OLYMPIADS SCHOOL/GRADE 9 ENGLISH/HANDOUT 7

This week, we will read four articles about science, specifically about genetic engineering and certain ethical implications. We will attempt to build a context that associates Frankenstein with the science fiction genre.

This handout facilitates a jigsaw reading activity to help us engage collaboratively with the four articles. Before you begin, your teacher may go through a slide presentation about *Frankenstein* and science fiction.

The goal today is to gain appreciation of how Shelley's novel, published in 1818, still works powerfully in the 21st century.

The Four Readings

Article One

Genetic editing is like playing God – and what's wrong with that?
http://www.theguardian.com/commentisfree/2016/feb/02/genetic-editing-playing-god-children-british-scientists-embryos-dna-diseases

Johnjoe McFadden

British scientists are getting permission to alter embryos' DNA. We have the chance to correct devastating diseases in the womb, so let's get on with it

Tuesday 2 February 2016 13.29

The announcement that scientists are to be allowed to edit the DNA of human embryos will no doubt provoke an avalanche of warnings from opponents of genetic modification (GM) technology, who will warn that we are "playing God" with our genes.

The opponents are right. We are indeed playing God with our genes. But it is a good thing because God, nature or whatever we want to call the agencies that have made us, often get it wrong and it's up to us to correct those mistakes.

Sadly, of the half a million or so babies that will be born in the UK this year, about 4% will carry a genetic or major birth defect that could result in an early death, or a debilitating disease that will cause misery for the child and their family. This research will eventually lead to technologies that could edit DNA in the same way that we can edit text – to correct the mistakes before the child's development goes to its final draft. Its successful implementation could reduce, and eventually eliminate, the birth of babies with severe genetic diseases.

But surely our DNA cannot be compared to the patterns of printer ink on page? Our DNA is considered to be so special that the phrase "it's in his/her DNA" is said with the same sense of fatalism that our ancestors would have spoken of their fate or their soul. Anti-GM activists, many of whom are devout atheists, often insist that our DNA is somehow special, something donated to us by an all-powerful, wise and benevolent nature, which has taken God's place as our creator. But nature is just blind chance – mutation – combined with the survival of the fittest. There's no grand plan and no reason why nature shouldn't, like the rest of us, occasionally make terrible mistakes. When those errors could lead to terrible human suffering, it is our duty to try to correct them.

Our DNA is just a chemical. Schoolchildren isolate it from cells in the class laboratory and it can be spooled out on a glass rod looking like slimy cotton wool. When dried, it looks like fibrous paper. You can eat it or burn it and it will return to those simple atoms and molecules from which it is made. There is no special magical ingredient between the atoms, no soul, just atoms and space. DNA is the most amazing chemical in the known universe, but it's just a chemical – made of the same atoms of carbon, hydrogen, oxygen and nitrogen you can find in the air. It is no more spiritual than your fingernails or hair. And we don't mind clipping those when we need to.

Gene editing of human embryos to eliminate disease should be considered to be ethically the same as using laser surgery to correct eye defects, or a surgeon operating on a baby to repair a congenital heart defect. DNA is just another bit of our body that might go wrong.

Yet gene editing could provide revolutionary benefits to our children. A team based at Great Ormond Street Hospital for Children in London recently used gene editing to treat a one-year-old girl with leukaemia, who is now in remission. More technology is in the pipeline. A team based at Perelman School of Medicine at the University of Pennsylvania reported in this week's Nature Biotechnology that they were able to correct a genetic liver disease in newborn mice. Taking this technology into human embryos could correct devastating genetic diseases in the womb.
But isn't this a slippery slope to designer babies genetically engineered to be healthier, cleverer or more beautiful than they would otherwise be? Wouldn't it provide a technology that would only be available to the super-wealthy, potentially creating the kind of divided society that HG Wells envisaged in his futuristic novel, The Time Machine? Perhaps. But let's worry about the future in the future.

