

Mutation Rate Analysis and Gene Engineering

**Molecular biology and basic cellular physiology and
Ethics, innovative research, businesses & IPR**

[24AIM112] [24AIM115]

Guide:

Mrs. Reshma sanal
Dr. Neelesh Ashok

Team Members:

C M Prakateessh	CB.AI.U4AIM24110
Mahashree C	CB.AI.U4AIM24128
Reha Sreekumar	CB.AI.U4AIM24146
Susanth Mohan Kamala	CB.AI.U4AIM24148

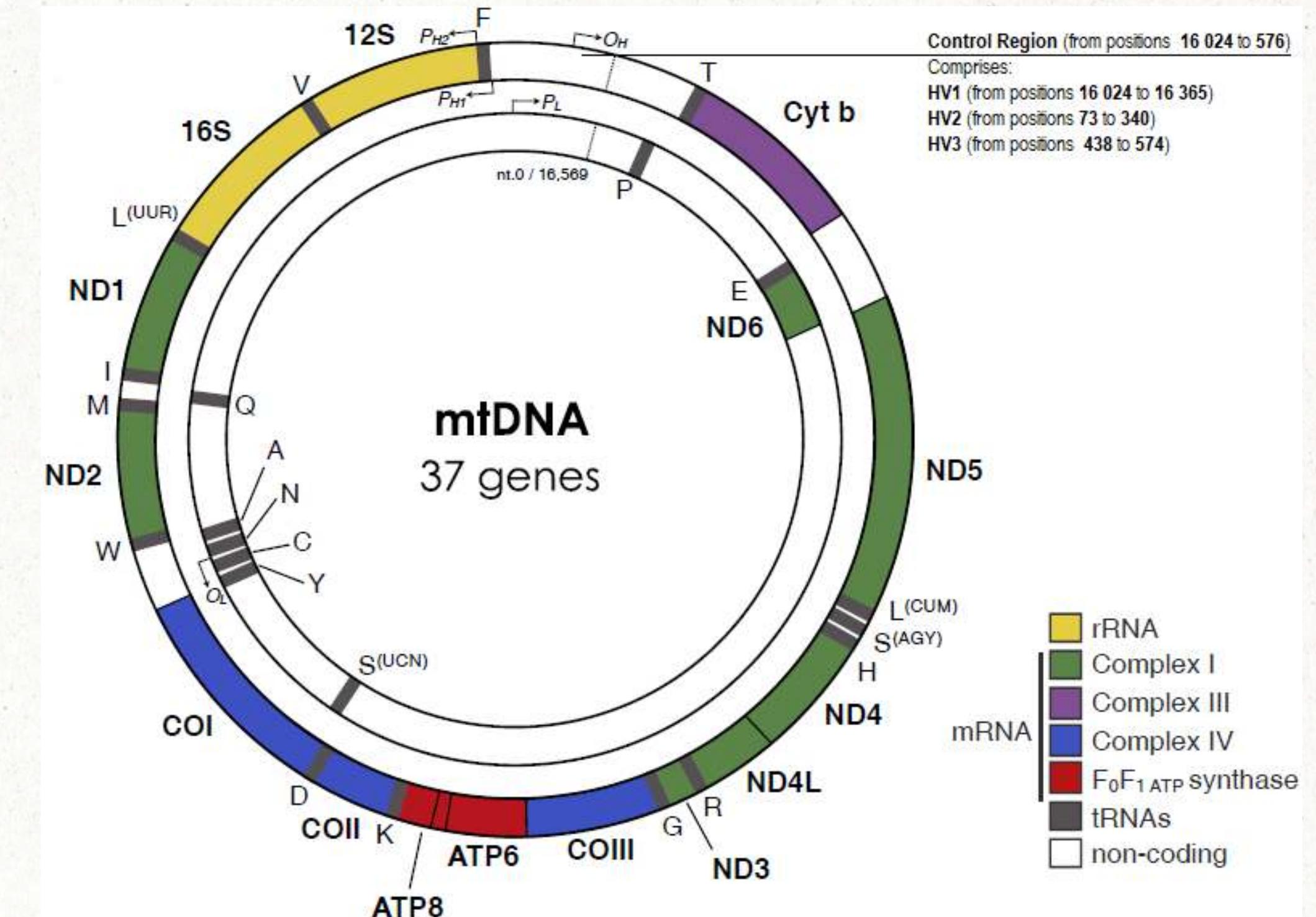


Introduction

- Mutation rates influence gene stability, evolution, and genetic diversity.
- High mutation rates can lead to genetic disorders and reduced gene functionality.
- Understanding mutation patterns helps predict gene stability.
- Ethical considerations are integral to gene engineering, ensuring responsible use of technologies like CRISPR to balance innovation with potential societal and environmental impacts.

