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The New Technology of Genetic Engineering-CRISPR

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***Abstract* –In recent times, the research to edit the genome of different organisms has led to marvelous discoveries. In the late 80s, scientists discovered palindromic sequences in the DNA which has since been used as the base for recombinant DNA technology to help create lab synthesized enzymes and medicines which have slingshot the pharmaceutical field into a whole new world, but now with work been done on the new gene-editing technologies like CRISPR. This is a whole new way of looking at the DNA. Something that we could add a piece to can now be edited to such an extent that we can choose what each gene does.**

***Keywords*–CRISPR, Cas9, Gene Editing, CRISPR Cas System, Cas3.**

I. INTRODUCTION

The research on CRISPR started in early 2010 and now it has become one of the leading fields of research involving scientists from all over the world. CRISPR or Clustered Regularly Interspaced Short Palindromic Repeats is an anti-viral mechanism developed by bacteria[1]. It is developed by those bacteria which have survived a viral attack. Once they survive, the create a complementary RNA copy of the viral DNA adhered to their genome and synthesize a protein system- CRISPR Associated Protein or CAS protein system.This is part of a very primitive immune system developed by prokaryotes[10]. The CAS systems are broadly divided into 2 classes based on their acting sites, structure, and working.

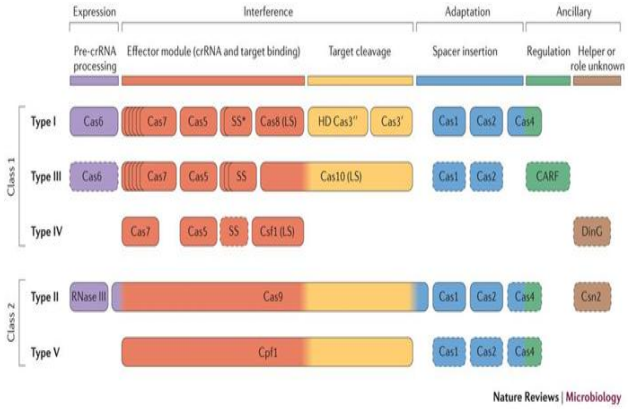

Fig.1. Different types of CAS systems and the bases for their classification.[13]

Once the CAS protein (bound with the cRNA or guide RNA) locates an exact copy of its template, it uses nuclease enzymes to cut out that part of the gene and uses DNA ligase to repair or join the remaining ends of the gene[2]. This allows scientists to add or remove certain bases to change the overall gene expression to get new phenotypic characters which may be beneficial for curing diseases.

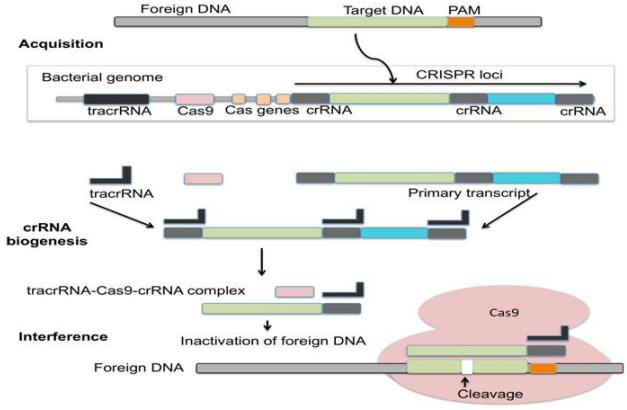

Fig.2. The basic working of CAS systems.[2]

II. THE PROGRESS AND RESEARCH

Soon, scientists discovered that these naturally occurring gene editors can be programmed to edit the desired genes. Scientists are now working on using CRISPR to cure diseases like cancer, AIDS[3], Hepatitis, Muscular Dystrophy, and other genetic disorders like Hemophilia, Huntington's, Alzheimer's which are fatal.[4] In recent years, scientists in China and the US are trying to use CRISPR as a method to cure AIDS.

In 2015, scientists used CRISPR to cut out the HIV virus from infected patients in labs to prove that this was indeed possible[3]. A year later, large scale experiments were conducted on mice where CRISPR CAS9 proteins programmed with HIV viral DNA were injected in the tails of these mice infected with the virus and had the virus in basically all of their body cells. Upon observation, more than 50% of the cells in these mice were found free of the HIV virus. Cancer is one of the most fatal diseases. This is caused when cells refuse to die

and keep multiplying while hiding from the immune system. CRISPR gives scientists the means to enhance the immune system to make it more efficient in hunting cancer cells. The first clinical trial of CRISPR on cancer patients was approved in June 2016 in the US. Not even a month later, Chinese scientists announced that they would used cells enhanced with CRISPR to treat lung cancer patients.[7] And then there are genetic diseases. They range from mildly annoying to deadly or entail decades of suffering. With a powerful tool like CRISPR, we could be able to end this. Over 3000 genetic disorders are caused by the error of a single base in the human DNA sequence. Scientists are already working on a modified version of CAS9 to change just one or two bases in the sequence, fixing the disease in the cell. In a decade or two, we can cure thousands of diseases using CRISPR.[6]

But all of these medical applications have one thing in common- they are limited to the individual and die with them-Except if they are used in the germ layer of reproductive cells or very early embryos. This would result in the creation of genetically engineered babies. This is one of the reasons why there are so many ethical issues pertaining to the widespread use of CRISPR.
CRISPR can also help in curing the single, biggest mortality problem- Aging. Two-thirds of the 150,000 people who die every day die due to age-related causes.[8]

Currently, we think that aging is caused due to the accumulated damage to our cells like DNA breaks and the systems responsible for fixing those-Telomeres- wear off over time. But there are also genes that directly affect aging[9]. A combination of genetic engineering and other therapy could stop or slow down aging. We know from nature that there are animals like Turritopsisnuctricula or the Immortal Jellyfish, Planaria, and some species of lobsters that are immune to aging. Their genes can be used to create anti-aging therapy for humans, thus increasing the lifespan exponentially. Humans would still die at some point but instead of doing that at the age of 90 in a hospital bed, we can decide how long we can spend time with our young ones and die at an age desired by us.