In the present, if those of us with mostly healthy children are worried about the ethics of gene editing, then we should ask the parents of children born withhaemophilia, cystic fibrosis or muscular dystrophy whether they would have used this kind of technology if it had been available to them. If science can be used to eliminate human suffering, then let's get on with it.

Article Two

Top U.S. Intelligence Official Calls Gene Editing a WMD Threat

https://www.technologyreview.com/s/600774/top-us-intelligence-official-calls-gene-editing-a-wmd-threat/

Easy to use. Hard to control. The intelligence community now sees CRISPR as a threat to national security.

By Antonio Regalado

February 9, 2016

That's according to James Clapper, U.S. director of national intelligence, who on Tuesday, in the annual worldwide threat assessment report of the U.S. intelligence community, added gene editing to a list of threats posed by "weapons of mass destruction and proliferation."

Gene editing refers to several novel ways to alter the DNA inside living cells. The most popular method, CRISPR, has been revolutionizing scientific research, leading to novel animals and crops, and is likely to power a new generation of gene treatments for serious diseases (see "Everything You Need to Know About CRISPR's Monster Year").

It is gene editing's relative ease of use that worries the U.S. intelligence community, according to the assessment. "Given the broad distribution, low cost, and accelerated pace of development of this dual-use technology, its deliberate or unintentional misuse might lead to far-reaching economic and national security implications," the report said.

The choice by the U.S. spy chief to call out gene editing as a potential weapon of mass destruction, or WMD, surprised some experts. It was the only biotechnology appearing in a tally of six more conventional threats, like North Korea's suspected nuclear detonation on January 6, Syria's undeclared chemical weapons, and new Russian cruise missiles that might violate an international treaty.

The report is an unclassified version of the "collective insights" of the Central Intelligence Agency, the National Security Agency, and half a dozen other U.S. spy and fact-gathering operations.

Although the report doesn't mention CRISPR by name, Clapper clearly had the newest and the most versatile of the gene-editing systems in mind. The CRISPR technique's low cost and relative ease of use—the basic ingredients can be bought online for $60—seems to have spooked intelligence agencies.

"Research in genome editing conducted by countries with different regulatory or ethical standards than those of Western countries probably increases the risk of the creation of potentially harmful biological agents or products," the report said.

The concern is that biotechnology is a "dual use" technology—meaning normal scientific developments could also be harnessed as weapons. The report noted that new discoveries "move easily in the globalized economy, as do personnel with the scientific expertise to design and use them."
Clapper didn't lay out any particular bioweapons scenarios, but scientists have previously speculated about whether CRISPR could be used to make "killer mosquitoes," plagues that wipe out staple crops, or even a virus that snips at people's DNA.

"Biotechnology, more than any other domain, has great potential for human good, but also has the possibility to be misused," says Daniel Gerstein, a senior policy analyst at RAND and a former under secretary at the Department of Homeland Defense. "We are worried about people developing some sort of pathogen with robust capabilities, but we are also concerned about the chance of misutilization. We could have an accident occur with gene editing that is catastrophic, since the genome is the very essence of life."

Piers Millet, an expert on bioweapons at the Woodrow Wilson Center in Washington, D.C., says Clapper's singling out of gene editing on the WMD list was "a surprise," since making a bioweapon—say, an extra-virulent form of anthrax—still requires mastery of a "wide raft of technologies."

Development of bioweapons is banned by the Biological and Toxin Weapons Convention, a Cold War–era treaty that outlawed biological warfare programs. The U.S., China, Russia, and 172 other countries have signed it. Millet says that experts who met in Warsaw last September to discuss the treaty felt a threat from terrorist groups was still remote, given the complexity of producing a bioweapon. Millet says the group concluded that "for the foreseeable future, such applications are only within the grasp of states."

