Gene editing for treating diseases

Science, Genetics

Genome editing is the modification of a specific DNA sequence, within a cell or organism. It has been around since 1970 but only in the recent years have scientists discovered technologies which allow them to precisely cut and edit DNA. Clustered regularly interspaced palindromic repeats (CRISPR)/cas 9 is perhaps the most exciting of these technologies. Compared to previous technologies it is faster, cheaper and more accurate. CRISPR/cas 9 works off two components: guide RNA and cas9 enzyme. The guide RNA matches the sequence of the target gene. This shows the cas9 enzyme where to cleave the double stranded DNA. Modifications can then be made to the genome.

The applications of gene editing are endless, yet public opinion remains sceptical. Although 65% of individuals from the US accept altering genes to cure diseases (Blendon et al., 2016) many areas remain a controversy. These include germline editing, the editing of unborn babies, and the editing of a person’s appearance or intelligence. In this essay I will discuss the advantages and disadvantages of gene editing, and the debate around it.

The main debate for gene editing would be its potential to cure thousands of diseases, for example muscle dystrophy. Muscle dystrophy can be caused by a number of different mutations in the dystrophin gene. It causes a deficient amount of dystrophin resulting in deterioration of heart and skeletal muscle. In 2018 scientists used CRISPR to correct the majority of these mutations (Long et al., 2018). The study delivered CRISPR/cas 9 to human heart cells. They cut the DNA at 12 ‘ hotspots’ for mutation sites in the gene. This allowed a bypass of the mutant exons and for the open reading frame to be read normally. The results found this method could be used to restore

dystrophin production in up to 60% of patients. Other diseases which could be cured by CRISPR/cas9 include cancer, blindness, HIV and cystic fibrosis.

This study and many other studies however only used singular cells. Humans are more complex. It could be argued we are still unaware of how well CRISPR/cas9 works. Researchers from Sweden's Karolinska Institute have recently published a study finding that CRISPR may trigger cancer (Haapaniemi et al., 2018). When CRISPR/cas 9 is used it may activate the P53 protein. The p53 protein is involved in DNA repair. It could compromise the effectiveness of CRISPR by repairing the broken DNA before it is altered. As a result scientists are more likely to select cells with a faulty p53 protein. DNA in cells with a faulty P53 protein, are more vulnerable to mutations. Over 50% of cancers carry a fault p53 protein (Ozaki and Nakagawara, 2011). Gene editing may therefore not be safe for the use in humans.

Gene editing for research

Gene editing has advanced our knowledge on DNA repair mechanisms, gene arrangements, human development, gene functions and human diseases. For example we can use gene editing to create knockout genes. This can help us to find out the function of genes. The function of the gene encoding OCT4 was discovered by using CRISPR/cas9 (Fogarty et al., 2017). The results found blastocyst development was compromised. It could be concluded that low OCT4 activity could be a cause for early miscarriages. Research like this will help us understand why some pregnancy's terminate and improve our IVF methods.

The research used 41 embryos donated by IVF couples. This is obviously highly controversial, with many questioning ‘ is it ethical to use embryos for research?’. 65% of Americans stated that if gene editing relies on embryonic testing it is taking medicine too far (Funk and Hefferon, 2018)(see figure 1). The issue is not particularly with gene editing, but when life begins for the embryo. It is mainly religious individuals who believe editing on embryos is taking it too far. This could be explained by their belief that life begins at conception.

Gene editing plants

Gene editing plants can optimise food production. It gives plant breeders the opportunity to produce crops with superior traits, such as resistance to pests. The European court has recently ruled that genetically edited plants are genetically modified organisms (citation needed). This means genetically edited plants will now face the same rules and restrictions that genetically modified organisms do. This is to protect the public from potentially unsafe products.

Overall even though gene editing has lots of useful applications, it does produce risks. Even CRISPR, the most accurate technology, still produces off target effects. It may sometimes cause large deletions and genome rearrangements (Kosicki et al., 2018). Gene editing must only be used if the benefits outweigh the risks. In china human trials using CRISPR have begun, for patients with an aggressive lung cancer (Normile, 2017). Treatments such as chemotherapy and radiotherapy have failed on the patients used. In this case the benefits CRISPR could produce outweigh the risks as the

patients have no other treatment options. Gene editing babies to be more intelligent is something that will likely never happen, as the risks will always be more severe. We must also apply this same logic to plants.