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# Redefining Human Evolution in Medical Sector with Genetic Engineering and Artificial Intelligence Collaboration

**Aishwarya Ashok Mundewadi[1], Shridevi Raghvendra Arkal[2], Komal Krishnappa Birajdar[3], Vaishnavi Pandurang Yeldi[4], Prof. Priyanka Shrihari Pasnur[5]**

[1] *Artificial Intelligence & Data Science at VVP Institute of Engineering & Technology, Solapur, mundewadiaishwarya@gmail.com*
[2] *Artificial Intelligence & Data Science at VVP Institute of Engineering & Technology, Shrideviarkal25@gmail.com*
[3] *Artificial Intelligence & Data Science at VVP Institute of Engineering & Technology, komalbirajdar8080@gmail.com*
[4] *Artificial Intelligence & Data Science at VVP Institute of Engineering & Technology, vaishnaviyeldi16jan@gmail.com*
[5] *Artificial Intelligence & Data Science at VVP Institute of Engineering & Technology, pasnur.work@gmail.com*

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**Abstract –** This study will redefine the human evolution and Medical sector by collaborating Pharmaceutical technology with Genetic engineering and Artificial Intelligence. While prior research has explored various research papers and articles to enhance the integration and empower the pharmaceutical industry by developing a technology that will predict the diseases and empower the rural areas, pharmaceutical industry and humankind to find a better life using technology

***Key Words***: Artificial Intelligence, Machine Learning, Genetic Engineering, Advanced Medical Technology, Geno-Phenotype, Disease prediction.

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## 1.INTRODUCTION

Genetic Engineering has revolutionized the medical and biomedical science over the past two decades by advancing from recombinant DNA to CRISPR/Cas9. This made way for personalized treatments and diagnosis, basically reshaping the future of healthcare and prevention diagnosis.

We are going to make an application that is powered by Machine Learning and Artificial Intelligence to predict the disease using Genotype and Phenotype to make the predictions more efficient and personalized. Genotype is the genetic information collected by the Biobanks od Bio-laboratory which is the dataset given to the Machine to learn and the Phenotype basically defines your lifestyle habits like smoking, drinking, supplement consumption and medical history.

## 2. Genetic Engineering Importance and Case Studies

Genetic Engineering has revolved very fast in last two decades and made statement changes and promising revolutions including the great contribution in Green Revolution and White Revolution who made the impactful changes in human colonization development and Industry Revolution.

As we are talking about Genetic Engineering the whole term revolves around DNA that is Deoxyribonucleic Acid the DNA samples are present in each and every cell of the human body including blood, nail, hairs, bones, skin, split, urine, motion and sweat. This DNA contains the script or encryption and decryption key of the human body the DNA is responsible for the human body growth and behavior like DNA is responsible for hair color, eye color, metabolism, emotional behavior of a person at different situations and allergies of a person of particular things that may not have any problem with other people.

Jennifer Doudna and Emmanuelle Charpentier are renowned for their groundbreaking collaborative research in developing the CRISPR-Cas9 system, a revolutionary tool for genome editing (genetic scissors) for this discovery, they were jointly awarded the 2020 Nobel in Chemistry. Their work was majorly focused on understanding a component of the ancient immune system that bacteria use to defend themselves against viruses.

According to some records scientists in China and South Korea have successfully engineered “super muscly” or “double muscly” pigs using a targeted genetic change via the CRISPR/Cas9 gene-editing technique. And according to Global Gene Editing Regulation Tracker China is conducting various research on gene-editing from 2017. In 2019, British livestock genetics firm Genus licensed its patented technique to develop virus-resistant pigs to Beijing Capital Agribusiness (BCA), which seek regulatory approval for the research.

A Chinese scientist claimed that he has created the world’s first gene-edited babies in 2018, the twin babies named Nana and Lulu DNA modified to make them resistant of HIV using the gene-editing tool CRISPR-Cas9 before birth.

According to a report published on Aug 12, 2023 By Jessie Yeung on CNN China has been pouring billions of dollars to establish their dominance with expert to collect massive population of 1.4 billion people can provide a treasure trove of data.

A report covered by Genomeweb says US Department of Defense Adds BGI Genomics to blacklist of 'Chinese Military Companies' along with 12 other companies, to Chinese military companies operating directly or indirectly in the United States.

According to a report published on 2017, Nov 1 by The Moscow Times Entitled "Top Officials Express Concern Over Foreign Collection of Russian DNA" The Russian officials are concern about the sensitive data of lab sample collection of biological materials of the Russian citizens by the foreign agencies. In action to that Russian government is all set to introduce new laws to ensure the "biological security" of Russian citizen. A Russian MP Kremlin said foreign labs were analyzing Russian's DNA and restriction on such research were necessary.

In order to the security concern with the sensitive genetic data if we can use the data for development and wellbeing of human kind and environment then this technology is going to be a blessing or boon to the whole mankind. So far, the awareness the laws and regulations in the international level is needed for the security and proper usage of the data. With this mindset we have started our project to serve the mankind well-being and empowerment.