Objective

- To compare the mutation rates among seven different species of mitochondrial gene.
- To identify unstable genes and perform gene editing to enhance stability.



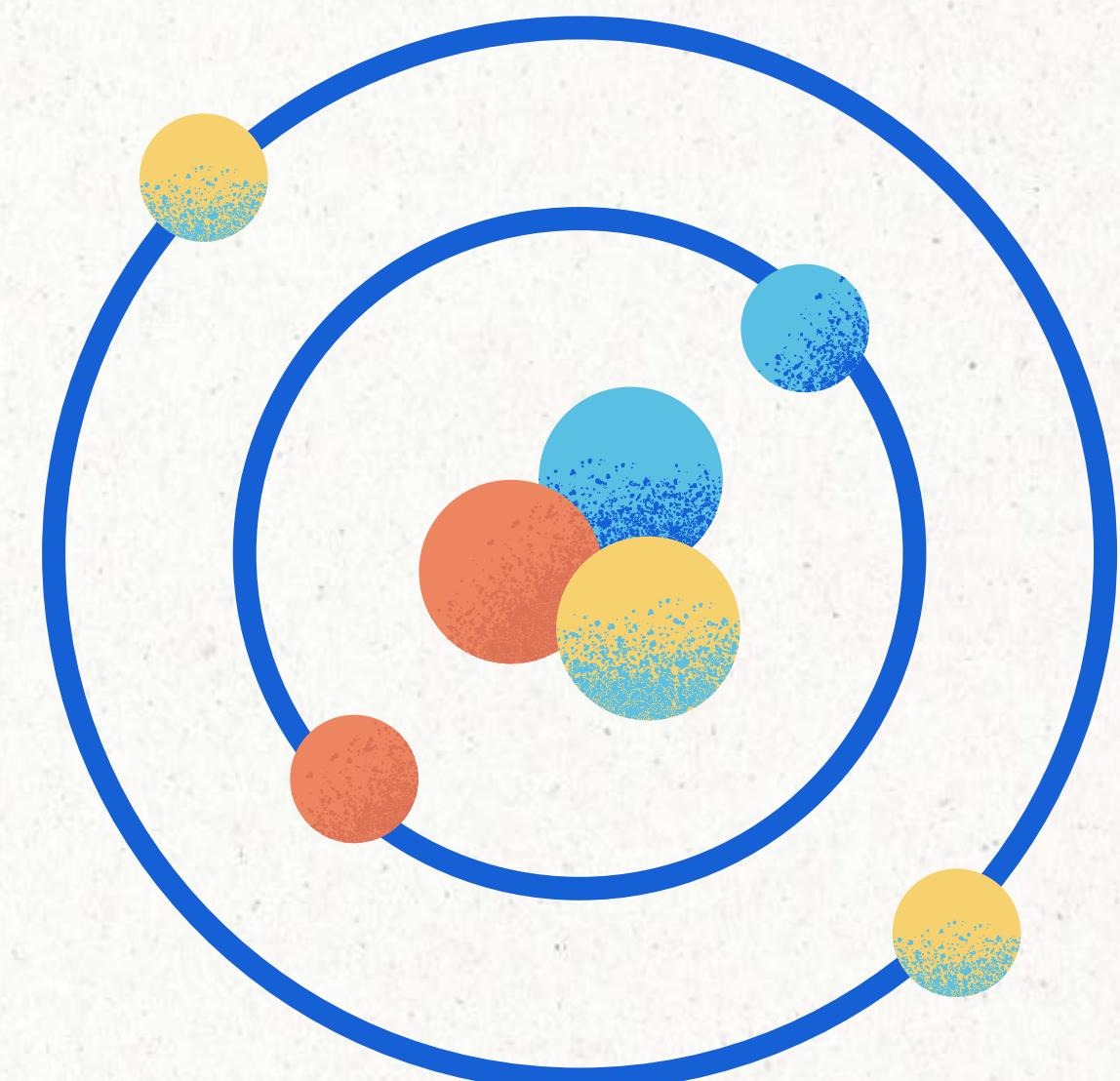
Literature Review

S.no	Title	Author	Year	Summary
1.	Correction of a Pathogenic Gene Mutation in Human Embryos	<u>Hong Ma</u>	2017	This study explored the application of CRISPR-Cas9 for correcting a dominant mutation(HCM) in the MYBPC3 gene. To improve gene correction efficiency and reduce mosaicism.
2.	A new era of mutation rate analyses: Concepts and methods	Kun Wu	2024	This review explores somatic and germline mutation rates using advanced sequencing techniques like whole-genome and long-read sequencing. It covers key evolutionary concepts, compares mutation rates across species and tissues, examines detection methods such as single-cell and duplex sequencing, and discusses technological improvements, research challenges, and influencing factors.

S.n o	Title	Author	Year	Summary
1.	Ethical considerations of gene editing and genetic selection	Jodie BA	2020	This paper discusses the historical development of gene editing, tracing its roots from early DNA modification techniques to modern approaches like CRISPR-Cas9. It emphasizes ethical concerns, particularly regarding genetic selection and the impact on human dignity. The study highlights the potential misuse of genetic engineering and the necessity for regulatory frameworks. Technologies discussed, germline editing.
2.	"Genome Editing with the CRISPR-Cas System: An Art, Ethics, and Global Regulatory Perspective" (Plant Biotechnology Journal, 2020)	Debin Zhang	2020	This paper provides an extensive overview of CRISPR-Cas applications in plants, animals, and human biomedical research. It discusses the technology's efficiency, ethical concerns, and regulatory landscapes across different countries. The study also highlights patent issues and the moral implications of gene modifications
3.	"Bioethical Issues in Genome Editing by CRISPR-Cas9 Technology"	Fatma Betül AYAN OĞLU	2020	This review examines the bioethical challenges posed by CRISPR-Cas9. It discusses the risks associated with genome editing, including unintended mutations and long-term consequences. The paper also addresses regulatory concerns and ethical considerations in clinical and agricultural applications

