1. **Mark your confusion.**
2. **Show evidence of a close reading.**
3. **Write a 1+ page reflection.**

# Editing the Human Race

Source: TheWeek.com, January 16, 2016

*A new genetic technology called CRISPR may enable scientists to make permanent changes in a person's DNA. Here's everything you need to know:*

**What is CRISPR?**

It's a revolutionary gene-editing technique that enables scientists to snip out a piece of any organism's DNA cheaply, quickly, and precisely — cutting and editing the code of life the way a film editor would splice an old film reel. Developed at the University of California, Berkeley, in 2012, CRISPR offers great promise, because it could provide a true cure for debilitating hereditary diseases such as Huntington's, muscular dystrophy, and sickle-cell anemia. But it is different from traditional forms of gene therapy in one key sense: CRISPR can be used to edit genes on the human germ line, so that those changes are passed down through generations — permanently altering the human gene pool. That capability has given new urgency to theoretical discussions about designer babies, mutants, and scientists "playing God." In December, an international group of scientists called for an immediate moratorium on inheritable human genome editing until CRISPR's risks have been assessed. "Everything I've learned here says we're not ready to be doing this yet," said Nobel Prize–winning biologist David Baltimore.

**How does CRISPR work?**

The technique was adopted from certain types of bacteria that have developed a gene-editing mechanism to defend against viruses. With an enzyme called Cas9 that acts like a molecular scissors, the bacteria cut out key genes of the viruses and store them, so their immune system recognizes and wards off those viruses every time it encounters them. In creating CRISPR, scientists learned to use Cas9 to cut out a target gene within any cell, replace it with another gene if needed, and neatly stitch the ends of the DNA back together. The entire process takes just days, can be used to alter dozens of genes in all kinds of living organisms, and costs as little as $30. "In the past, it was a student's entire Ph.D. thesis to change one gene," says geneticist Bruce Conklin. "CRISPR just knocked that out of the park." As a result, genetic research is nearing a breakthrough that could transform the world.

**How so?**

CRISPR is already being used to make certain crops invulnerable to killer fungi, and scientists have also created a strain of mosquitoes with malaria-blocking genes that the insects successfully passed on to 99.5 percent of their offspring. But the technique's most promising application is as a potential cure for hereditary diseases. In theory, scientists could use CRISPR to cure single-gene defects like Huntington's by editing out the disease-carrying gene from the DNA of a fetus in the womb — permanently erasing the disease from the person's germ line, so the offspring would also be saved. Sounds simple enough, but as a team of Chinese researchers discovered last year, modifying the actual human genome is fraught with difficulties.

**What happened in China?**

A team at Sun Yat-sen University in Guangzhou attempted to modify the germ line in dozens of

human embryos, hoping to snip out a defective gene that causes a deadly blood disorder. The study caused shock waves in the scientific community — but also highlighted the practical difficulties of DNA editing in higher organisms. Of the 86 embryos used — all of which were nonviable — just four manifested the new gene designed to replace the defective one. Worse, there were inexplicable mutations in genes that weren't targeted by the researchers. "The number of unintended effects is precisely why this technique is not appropriate for use in clinical applications," bioethics professor R. Alta Charo told *Wired*.

**What are scientists' biggest fears?**
The first is whether CRISPR can be used safely and without causing unintended genetic changes. Even the best geneticists admit they have only scratched the surface in their understanding of human DNA and the effects that CRISPR might have on a person's 20,000 to 25,000 genes, which interact in still-mysterious ways. The larger question, of course, is whether scientists should be tinkering with the human gene pool at all. At some point, researchers could switch their attention from curing hereditary diseases to editing supposedly desirable traits into a person's DNA, such as high intelligence, tall stature, or blue eyes. "Great things can be done with the power of technology — and there are things you would not want done," said Jennifer Doudna, a Berkeley biologist who co-invented CRISPR. "Most of the public does not appreciate what is coming."

**Will there be a moratorium?**
That's unclear. The international conference of scientists who called for the freeze in December included authoritative figures from across the world. But they have no regulatory powers and can do nothing to stop researchers in countries like China from vigorously pursuing CRISPR experiments. Doudna says she dreads the idea of the technique being used on human embryos, but given its potential for preventing children from inheriting debilitating diseases, believes that step is inevitable. At a recent meeting of geneticists, Doudna said, one of her colleagues observed, "There may come a time when, ethically, we can't *not* do this."

**Return of the woolly mammoth?**
CRISPR has prompted fears that rogue scientists will create "Frankenbabies," but researchers have been using the technique to resurrect a completely different kind of beast. In March, a team led by Harvard geneticist George Church announced they had successfully copied the genes from the frozen tissue of a woolly mammoth, a species extinct for the past 4,000 years, and pasted them into the genome of an Asian elephant. The next step will be to insert those genomes into an elephant egg cell for implantation. The team hopes to create a furrier elephant-mammoth hybrid that can survive in cold temperatures, so that elephants can live comfortably outside of Asia and Africa, where their own existence is threatened by conflict and poverty. What was once purely the realm of science fiction is quickly becoming reality, says Church. "First there was *Jurassic Park*. Now we have the exact DNA for these ancient species, and, in some cases, we have the appropriate hosts that are pretty close."

**Possible Response Questions:**

- Do you support the “Jurassic Park” experiment? Explain.
- Pick a passage from the article and respond to it.