Biotech And Genetic Engineering: Promising Aspects And Discouraging Risks

Introduction

When exploring the vast unknown world of Biotech and Genetic engineering there is one piece of technology that towers over the competition, demanding attention due to its promise to change the world. This piece of technology is CRISPR/Cas9. CRISPR is essentially a cut and paste tool for DNA allowing for unwanted genes to be removed or desirable ones to be added. DNA is made up of bases consisting of a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T) which are attached to a sugar molecule and a phosphate molecule. Together, a base, sugar, and phosphate are called a nucleotide. Nucleotides are arranged in two long strands that form a spiral called a double helix. (GHR, 2016)[image:](Figure 1, Double Helix)

These strands of DNA are the blueprint for all life with each individuals being specific to them. It is DNA that tells our body what and where everything does and goes. DNA is located in the nucleus of every cell in our bodies and it is here that a chemical is released simplifying the DNA into RNA.[image:](Figure 2, DNA to RNA Transformation)

Once Translated the RNA exits the Nucleolus through tiny pores into the cytoplasm where a Ribosome reads the RNA three letters at a time and then assembles Amino acids as per ‘described’ by the RNA into specific shapes forming proteins. These proteins are assembled in exact ways according to the RNA and each one them goes on to form different parts of the body from skin to muscle to tiny particles in your stomach each playing a specific role. (Stated Clearly, 2012)

The Technology

As previously described CRISPR is essentially a cut and paste tool to our DNA. CRISPR allows for access into one’s DNA and for the ability to edit it either by adding and or removing sections of a gene which is a section of DNA. CRISPR stands for clusters of regularly interspaced short palindromic repeats. It is a specialized region of DNA with two distinct characteristics: the presence of nucleotide repeats and spacers. Repeated sequences of nucleotides are distributed throughout a CRISPR region. Spacers are bits of DNA that are interspersed among these repeated sequences. CRISPR was first discovered in archaea (and later in bacteria) by Francisco Mojica in 1993 as an immune system defence. (Live Science, 2017) CRISPR is able to combat viruses using a three step process including; Adaptation, Production and Targeting.

Adaptation involves the CRISPR array consisting of cas proteins and CRISPR DNA using cas 1 & 2 proteins to incorporate a section the invading DNA called a protospacer (PAM) into the CRISPR array. The protospacer is a short DNA sequence that follows the gene that is being targeted. (NCBI, 2016) The PAM is required for Cas9 to be able to target the gene of that which it needs to cut. The second step Production is the development where the PAM that was incorporated into the CRISPR array becoming CrRNA matures through processes into the more

intricate tracrRNA. Finally targeting sees tracrRNA guide bacterial molecular machinery, the cas9 protein to cut the viral material. Because tracrRNA sequences are copied from the invading DNA during adaptation they are precise guides. (Harvard, 2014) Because CRISPR can locate specific DNA and cut it can be used to destroy negative genes or make a cut where new sections of DNA can be inserted.

Promising Aspects

In the past our ability to edit DNA has been inaccurate with unpredictable results. With previous technology, it has been like trying to edit a book a page at a time with no control of the contents of each page. The power CRISPR brings is it literally can edit down to each individual letter. This precision is far greater than anything that we have had before. Past technologies have been able to locate DNA sections only 2-6 bases long whereas CRISPR can locate strands that are 17-20 bases long. With this new found ability to edit DNA with such precision there is new realities for what can be achieved to drastically improve quality of life. The most promising application of CRISPR is the restoration of mutated and negative genes. There are over 7,000 monogenetic diseases that we can trace back to a single gene that has a defect. CRISPR is the key to extinguishing these diseases that have plagued humans for countless years. There are two types of genetic diseases; toxic gain of function and toxic loss of function. While toxic gain is a mutation that causes the proteins to gain an undesirable function, loss of function is as the name states where a protein is no longer doing its job correctly. An example of toxic gain of function is a disease called transthyretin in which a mutation causes a clumping up of different proteins. And that leads to a disease called amyloidosis, where these proteins, which normally don’t stick together, because of this kink in them due to the mutation, they become very sticky. They form aggregates and those aggregates can build up in various cells in the body. Sometimes the brain, sometimes the heart obviously causing many problems. (Scitech Daily, 2018) CRISPR allows for this type of illness to be rid of as the mutated cells in the genes can be directly accessed and repaired hence any problems these monogenetic diseases would have caused are avoided. Cancer, one of the most lethal epidemics also like monogenetic diseases originates as a mutation in a gene and CRISPR offers to be a promising solution to it as well. Besides the preservation and restoration of genes CRISPR also makes way for very specific genetic enhancements to animals and plants promising to revolutionise farming due to the same power to edit genes at their base.

Discouraging Risks

The one potential danger of CRISPR that seems to shroud the numerous positives put simply is the uncertainty of genetic engineering. Not just the technology of CRISPR but genetic engineering as a whole science is a modern discovery dating back only until 1964. Because of this the rate at which new discoveries are occurring are exponential and because of the immediacy that which discoveries are made scientists have not been able to complete a full risk assessment as nothing is fully understood. Questions arise such as could editing genes actually be the catalyst for mutation? One geneticist stated that unexpected events had occurred after CRISPR editing and that changes that would occur were severely underestimated. (Science Alert, 2018) With the concern that gene editing may cause results that are unexpected the risk involved is greatened immensely due to the concept of gene drive, or genetic drive. What that means is that because you’re actually manipulating genes and those genes get incorporated into the genome, into the encyclopaedia, basically, that sits within cells, potentially those genes

can then be transferred on to other organisms. And once they're transferred on to other organisms, once they become part of the cycle, then those genes are in the environment. If someone was to be genetically modified using CRISPR and developed an undesirable mutation which went undetected it would be transferred into the genes of their offspring spreading through generations. Combined with the fact that any DNA modification is irreversible an undetected mutation spread through generations could have catastrophic repercussions that is very difficult to rid of. Until this science is understood to a much greater extent the potential risk that is the implications of underestimated DNA changes due to CRISPR the technology should not be used broadly. (The Conversation, 2018)

Ethics

Besides the discouraging risks or the promising aspects CRISPR provides there is a dilemma of ethics that arises whenever the idea of genetic engineering is discussed. scientists have reported using CRISPR to repair a genetic mutation, one that could cause a heart defect in an embryo. This raises the promise that gene editing will used to protect off spring from hereditary diseases. (Scitech Daily, 2018) Birth defects are some of the saddest illnesses as the person in question will be forced to live their entire life with whatever the disability in question is. If CRISPR could be used to ensure babies are no longer born with such a terrible burden, then should be used. However, if a baby's genes are edited to cure a sickness then where would the line be drawn to what can and cannot be done to a baby in regards to gene editing. If someone wanted to edit their offspring to have greater athleticism or intelligence should they be able to? The use of CRISPR to cure, repair or restore burdened lives is widely agreed on to be desirable however where this idea of fixing blurs into enhancement is where attitudes and beliefs clash on what the limits to what CRISPR should be used for exists. As this dilemma is purely ethics based there is no right or wrong answer however as previously described by the risk of gene drive the modification of genes should be taken very seriously and to minimise the risks genetic modification should occur as little as possible.

Conclusion

CRISPR has proved itself to be a very promising piece of technology that is guaranteed to play a huge role in the near future as genetic engineering is on a trajectory to change the world. However, despite this due to the amount of uncertainty and mystery still regarding genetics and DNA as well as the unresolvable issue that is the ethics of the issue there is a long way to go in the world of Biotechnology and Genetic engineering.

Reference List

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