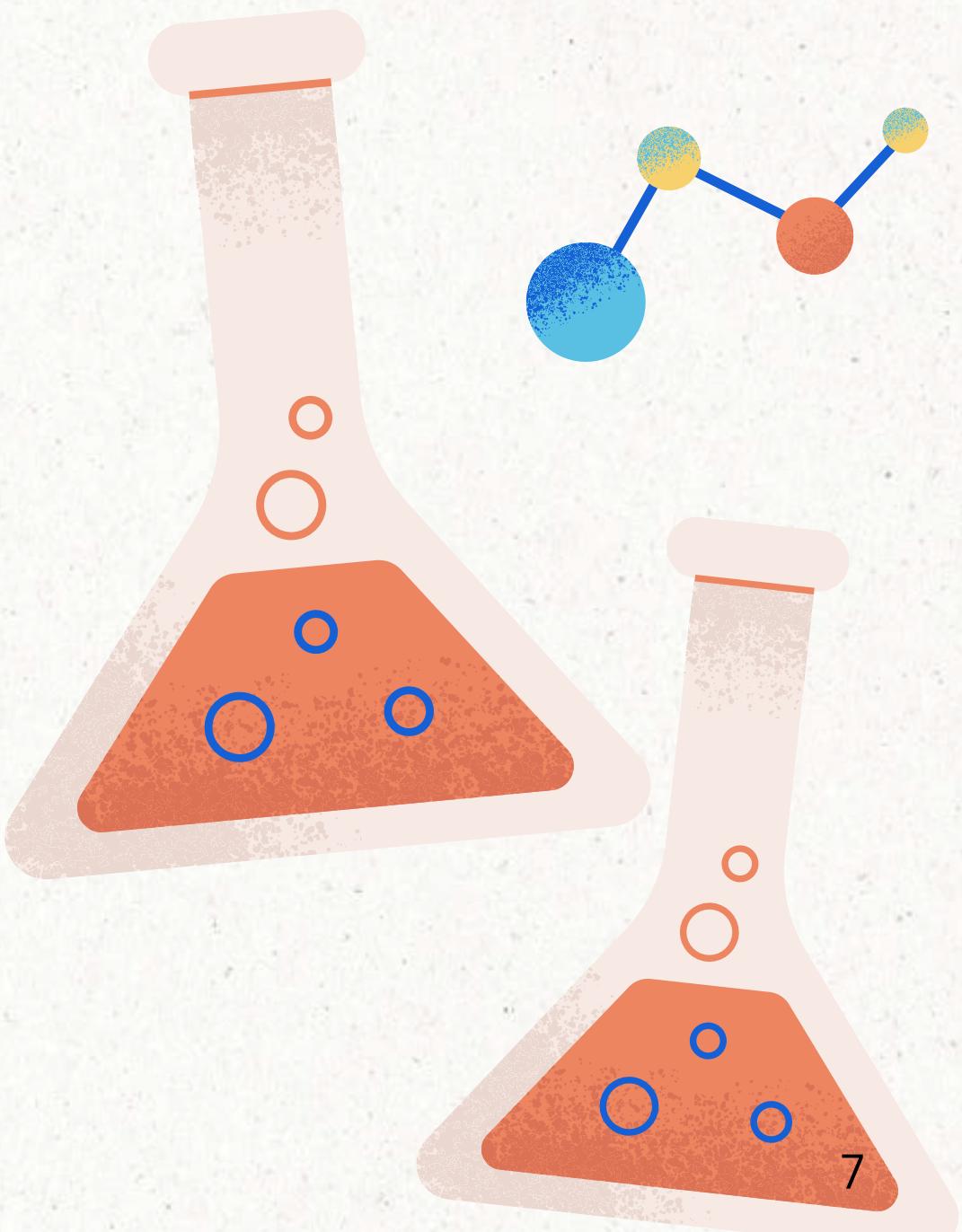
Research Gap

- Limited Cross-Species Comparative Studies
- Inadequate Predictive Models for Gene Stability
- Challenges in Mutation Identification
- Unexplored Gene Engineering Approaches
- Ethical and Regulatory Uncertainties



Problem Statement

- Excessive or unstable mutation rates can lead to genetic disorders, reduced gene efficiency, and evolutionary disadvantages.
- Despite advancements in bioinformatics and genetic engineering, predicting gene stability and mitigating harmful mutations remains a challenge.
- By addressing these challenges, this project seeks to provide insights into evolutionary genetics.
- To develop practical applications for medical advancements while considering ethical implications.



Methodology

Data Collection

- Select seven species and target genes for analysis.
- Collected from GenBank
- Gene Name: Mitochondrial Cytochrome B



Mutation Rate Analysis

- Multiple Sequence Alignment using MEGA and MAFFT
- Compare the mutation rates across 7 different species.

Predicting Gene Stability

- Analyze GC content, codon usage, and evolutionary conservation.