The intelligence assessment drew specific attention to the possibility of using CRISPR to edit the DNA of human embryos to produce genetic changes in the next generation of people—for example, to remove disease risks. It noted that fast advances in genome editing in 2015 compelled "groups of high-profile U.S. and European biologists to question unregulated editing of the human germ line (cells that are relevant for reproduction), which might create inheritable genetic changes."

So far, the debate over changing the next generation's genes has been mostly an ethical question, and the report didn't say how such a development would be considered a WMD, although it's possible to imagine a virus designed to kill or injure people by altering their genomes.

Article Three

Should we worry about gene editing?

By Robert Klitzman

Updated 8:42 AM ET, Wed February 10, 2016

(Robert Klitzman is a professor of psychiatry and director of the Masters of Bioethics Program at Columbia University. He is author of "The Ethics Police?: The Struggle to Make Human Research Safe." The opinions expressed in this commentary are solely those of the author.)

(CNN) Every week, I get unsolicited email ads from airlines, Nigerian widows -- and now biotech companies selling gene editing services. I usually just reflexively delete the biotech emails along with most of the others, giving them little thought. That was until last week, when British researchers made a momentous announcement: A British regulatory agency has given them permission to begin altering genes in human embryos.

We have entered a Brave New World.

So-called gene editing involves the use of technology, known as CRISPR-Cas 9, to alter the genes, or DNA, in our cells. One of the greatest technological discoveries in the past 50 years, if not longer, this powerful tool holds the promise of revolutionizing our lives and those of our descendants.

The technique, first discovered among bacteria trying to avoid viruses, lets us clip out bad genes in cells or insert better ones. Moving forward, the potential applications are enormous. If a mutation is destroying your cells, we could simply splice it out. As a result, countless patients could potentially be treated for horrific disease.
Ultimately, the technique could be used for altering genes either inside you -- affecting only you -- or in embryos that will mold your children and their descendants. In the future, parents may want to give their children certain genes for blond hair and blue eyes, added height or certain kinds of athletic prowess.

We may also eventually find genes that are strongly associated with perfect pitch, intelligence or homosexuality, for example, and parents may want to pick and choose among these as well. The possibility of altering or "enhancing" future humans may seem like science fiction but may soon be possible.

But there are risks. Certain genes may increase your odds of getting one disease but protect you against other ailments -- if we impair such a gene, you may avoid the first disease but get another. For example, in mice, researchers blocked a gene that caused cancer, but the mice ended up aging prematurely. In addition, gene editing, at least in the near future, might also lead to mistakes such as parts of the wrong gene accidentally getting snipped.

Where do things currently stand?
Last year, Chinese researchers reported that they had tried to alter the genes in embryos but hadencountered problems. International debate erupted: Should we allow this technology to proceed in humans? And if so, when?

Some critics argued that the research should be permanently banned. Many scientists, however, felt that the technology might be used in the future but not until the pros and cons were discussed in an international forum.

As a result, in December 2015, researchers from China, Britain, the United States and elsewhereheld a summit in Washington to decide what to do.

They agreed to place certain limits on the technology, at least for now. They also decided that basic preclinical research, involving cells in petri dishes, should proceed as long as appropriate oversight and rules exist. Research on genes in our bodies that won't be transmitted to future generations is also similarly permissible. DNA in human embryos could be changed but only if they are never implanted into a womb.

Researchers around the world were still trying to make sense of all this when suddenly, last week, the British researchers proclaimed that they were set to start their research. And while these embryos are not supposed to be implanted into wombs to become human beings, the fact that this research has now begun has thrust the issue back into the headlines.

Should we be worried?

Tampering with nature undoubtedly has perils, but having been very public about what they are planning, the UK researchers will be closely watched. It is therefore not so much what these researchers do, but what might happen in the future that we need to keep a close eye on. The reality is that all technologies are tools that people can use for good or bad. Nuclear research, for example, has given us relatively inexpensive electricity but also atomic bombs.

