Lesson 5: ETHICAL ISSUES IN SCIENCE & TECHNOLOGY (GENE EDITING)

INTRODUCTION

Genes are small units of information inside our cells that contain instructions for how our bodies develop and function. While **Deoxyribonucleic acid** (DNA) is a molecule that carries genetic information in living organisms. Found inside the nucleus of our cells. Gene editing, a revolutionary that technology that allows scientist to modify the DNA of living organisms. This report aims to present an overview of gene editing, techniques or methods, possible benefits and downsides, ethical and societal concerns.

OVERVIEW OF GENE EDITING

Genome editing (also called **gene editing**) is a group of technologies that give scientists the ability to change an organism's DNA. These technologies allow genetic material to be added, removed, or altered at particular locations in the genome.

Gene editing is performed using enzymes, particularly nucleases that have been engineered to target a specific DNA sequence, where they introduce cuts into the DNA strands, enabling the removal of existing DNA and the insertion of replacement DNA.

GENOME EDITING METHODS

Scientists have had the knowledge and ability to edit genomes for many years, but CRISPR technology has brought major improvements to the speed, cost, accuracy, and efficiency of genome editing. The history of genome editing technologies shows the remarkable progress in this field and also relays the critical role that basic science research plays in the development research tools and potential disease treatments.

Homologous Recombination

- the earliest method scientists used to edit genomes in living cells.
- Scientists began developing this technique in the late 1970s.
- It is limited by the fact that it is extremely inefficient in most cell types. This technique can have as low as a one-in-a-million probability of successful editing.
- Inaccurate and has a high rate of error when the injected DNA fragments insert into an unintended part of the genome.

Zinc-finger nucleases (ZFN)

- 1990s researchers started using ZFN to improve the specificity of genome editing and reduced off-target edits.
- Scientists can engineer these proteins to bind to specific DNA sequences in the genome and cut DNA. Once bound to their target DNA sequence, the ZFNs cut the genome at the specified location, either to delete or replace the DNA.

- Although ZFNs improved the success rate of genome editing to about 10 percent, it is difficult and time-consuming to design, construct, and produce successful zinc finger proteins.

Transcription activator-like effector nucleases (TALENs)

- 2009, new class of proteins called TALENs
- Similar to ZFNs, TALENs are engineered from proteins found in nature and are capable of binding to specific DNA sequences.
- TALENs bear the advantage of greater simplicity. Much easier to engineer than ZFN.

Clustered regularly interspaced short palindromic repeats (CRISPR)

- Simple technology with little assembly required.
- CRISPR associated DNA sequences were first observed in bacteria in the early 1990s, but it was not until the 2000s that the scientific community understood its ability to recognize specific genome sequences and cut them via the **Cas 9**.
- In nature, CRISPR is used by bacteria as an immune system to kill invading viruses, but it has now been adapted for use in the lab.
- Biochemist Jennifer Doudna and microbiologist Emmanuelle Charpentier co-invented this gene-editing system.
- This combination of precision, speed, and versatility makes CRISPR the go-to tool for gene editing in both research and practical applications, such as medicine and agriculture.

BENEFITS AND DOWNSIDES OF GENE EDITING

Possible benefits are the following:

1. Radical improvements to human health.
2. Fix gene mutations that can cause cancer
3. Enable new therapies for HIV
4. Make crops more nutrition
5. Help animals resist diseases

Possible downsides:

1. Genes could be edited in human embryos.
2. The possibility of designer babies.
3. Gene editing tools cut in the wrong spot.
4. Expensive
5. Can be used for nonmedical reasons.
6. Threaten biodiversity

There are some ethical and societal concerns to consider. The technology is already in our hands, now's the time to debate how we use it, regulate it, avoid negative uses, and unlock its potential to provide life-changing solutions to some of the world's biggest challenges.

CONCLUSION

Gene editing represents a significant advancement in biotechnology, with far-reaching implications for human health, agriculture, and the environment. While it holds great promise, careful attention must be paid to its ethical, social, and scientific challenges to ensure that its full potential is realized responsibly.