- Apply tools like SIFT.

Comparative Analysis

- Compare mutation rates and stability across species.
- Evolutionary rate analysis

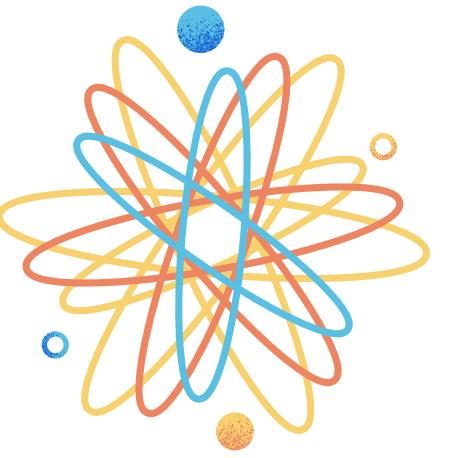
Gene Engineering Strategies

Use CRISPR and base editing to enhance gene stability.

Ethical Considerations & Applications

- Address ethical concerns in gene editing.
- Explore applications in medicine.

Role of Ethics



- Ensuring Responsible Gene Editing. [Designer babies]
- Avoiding Unintended Consequences. [Chinese scientist]
- Regulatory Compliance Balancing Scientific Progress and Moral Values. [Human cloning]
- Preventing Genetic Discrimination. [Insurance company]
- Transparency and Public Trust.
- Environmental and Biodiversity Considerations. [Mosquitoes]



Role of IPR and Patent

In the United States, Broad has been granted 31 CRISPR patents, including 26 patents for CRISPR-Cas9, as well as 3 for CRISPR-Cas12/Cpf1.

Patent No.10,000,772: which was issued in June 2018, covers methods of using optimised guide RNA formats (including single-guide and dual-guide formats) in certain environments, including eukaryotic cells (such as human, animal, and plant cells).