Similarly with CRISPR, careful oversight and transparency are crucial because "garage science" flourishes in many fields, as do researchers in countries with little oversight. If I am receiving emails selling these technological services, so too are countless others.

The other big question is whether U.S. scientists should also start such research in human embryos. On this, the answer seems to be that they probably will. Though Congress has decreed that federal funds cannot be used to destroy embryos, investigators can still use state or private funds.

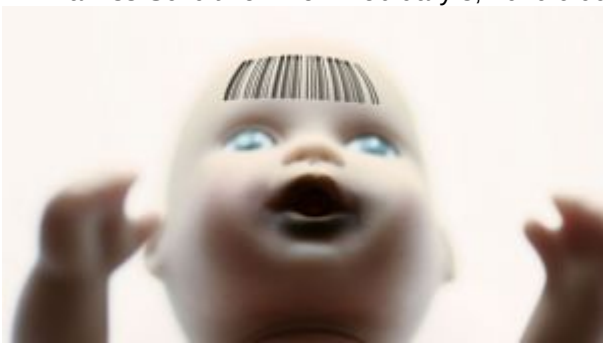
We have now embarked on a long journey, and it is unclear what any of us will find. At times, we will be scared. But we should make sure we know and discuss each step that we take because it is unlikely we will ever completely be able to turn back.

Article Four

We Are This Close to "Designer Babies"

http://m.motherjones.com/politics/2016/02/genome-embryo-crispr-designer-babies

One CRISPR skeptic sheds light on what human gene editing could mean for the future.
—Nina Liss-Schultz on Mon. February 8, 2016 6:00 AM PDT



Photosani/Shutterstock

On February 1, scientists from the United Kingdom's Francis Crick Institute got the okay to start research on human embryos using a new genome editing technology called CRISPR. Their work, which will mark only the second time CRISPR has been applied to humans, will use embryos to try to

understand the very early stages of human development and pinpoint the genes causing miscarriages and fetal defects.

Not surprisingly, the Crick project has reignited a firestorm of debate over the ethics of human gene editing. "This is the first step in a well mapped-out process heading to genetically modified babies, and a future of consumer eugenics," said Dr. David King, director of Human Genetics Alert, in response to the news.

CRISPR is essentially a cellular scalpel. The small enzyme works by moving through the body's cells and cutting away at precise pieces of the genome—something that's never before been possible to do with such efficiency and ease. Since 2012, it's been used to cut out the gene mutations leading to HIV and sickle cell anemia. Last spring, researchers in China became the first to genetically modify embryos with CRISPR after they used the technology to replace a gene in a single-cell embryo.

The technology can also be used to edit what scientists call germline cells—embryos in such early stages of development that any changes will become hereditary and can be passed on to future generations. Using the technique, for example, scientists could potentially edit out the gene for Huntington's disease in a woman before she's born. Not only would she be disease free; she wouldn't be able to pass it on to any future children.

Even though the Crick Institute's research is limited to 14 days and the cells they edit won't be implanted, critics still say this type of research might soon lead to something less benign—that one day we'll be creating "designer babies," whose genetic makeup will be determined in a lab. Many scientists, bioethicists, and politicians are calling for a moratorium on human embryo editing, which is already banned from receiving public funds in the United States. One of those skeptics is Marcy Darnovsky, executive director of the Berkeley-based Center for Genetics and Society, whose research focuses on biotechnology and reproduction. I caught up with Darnovsky to talk about designer babies, embryo harvesting, and the unforeseen consequences of germline editing. Here are seven takeaways from our conversation:

1. Gene editing with CRISPR is still not very safe. "It's almost universally accepted that right now it would be crazy to proceed with the technology. Some of the problems that have come up, including in the Chinese experiment, is with what's called off-target mutation. There's this thing described as a molecular scissors that's supposed to have a homing device that'll take you to the exact spot on the DNA strand that you want to cut, but sometimes it's not that precise—it'll go somewhere else and sometimes the change that it makes isn't what you intended. Other times the change is made accurately in some of the embryonic cells but not in all of them, which leads to a condition called mosaicism that can lead to problems later in development. Another problem is that the scissors component of the system can hang around in the cell and later on, when you think you're done, it starts snipping away. The term 'gene editing' helps people understand how the technology works, but it also suggests a level of precision and safety that at least for now isn't there."

