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Integrating CRISPR and Gene Editing in the Forensic Investigation of Inherited Diseases

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Introduction

The rapid advancements in genetic research and biotechnology have profoundly impacted many fields, including forensic science. One of the most significant breakthroughs in genetics over the past decade has been the development of CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) technology, a tool that allows precise, targeted alterations to DNA. This powerful tool has revolutionized how scientists understand and manipulate genetic material, enabling not only potential treatments for inherited diseases but also new possibilities for forensic investigation. The integration of CRISPR and gene editing in forensic science could provide critical insights into inherited diseases, enabling the identification, diagnosis and investigation of genetic disorders with unprecedented precision [1].

In forensic investigations, particularly those involving cases of inheritance or familial diseases, CRISPR-based gene editing techniques offer new avenues to study the genetic underpinnings of diseases, trace disease inheritance patterns and even offer insights into the presence of genetic predispositions in individuals or families. This paper explores how CRISPR and gene editing could be integrated into forensic investigation, particularly in the context of inherited diseases and evaluates the potential benefits, challenges and ethical considerations associated with these emerging technologies. CRISPR, first discovered as a component of the bacterial immune system, has become a transformative tool in molecular biology. Its ability to edit genes with unprecedented precision and efficiency has allowed for the development of a range of applications, from basic research to potential therapies for genetic diseases. CRISPR operates through a system of RNA-guided nucleases that enable the targeted modification of specific DNA sequences, allowing researchers to either disrupt, repair, or replace genes within living organisms [2].

Description

Gene editing, particularly with CRISPR, has allowed scientists to address both dominant and recessive genetic diseases. Dominant diseases occur when a single copy of a mutant gene is sufficient to cause the disorder, while recessive diseases typically require two copies of a mutated gene to manifest. By using CRISPR, researchers can insert, delete, or correct specific sequences in the genome, thus providing a powerful tool for studying disease mechanisms, understanding inheritance patterns and potentially correcting genetic mutations that lead to disease. In forensic science, where genetic analysis is crucial for identifying individuals and solving crimes, CRISPR can enhance the accuracy and depth of genetic investigations. Forensic investigations that deal with inherited diseases can benefit from CRISPR technology by allowing forensic professionals to not only trace genetic evidence but also to gain deeper insights into the inheritance patterns of certain diseases, thus providing crucial evidence in criminal cases or paternity tests. Forensic investigations involving inherited diseases often require the detailed analysis of genetic material from various individuals involved in a case, be it family members, suspects, or victims. Traditional genetic techniques, such as sequencing or polymerase chain reaction (PCR), provide important insights into the genetic makeup of individuals, but the integration of CRISPR technology could allow for much more targeted and specific analysis, leading to more accurate diagnoses and investigations [3].

Inherited diseases are often caused by mutations in specific genes that can be passed down from one generation to the next. In cases where forensic investigators need to determine the presence of inherited diseases, CRISPR technology can be used to precisely identify and isolate the mutations responsible for these diseases. By using CRISPR-based tools to correct or alter specific gene sequences, forensic scientists could pinpoint the exact mutation responsible for a genetic disorder and trace its inheritance through family lines. This could be particularly valuable in cases involving genetic disorders like cystic fibrosis, sickle cell anemia, or Huntington's disease, where identifying the specific gene mutation is crucial for diagnosis and understanding how the disease may manifest in offspring. In forensic investigations, understanding inheritance patterns is often critical to solving cases involving familial connections, inheritance of genetic diseases, or questions of paternity. CRISPR technology can be used to investigate the inheritance patterns of genetic disorders, whether dominant or recessive and determine how a disease is passed from one generation to the next. Forensic scientists could utilize CRISPR to simulate how a specific mutation might behave in an individual or family and study how the mutation may be inherited across generations. For example, in a case where a family member is suspected to have inherited a genetic disorder, CRISPR could allow forensic experts to analyze how the genetic trait is passed through the family tree, providing invaluable evidence in legal or investigative contexts. CRISPR can also play a significant role in diagnosing genetic predispositions to inherited diseases. Forensic investigations into cases involving diseases like cancer, cardiovascular conditions, or neurodegenerative disorders may require understanding whether a suspect or victim carries genetic mutations that predispose them to certain conditions. CRISPR-based gene editing allows for the precise identification of these mutations, providing forensic scientists with the ability to trace genetic predispositions that could have an impact on the investigation. By identifying specific genetic markers that indicate an increased risk for developing a disease, forensic experts could piece together a more comprehensive picture of a person's genetic makeup, shedding light on the potential cause of a disease or the likelihood of it being inherited [4].