Application: Researchers at the Broad Institute of MIT and Harvard have developed a gene-editing treatment for prion disease that extends lifespan by about 50 percent in a mouse model.

Patent No.10,113,167: issued October 30, 2018, covers “Methods and compositions for RNA-directed target DNA modification and for RNA-directed modulation of transcription.”

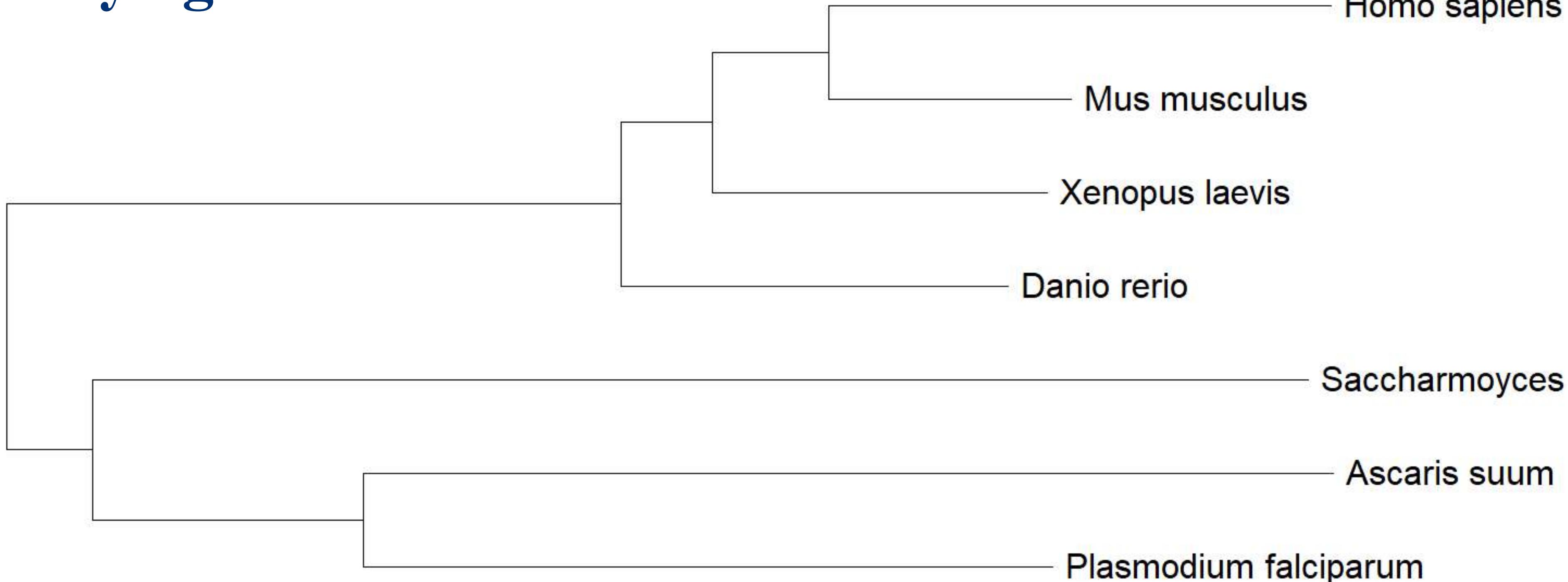
Application: Scientists have discovered that about 5% of adult cancers rely on a gene called PELO to survive. If they disable the PELO gene, these cancer cells die.

