Shall we manufacture our children? The promise and problems of "gene editing"

Richard M. Doerflinger Annual Diocesan Conference Diocese of Reno, Nevada January 6, 2018

I. The Age of CRISPR

The discovery of an easier and more effective technique for modifying the genetic makeup of any species, including humans, "will forever alter the landscape of medicine and science" (Fr. Nicanor Austriaco of Providence College). It also raises serious and difficult moral issues – some familiar to Catholics, and some that test our traditional moral categories.

The technique: CRISPR-Cas9

CRISPR: "Clustered Regularly Interspaced Short Palindromic Repeats" Cas-9: A particular "CRISPR-associated protein"

These are found in some bacteria as a natural defense against an attacking virus – together they can be used to match the virus's DNA and cut it, rendering it harmless.

Timeline

2015: The journal *Science* calls discovery of this technique the "Breakthrough of the Year"; in April 2015, Chinese researchers use it to alter the genome of 86 "non-viable" human embryos.

December 2015: U.S. researchers use CRISPR to treat muscular dystrophy in grown mice.

January 2017: CRISPR is used to alter rat stem cells that are injected into mouse embryos lacking a gene needed for development of a pancreas, allowing them to survive to maturity.

February 2017: In Korea, CRISPR used to treat age-related macular degeneration in mice.

August 2017: Researchers in Oregon fertilize dozens of *human* eggs with sperm from men with a hereditary heart condition, and with the CRISPR machinery; some resulting embryos carry the corrected gene in all or some cells. All the human embryos are destroyed.

The promise

- Correcting genetic conditions in mature human beings (somatic cell gene therapy).

- Preventing such conditions by editing human DNA at the early embryo stage. The corrected genes end up in every body cell, including later egg and sperm cells, so the alteration is passed on to future generations (germline genetic modification).

- Altering animal genomes for human clinical benefit (i.e., altering pigs so their hearts and other organs could be transplanted into humans without rejection)

- Fighting infectious diseases (e.g., use of CRISPR "gene drive technology" to make future generations of mosquitos unable to transmit malaria, or even to make an entire species infertile)

The problems

1. Safety and unintended consequences. There have been "off-target" (unintended) genetic changes, and with germ-line modification "even a small mistake could change the human gene pool forever" (journlist Alessandra Potenza). In 2016, the U.S. director of national intelligence listed gene editing under the category of potential "weapons of mass destruction."

2. Harmful, often lethal, human experimentation. Currently all efforts to alter human embryos involve *in vitro* fertilization, which violates Catholic teaching on the integrity of procreation and has its own high embryo death rate and a risk of causing genetic defects. In the Oregon experiment, women were enlisted to take risky superovulatory drugs to produce many eggs at once for research use. They tested the resulting dozens of embryos and found many to be healthy -- reducing the likelihood of having the defect from 50 percent to 28 percent. When the experiment was concluded, over a hundred embryos – including those with no apparent genetic defect – were destroyed. The National Academy of Sciences and other countries' research groups are actually demanding this approach at present, as a hedge against the "safety" problems above. Until safety is assured, no embryo gets out alive. As one headline reported: "Editing human embryos is okay – but don't turn them into people yet, geneticists say."

3. From therapy to enhancement: Making the "better" child. If safety problems are solved, CRISPR will be available not only to correct genetic defects but to alter the genome to "improve" the human race. Do we have the moral maturity even to assess what that means? And some scholars say the line between therapy and enhancement is almost impossible to draw. Will we make man himself "the last of man's man-made things" (Leon Kass)? See the implications outlined in the film *Gattaca* (unaltered humans become second-class citizens), Aldous Huxley's *Brave New World* (people genetically tailored and programmed to serve different roles in society), and C.S. Lewis's *The Abolition of Man* (not freedom for all, but the control of all future generations by a few very fallible people in our generation). A new kind of moral challenge.

This Brave New World is rapidly approaching. Catholics must be informed and morally engaged.