2. Genome modification isn't the only available method of stopping the transmission of inherited diseases. "Some of the more cautious and shrewd people are saying, 'We'll only use this to prevent the transmission of diseases.' That does sound like a worthy goal, but here's the thing: You don't need to be editing genes to accomplish this because we already have embryo screening techniques that at this point are pretty standard add-ons in in vitro fertilization clinics. They accomplish the very same thing with far less physical danger for the resulting child and without anything like the level of societal risk posed by germline modification."

3. Once the door to editing our genome gets opened, there's no going back. "Say there was a policy effort to use this gene editing technique to prevent Huntington's disease. Well, it's impossible to really draw a policy line. It's like how the FDA doesn't regulate off-label uses of drugs and devices: Once the FDA approves the drug for one thing, a doctor can use it and prescribe it for anything. No one is telling fertility clinics what they can and cannot do. And maybe that's a good thing, but it also means

we could not control fertility clinics that were trying to use CRISPR to push the envelope. So this mission creep would be very difficult—if not impossible—to control.

And there are Futurists, including a few scientists, who say we're going to produce superior children and improve humanity. A prominent scientist has already spelled out a list with 10 conditions, things like stronger bones, slow- and fast-twitch muscles, so that the resulting child could be good at an endurance or sprinting sport, and sleep—there's a gene that's correlated with people needing less sleep.

I think it's very possible that once you unleash this technology onto the market and set it in motion, commercial and competitive dynamics would set in, and you'd see people that wanted to give their future children the best start in life. You can really see the ad copy writing itself."

4. So-called "designer babies" would be available only to the rich. "IVF is already expensive. It's not only rich people who use it—people take out second and third mortgages on their homes—but it is expensive. Gene editing would be more so. And so you'd have children born to the more wealthy class that either were genetically superior or even thought to be genetically superior. This would exacerbate trends toward great inequality and could introduce new forms of inequality."

5. Harvesting eggs from women carries its own risks. "The Chinese experiment in April was using nonviable embryos that were created but not used in fertility treatments. In the process of fertility treatments, some of the embryos don't turn out right, so they can't be developed into a human child even if they were implanted.

But in the UK, they want to use viable human embryos because they want to investigate what goes wrong in early embryonic development. The retrieval of eggs from women is invasive, it carries risks that are understudied, and the women that are recruited to provide eggs often aren't made fully aware of what the risks are."

6. Skepticism of embryonic modification is different from anti-abortion groups' belief that personhood begins at fertilization. "There are some anti-choice groups that have come to the same conclusions [the Center for Genetics and Society] has. I can't say exactly what their logic is, but it has to do with attempts to elevate the status of the embryo. They're concerned with the destruction of embryos. Back when there were headlines about human cloning, some bishops thought that once you produced cloned human embryos it might be better to implant them into a woman's uterus than be destroyed."

7. But even the skeptics are excited by the science. "It's not exactly the technology itself that I'm worried about—it's with the application of creating genetically modified human beings. The gene-editing technology itself is first of all scientifically exciting, and second of all it could be used to help people who are sick. That could be great."

JIGSAW READING ACTIVITY

Your instructor will assign an article to each student in groups of four. You will be in charge of summarizing your reading to your group. Use the boxes below to write your summary and also to take notes when your group mates present their summaries.

Article One Summary
Article Two Summary
Article Three Summary

Article Four Summary

REFLECTION

Do the articles offer a humanist critique of science? Explain.

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