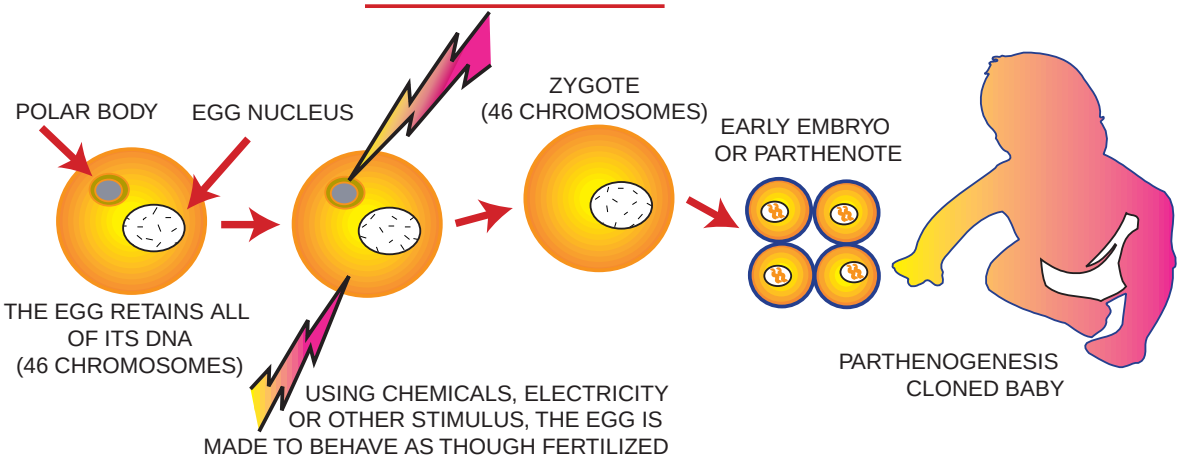
**Cloning is an asexual form of reproduction. All the child's genes would come from a *body cell* of a *single* individual:**

### CLONING OR ASEXUAL REPRODUCTION




**Who is the clonal child's genetic mother or father? As we understand those terms, a clonal child wouldn't have a genetic mother or father, it would have a single 'nuclear donor.'**

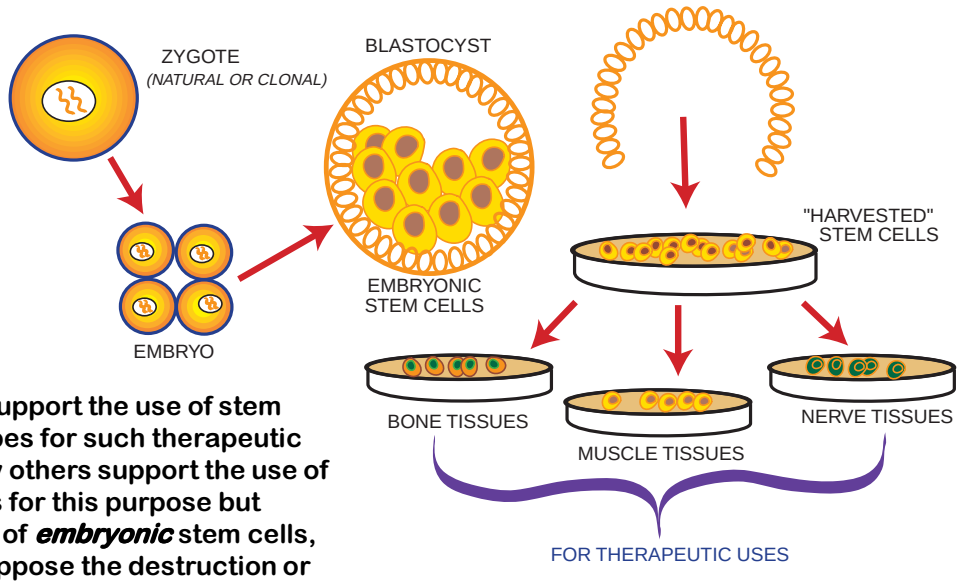
### PARTHENOGENESIS




**If a man cloned himself, would the child be that man's son or his twin brother? It would be neither, it would be a new category of biological relationship: his clone.**

## III. STEM CELLS

Stem cells are primordial cells capable of developing into a variety of types of cells. Some stem cells are found in the adult body. Others are found in very early embryos. These stem cells can be cultured in petri dishes and potentially used to generate "therapeutic tissues" or "spare organs":




Many people support the use of stem cells of both types for such therapeutic purposes. Many others support the use of ***adult*** stem cells for this purpose but oppose the use of ***embryonic*** stem cells, because they oppose the destruction or manipulation of human embryos.

## IV. HUMAN CLONING: A CRITICAL DISTINCTION BETWEEN TWO APPLICATIONS

1. ***Reproductive*** cloning uses the cloning procedure to produce a clonal embryo which is implanted in a woman's womb with intent to create a fully formed living child--a clone-as shown in diagram 3 above..