III. SOME COMMON PROBLEMS IN CRISPR

All that has been discussed above have to be taken with a grain of salt as none of this will happen any time soon. As powerful as CRISPR is, and it is, it's not infallible yet. Wrong edits still happen and well as unknown errors that could occur anywhere in the DNA and might go unnoticed. The gene edit might achieve the desired result, disabling the disease, but also might accidentally trigger unwanted changes. Humans have only scratched the surface of this technology and thus only so much is known. Working on monitoring and accuracy methods is a major concern as the first human trials begin. Along with this comes the ethical issues of genetically enhanced humans. Theoretically, CRISPR can also be used to create super soldiers which could push the world towards another global war.

IV. GRAPHS AND SURVEY REPORTS

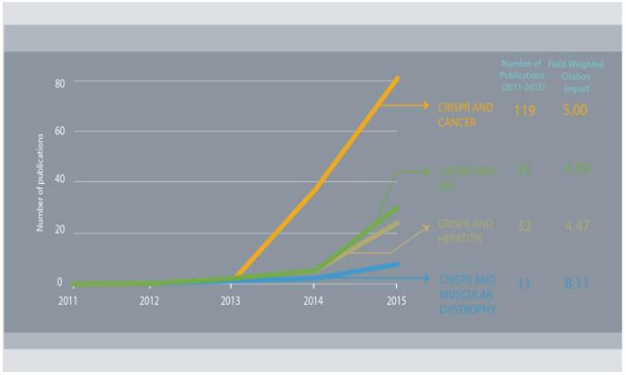

Fig.3.Papers published on the use of CRISPR on various diseases during 2011-15

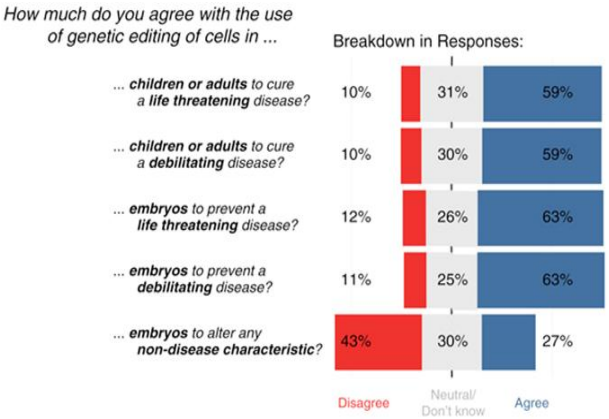

Fig.4. Common people's response to the various uses of gene editing.

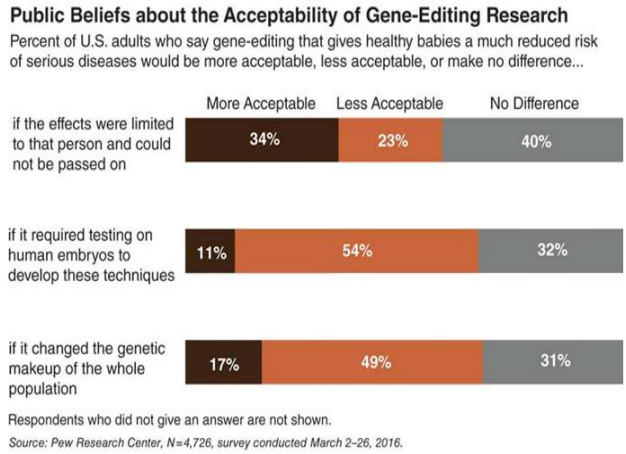

Fig.5. Common people's response to the use of gene editing on humans considering cases when the editing can or cannot be passed on.

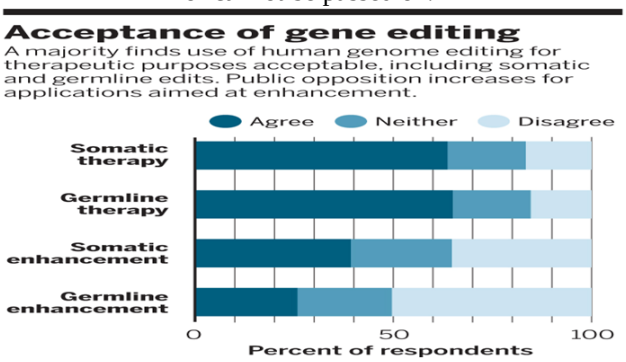

Fig.6. Acceptance of different uses of gene editing- Therapy and Enhancement.

V. CONCLUSION

Though it has its shortcomings, a lot can be gained from this. Genetic engineering might just be the next step in the natural evolution of intelligent species of the universe. Diseases might be ended and life expectancy could be extended by centuries and deep space travel could be turned into a reality.Most people seem to know what CRISPR technology is and agree that it could be a game-changing thing in the field of medical and research sciences. But they also agree that there should be strict restrictions put up in order to prevent its misuse.

Thus its save to say that CRISPR research is still in its infancy. It is too early to declare it a miracle or a disaster but as more and more research is done, we can be sure to find new outcomes to better understand this technology.

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