Expected Outcomes

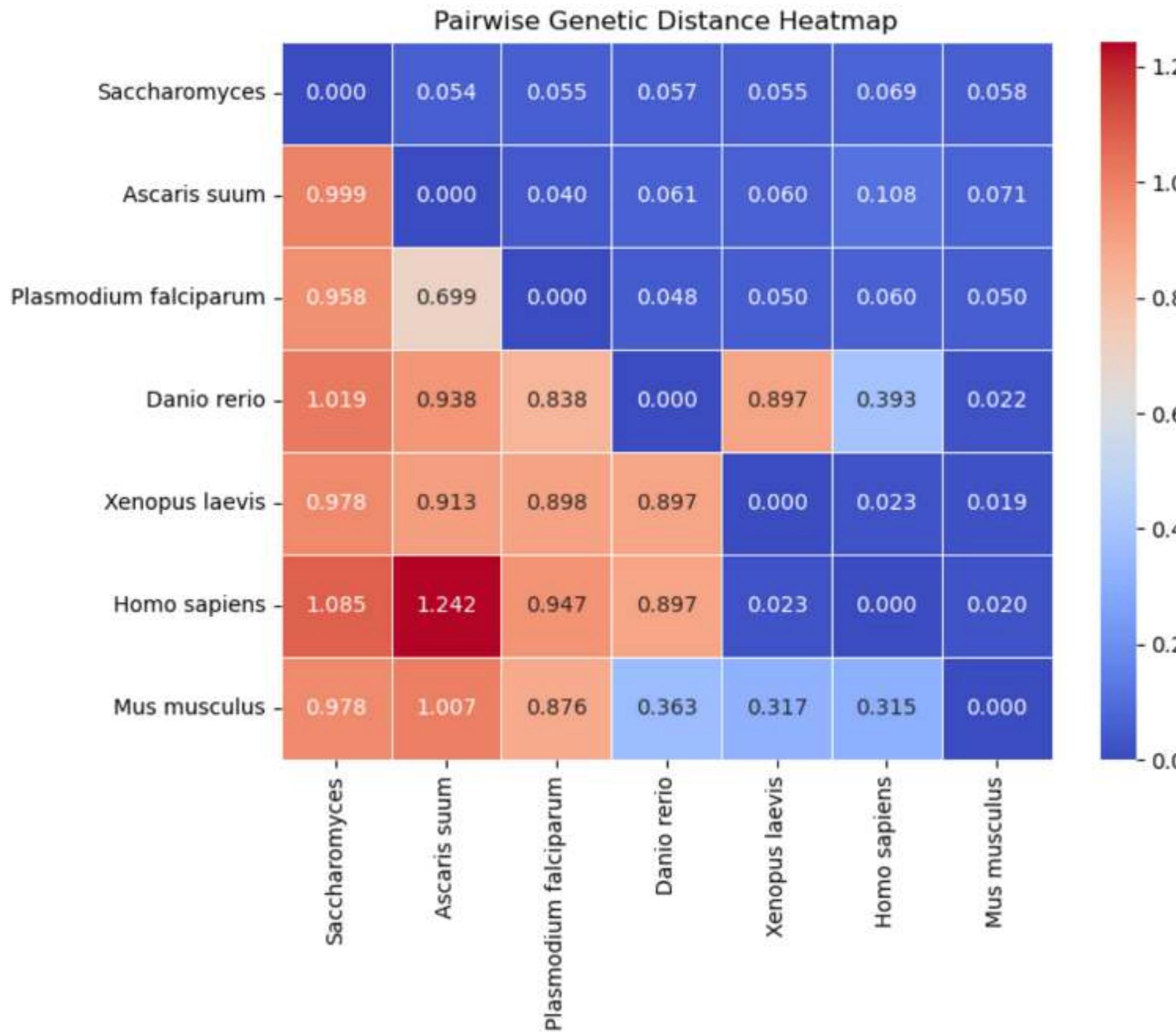
- Accurate Mutation Rate Analysis.
- Predictive Model for Gene Stability.
- Effective Gene Engineering Strategies.
- Cross-Species Comparative Insights.
- Ethical and Regulatory Considerations.



