STEMBoost Newsletter

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Hello Science Enthusiasts,

STEMBoost is pleased to announce the first issue of the STEMBoost Newsletter, a monthly newsletter aiming to bring the latest advances in STEM fields in both the United States and the world, as well as preexisting inequalities and how both of these may affect society as a whole. This and future issues will appear on the STEMBoost website, and if any of you guys have any tips for any areas of STEM in which has a topic which you think others would find interesting feel free to let us know! We are also thinking about doing an issue in the future in which a few of your Science Olympiad experiences can be placed on display.

This August, STEMBoost officers held a sendoff party for two graduating officers, Iris Xia and Prasanna Srinivas. Both of them held the role of STEMBoost president in 2019 and have contributed greatly to not only the operations of STEMBoost and the summer workshops but also to the Kennedy Invitationals for the past three years. We all wish them a great time in college and for their future careers.

Fun Fact

Do you know where the world's largest desert is?
(See answer in the back)

Editorial – Gene Editing: A Double-edged Sword

Ryan Li

Genetic testing. The pinnacle of modern science. The ability to read one's own traits written in DNA, and to see if they may pose any risk to oneself or to one's future children. Ever since Watson and Crick discovered the double helix structure of DNA, which consists of two long strands of complementary nucleotides (subunit of DNA; includes A, T, C, and G), the field of genetics has been on an exponential rise. New interests and medical advances sprouted like wildlife re-emerging after a wildfire. Vaccines for polio, a disease which has the potential to paralyze a victim, and measles, a highly contagious respiratory illness, along with many others allowed for a dramatic decrease in their presence in both the developed and developing world during the twentieth century (Editors of Publications International, 2007). DNA profiling using polymerase chain reaction also gained popularity in the 1980s as a new method of determining the culprit behind violent crimes (The history of DNA testing). In 2003 the Human Genome Project was completed, providing a wealthy database of the roughly 20,000-25,000 genes (a series of nucleotides which serves as "instructions" for cellular function) and 3 billion nucleotide base pairs (complementary nucleotides i.e. A&T or C&G) present in human DNA and their locations within the human genome to be used for future research with up to 99.99% accuracy (Human Genome Project, 2019 & Human Genome Project Results, 2018).

At this point scientists had already gotten the notion that if we knew quite a bit about our genome, couldn't we put this knowledge into use by diagnosing and potentially treating genetic disorders present in somatic (adult) stem cells? This idea pushed scientists to create more effective ways of harvesting one's DNA to test for traits such as if a person is being a carrier (having one dominant and one recessive gene) for a serious genetic disorder such as sickle cell anemia or cystic fibrosis. That way, couples could make more informed, but not with 100% certainty, decisions on whether they would still like to have a child based upon potential risks present within their own DNA. Soon, it became clear that there needed to be a way to act on these findings, especially for people who already diagnosed or exhibited symptoms of these genetic disorders, and thus the powerful and relatively cheap tool CRISPR-Cas9, which was based off of a similar system which had an "immune" function in some prokaryotes (single-celled organisms), was born. The CRISPR-Cas9 tool includes the enzyme Cas9 as well as a piece of guide RNA (similar to DNA but single-stranded). This guide RNA leads the Cas9 enzyme to its targeted section of DNA, where Cas9 proceeds to act like a pair of scissors and splices the two complementary DNA strands. Then, the cell's

DNA repair system comes into play and places a new nucleotide/series of nucleotides in the cut section, effectively introducing a new mutation to the genetic code (What is CRISPR-Cas9?).

However, in November of 2018, Chinese scientist He Jiankui revealed to the world that he had created the first ever genetically engineered humans using the technology CRISPR. Two twin embryos had had their DNA modified to resist HIV, and the result were two twin girls, both with a murky future. Not only was this act immediately condemned by 122 of He's colleagues in China and from world leaders (Kolata et al., 2018), but it also answered the question that had been present ever since the technology CRISPR was invented: could this technology be enforced?

Some may view this event in a positive light as it proves that CRISPR is already an easily accessible mechanism and can be applied to patients soon, but the reality is that the science of gene-editing is something we have barely begun to explore yet. How are we affecting other parts of the genome by editing a single nucleotide? Just one change in A, T, G, or C can result in something catastrophic that we haven't seen before. Perhaps a new disease or an increased susceptibility to an already existing one? Or maybe a new gene coding for an enzyme which can turn an innocent individual into a blood-thirsty vampire? The truth is, geneticists really don't know for sure. Another thought which keeps scientists and geneticists awake at night is the ethical aspect of this: the knowledge that these changes to embryonic DNA can be and will be passed down to future generations for they are occurring in embryonic stem cells, which will differentiate into every cell within the resulting fetus, including that newborn's germ (reproductive) cells. As Stanford's bioethicist William Hurlbut puts it, "It's not like you're just dealing with an individual patient. You're now dealing with the entire human gene pool." (Stein, 2019). In other words, people who haven't even been born yet are already having their lives picked for them, as is the case of the two girls and their potential offspring assuming they do grow up and decide to have children.

CRISPR was originally intended to be a beacon of hope for patients with severe genetic illnesses such as cystic fibrosis or sickle cell anemia. Now, without a proper set of guidelines to regulate it and prevent it from falling into the wrong hands, this valuable technology can potentially be used in a negative way and be prematurely used, creating unintended consequences that have yet to appear in our imaginations. The two twin girls who were born in China that were supposedly immune to HIV may live perfectly normal lives, unperturbed by the thought of contracting HIV. Or they can grow up, constantly reminded that their DNA was modified when they were a tiny mass of cells and face a stream of negativity from people around them for having a leg up over everyone else. The worst aspect of this ordeal is that it wasn't even their decision to make. It was a single geneticist's idea, and when he went against the ideals and values of most of the scientists in the world, the result was them. Two souls who had their life picked for them before they were even born. And unless the entire scientific community can get a grip and put solid regulations in place for this technology, the future of genetics will be a dark place.

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Answer: The Antarctic Desert