Another ethical concern is the potential for genetic discrimination. The ability to identify inherited diseases and genetic predispositions raises the risk that individuals could be unfairly discriminated against based on their genetic makeup. In the context of forensic investigations, this could manifest in legal cases where an individual's genetic information is used to make inferences about their behavior or health. It is essential that ethical safeguards are in place to prevent the misuse of genetic data and to protect individuals from discrimination based on their genetic profile. The potential for CRISPR to be used in human gene editing also raises concerns about the ethical implications of altering the human genome. While gene editing in somatic cells (non-reproductive cells) is generally considered acceptable in therapeutic contexts, editing the germline (reproductive cells) is highly controversial. The prospect of using CRISPR in forensic investigations to potentially alter human genetics in the future could raise serious ethical questions about the boundaries of genetic intervention and the potential long-term consequences of altering the human gene pool. The application of CRISPR in forensic investigations is still in its early

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stages and its reliability and accuracy need further refinement. CRISPR-based gene editing may not always produce the desired outcomes and the possibility of unintended genetic changes or off-target effects remains a concern. Forensic investigations require a high degree of precision and any errors in gene editing could have significant legal and ethical implications. As such, researchers must ensure that CRISPR technology is sufficiently advanced and reliable before it becomes a standard tool in forensic investigations [5].

Conclusion

The integration of CRISPR and gene editing in forensic investigations of inherited diseases offers significant potential for advancing the field of forensic science. By allowing for the precise identification of genetic mutations, the study of inheritance patterns and the diagnosis of genetic predispositions, CRISPR-based technologies could enhance the accuracy and depth of forensic investigations. However, the use of these technologies must be approached with caution, considering the ethical, legal and practical challenges that arise from manipulating genetic material. As the technology continues to evolve, it is essential that forensic scientists, ethicists and policymakers work together to ensure that CRISPR and gene editing are used responsibly and ethically in forensic investigations, benefiting both science and society as a whole.

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Conflict of Interest

The author declares there is no conflict of interest associated with this manuscript.

References

1. Hwang, Sang Mee, Ki Chan Lee, Min Seob Lee and Kyoung Un Park. "Comparison of ion personal genome machine platforms for the detection of variants in BRCA1 and BRCA2." *Cancer Res Treat* 50 (2018): 255-264.
2. Hess, Jacob Friedrich, T. A. Kohl, M. Kotrová and K. Rönsch, et al. "Library preparation for next generation sequencing: A review of automation strategies." *Biotechnol Adv* 41 (2020): 107537.
3. Hwa, Hsiao-Lin, Chun-Yen Lin, Yu-Jen Yu and Adrian Linacre, et al. "DNA identification of monozygotic twins." *Forensic Sci Int Genet* 69 (2024): 102998.
4. Børsting, Claus, Sarah L. Fordyce, Jill Olofsson and Helle Smidt Mogensen, et al. "Evaluation of the Ion Torrent™ HID SNP 169-plex: A SNP typing assay developed for human identification by second generation sequencing." *Forensic Sci Int Genet* 12 (2014): 144-154.
5. Alvarez-Cubero, Maria Jesus, Maria Saiz, Belén Martínez-García and Sara M. Sayalero, et al. "Next generation sequencing: An application in forensic sciences?." *Ann Hum Biol* 44 (2017): 581-592.

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