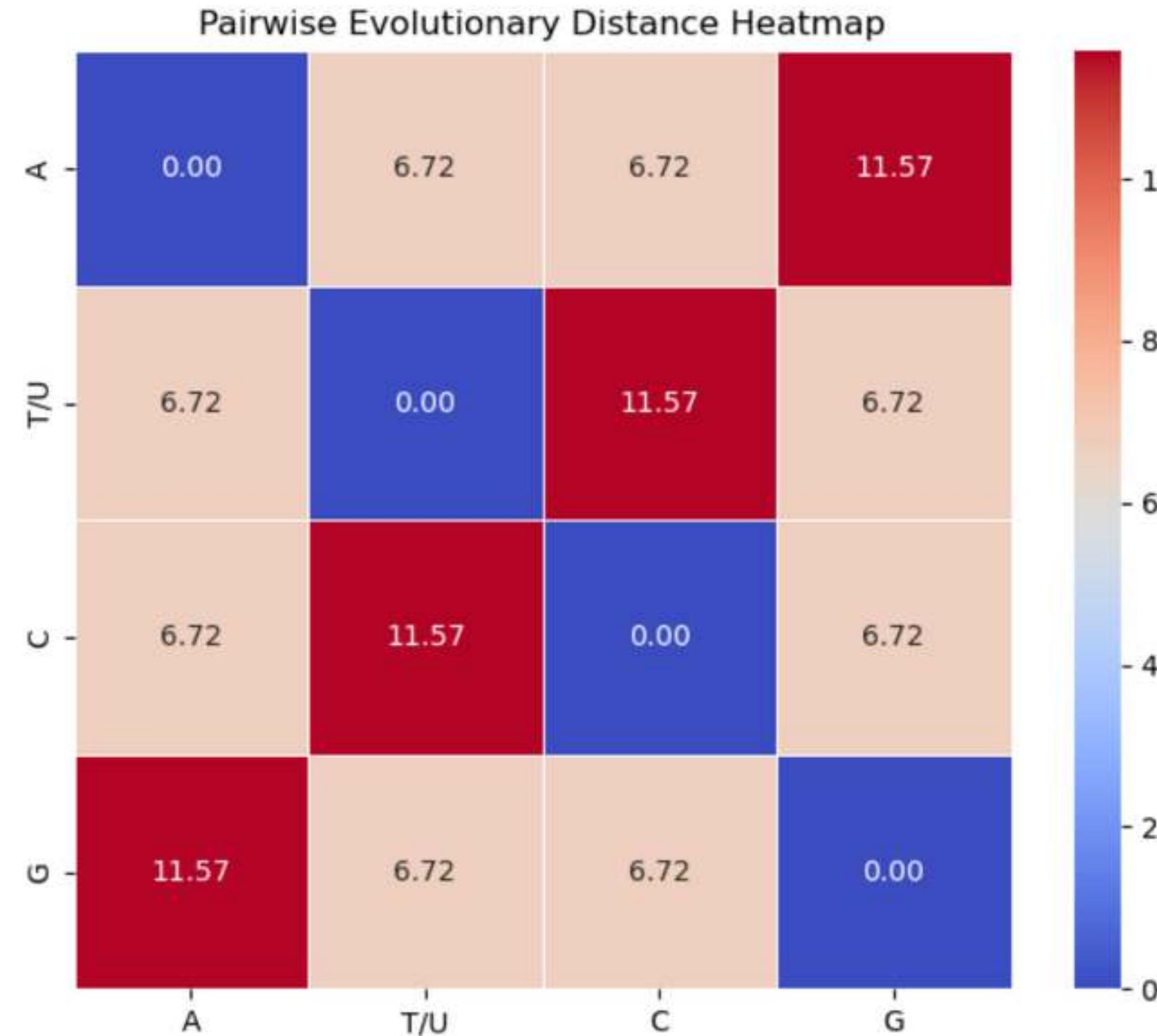
Phylogenetic Tree

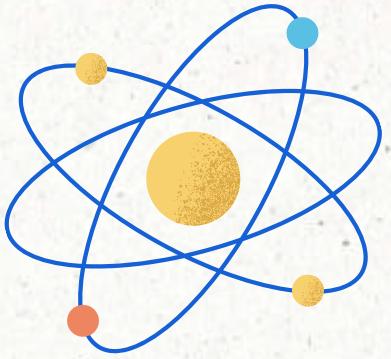


Confusion Matrix of Mutation Rate Analysis



Confusion Matrix of Evolutionary Rate Analysis

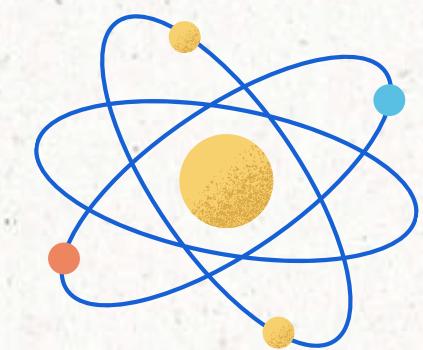




CONCLUSION



- This project highlights the importance of mutation rate analysis in understanding gene stability across species. By leveraging computational models, we identified mutation rates and predicted gene resilience. Gene engineering techniques, such as CRISPR, to stabilize genes and minimize harmful mutations, with potential applications in medicine.
- Ethical considerations remain crucial, ensuring responsible use of genetic modifications while addressing concerns related to unintended consequences and biodiversity impact. This project offers insights into evolutionary biology and future genetic innovations.



**THANK
YOU!**