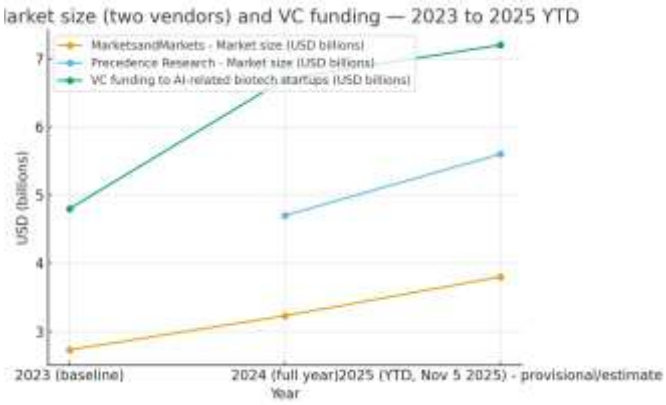


**Fig-1:** The Market Size and VC funding data of 2023 to 2025 YTD

## 3. Importance of The Genetic Engineering and Artificial Intelligence Collaboration

Integrating AI with genetic engineering accelerates the discovery, design, and optimization of genes, proteins, and therapies. AI algorithms analyze vast genomic datasets, predict gene functions, and identify patterns that humans might miss-enabling faster development of precision medicine, gene editing (like CRISPR), and synthetic biology solutions. This collaboration reduces research time, lowers costs, improves accuracy in genetic modification, and supports personalized healthcare and sustainable agriculture innovations.

In short, AI amplifies the power of genetic engineering, turning complex biological data into actionable insights for science, medicine, and industry.

**Table 1:** Vital Roles can be played by AI

| Area | Role of AI | Impact |
|---|---|---|
| Genomic Analysis | Identifies patterns in DNA | Faster gene discovery |
| CRISPR Precision | Predicts off-target edits | Safer gene editing |
| Personalized Medicine | Analyze patient genomes | Custom therapies |
| Agriculture | Simulates crop gene edits | Higher yield, sustainability |
| Synthetic Biology | Design biological circuits | Biofuels, materials |
| Ethical Oversight | Predicts risks | Responsible innovation |

Charts

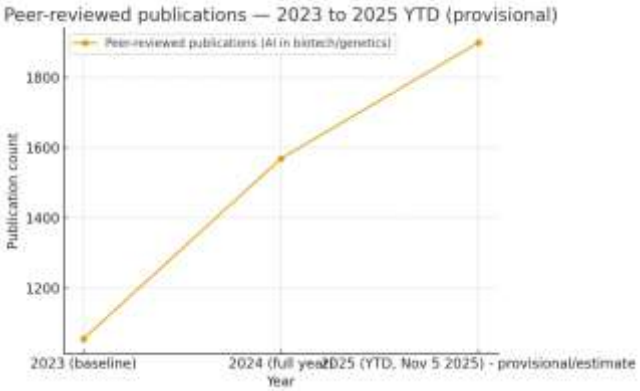


**Fig-2:** Researches around the world on collaborative projects with AI and Genetic Engineering

A Machine Learning (ML) predictive model that uses collaborative genetic data is a powerful tool for early and accurate disease prediction. By combining large-scale genomic datasets from diverse populations, these models can recognize subtle genetic patterns linked to diseases that traditional methods often miss.

## 4. Key Operations

- Early Detection:

ML models analyze genetic variations (like SNPs and mutations) to identify individuals at risk before symptoms appear, enabling preventive healthcare.

- Precision & Personalization:

Collaborative data from multiple sources improves the model's accuracy and generalizability, allowing personalized treatment plans based on an individual's genetic profile.

- Integration with Clinical Data:

When combined with medical records and lifestyle data, ML models provide comprehensive disease risk assessments, enhancing diagnostic precision.

- Accelerated Research:

AI-driven analysis of shared genetic datasets helps researchers discover new biomarkers and gene–disease relationships faster than manual analysis.

- Global Health Impact:

Collaborative data sharing reduces bias (since it includes diverse genetic backgrounds), leading to more equitable and globally relevant healthcare insights.

## 5. Challenges

- Data-Related concerns:

Genetic data is very sensitive data which must be restricted due to privacy and ownership issues.

- Ethical and Legal concerns:

Accessing Genetic data requires strict ethical and legal approval and informed consent to avoid misuse.

- Technical issues:

Requires universal data formats and Analyzing genome-scale data needs advanced specialized algorithms and requires cross-disciplinary.

## CONCLUSIONS

In conclusion, this review has summarized the current advancement, challenges, and future prospects in the field of genetic technologies and medical innovation combination tools such as artificial intelligence, big data analytics, and machine learning has revolutionized research and clinical application. However, issues such as ethical, data privacy, integrity, and limited accessibility are the major challenges to be focused. Addressing these barriers through collaborative research and policy-level interventions will be crucial in ensuring use of these technologies. Future work should focus on translating laboratory findings into real-world applications that enhance human health and wellbeing.

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