2. ***Therapeutic*** cloning uses the cloning procedure to produce a clonal embryo, but instead of being implanted in a womb and brought to term it is used to generate stem cells, as shown in diagram 4 above.

The purpose of using clonal embryos to generate stem cells is to allow creation of tissues or organs that the clonal donor can use without having these tissues or organs rejected by their body's immune system.

Most people oppose reproductive cloning. Some people oppose reproductive cloning but support therapeutic cloning. Others oppose therapeutic cloning as well as reproductive cloning, either because they are opposed to the destruction of embryos as a matter of principle, or because they feel the acceptance of therapeutic cloning will set us on a slippery slope to the acceptance of reproductive cloning and human genetic manipulation.

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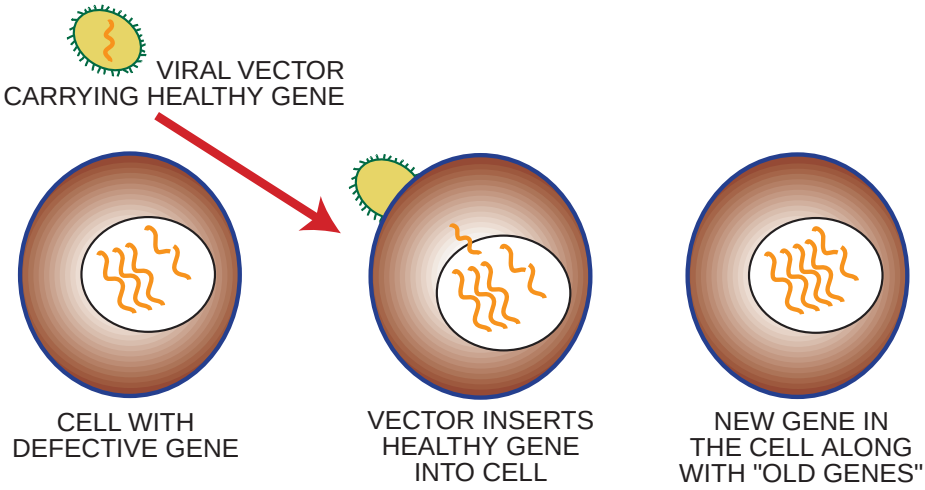
It is possible to support stem cell research and still oppose research involving therapeutic cloning.

## V. HUMAN GENETIC ENGINEERING

Human genetic engineering means changing the genes in a living human cell. Suppose you had a lung disease caused by defective genes in your lung cells. If there was a way to fix those genes, you might be cured.

Scientists change the genes in living cells by putting the desired "new" gene into a little virus-like organism which is allowed to get into your cells and which inserts the new gene into the cell along with the "old" genes:

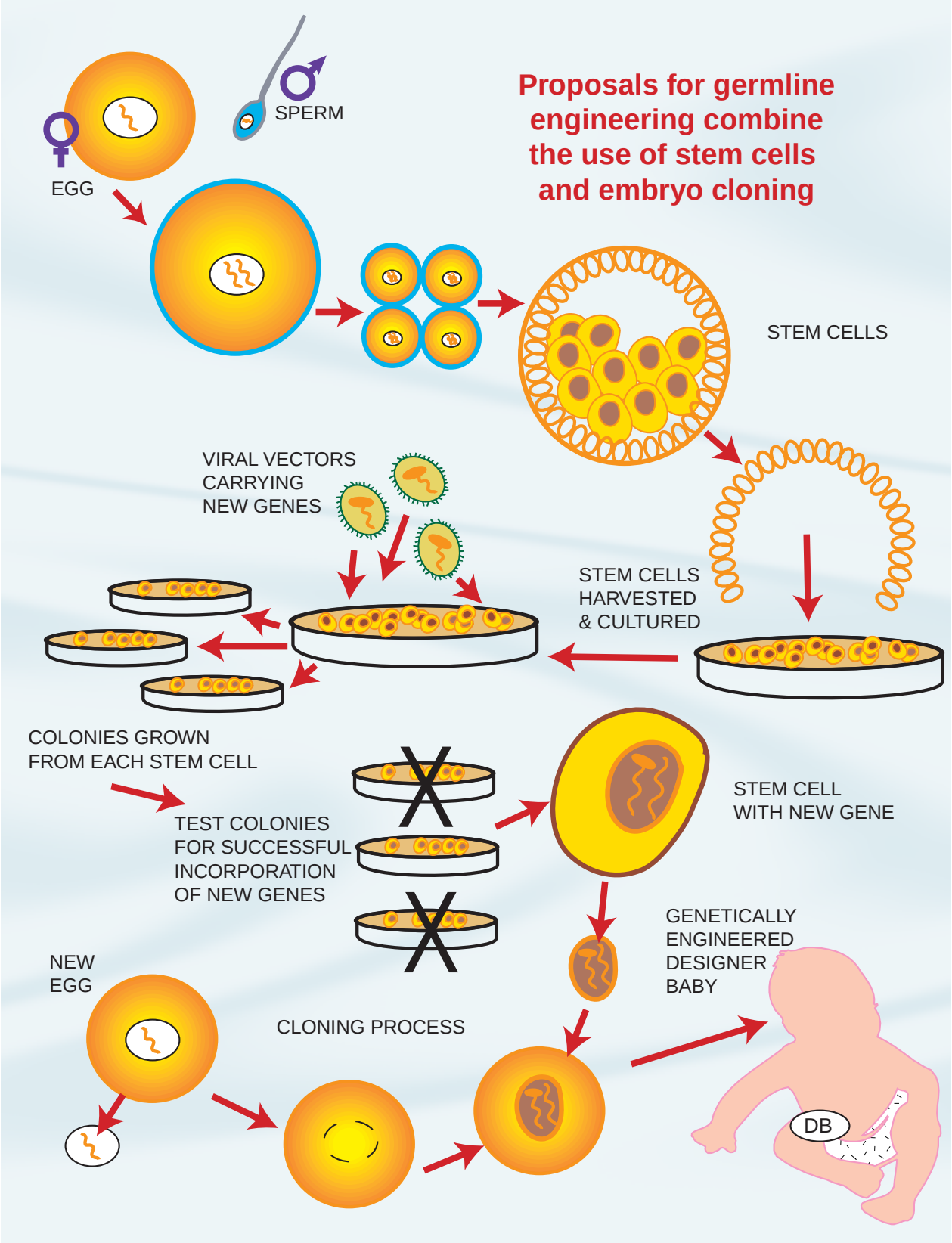



## VI. HUMAN GENETIC ENGINEERING: A CRITICAL DISTINCTION BETWEEN TWO APPLICATIONS

1. ***"Somatic"*** genetic engineering is genetic engineering that targets the genes in specific organs and tissues of the body of a single existing person without affecting genes in their eggs or sperm. Somatic gene transfer experiments are currently undergoing clinical trials, with mixed results to date. But they may someday be effective. Diagram 5 above shows how somatic genetic engineering works.

2. ***"Germline"*** genetic engineering is genetic engineering that targets the genes in eggs, sperm, or very early embryos. The alterations affect every cell in the body of the resulting individual, and are passed on to all future generations. Germline engineering is banned in many countries but not in the U.S. Diagram 5 shows how germline genetic engineering works.

*[note: The term "somatic" comes from the Greek "soma" for "body." The term "germline" refers to the "germ" or "germinal" cells, the eggs and sperm.*


Proposals for germline engineering combine the use of stem cells and embryo cloning
SPERM
EGG
STEM CELLS
VIRAL VECTORS CARRYING NEW GENES
STEM CELLS HARVESTED & CULTURED
COLONIES GROWN FROM EACH STEM CELL
TEST COLONIES FOR SUCCESSFUL INCORPORATION OF NEW GENES
STEM CELL WITH NEW GENE
GENETICALLY ENGINEERED DESIGNER BABY
NEW EGG
CLONING PROCESS
DB

## VIII. PRE-IMPLANTATION GENETIC DIAGNOSIS AND SELECTION (PDS)

Many people assume that germline engineering is necessary to allow couples at risk of passing on a genetic disease to avoid doing so. This is not so. Procedures already exist that make this possible, including adoption and gamete and embryo donation. In addition the alternative of ***pre-implantation diagnosis and selection*** allows couples to have a child that is fully genetically related to both of them and which does not carry the genetic disease about which they are concerned.

The PDS procedure begins in the same way that germline engineering would, with an IVF procedure, but instead of seeking to ***change the genes in unhealthy embryos*** it simply ***selects the healthy embryos themselves*** for implantation in the mother:


This technique is more straightforward than germline genetic manipulation, and does not open the door to an out-of-control techno-eugenic human future. The only situation in which germline engineering would be required over pre-implantation selection is one in which a couple would like to endow their child with genes that neither member of the couple possesses. This is the "enhancement" scenario, which we believe would lead to a dystopic human future if it were allowed. PDS, on the other hand, would have only a minimal effect on the human genome, even if it were widely used, because the procedure selects from the range of existing human traits. But ***engineering*** the genes by means of germline modification would allow novel forms of human life to be created within one generation.

While pre-implantation diagnosis and selection can be used for the acceptable reasons of preventing genetic disease, it could also be used in ways that societies might find unacceptable, eg., to select for cosmetic, behavioral, or other non-disease traits. Societies have the right and responsibility to decide which uses of such screening technologies should be allowed and which should be banned.

**Additional Resources:** Many sections of this ARHP educational tool are taken from 'Human Cloning and Genetic Modification: The Basic Science You Need to Know' by the Center for Genetics and Society, with their permission. Contact them at 436 14th Street, Suite 1302, Oakland,CA 94612, phone: 510-625-0819; fax: 510-625-0874, email: info@genetics-and-society.org; website: http://www.genetics-and-society.org