
POPULAR ARTICLE

Gene silencing and genome editing which is best ?

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Gene silencing is the process of preventing a gene from being expressed, which can be done naturally by a cell or by using genetic engineering techniques. It is used to regulate gene expression, often to stop a faulty or harmful gene from producing proteins. Key mechanisms include RNA interference (RNAi) and epigenetic modifications, which can block expression at either the transcriptional (DNA to RNA) or post-transcriptional (RNA to protein) level.

How gene silencing works

Natural process: Gene silencing is a natural regulatory mechanism in many organisms, playing a role in development and defense against viruses.

Genetic engineering: Scientists use gene silencing to control specific genes.

Different from gene knockout: Gene silencing is different from a gene knockout, which completely removes a gene from the genome. Silencing reduces or blocks the gene's function without eliminating the gene itself.

Key mechanisms

Transcriptional gene silencing (TGS): This mechanism works by blocking the

transcription of DNA into RNA. It can involve epigenetic modifications, such as DNA methylation.

Post-transcriptional gene silencing (PTGS): This process silences a gene after it has been transcribed into messenger RNA (mRNA).

RNAi: A major mechanism where small interfering RNAs (siRNAs) or microRNAs (miRNAs) are incorporated into a complex (RISC) that guides them to target mRNA molecules. The RISC complex can then cause the mRNA to be cleaved and degraded, preventing translation into protein.

Anti-sense oligonucleotides (ASOs): Synthetic RNA molecules that bind to specific mRNA sequences, blocking translation.

Applications, importance and how it work

Disease treatment: Gene silencing has potential applications in medicine for treating diseases caused by the overexpression of a faulty gene, such as certain types of cancer or genetic disorders.

Scientific research: It is a valuable tool for researchers to understand a gene's function by observing the effects of its absence or reduced activity.

Biotechnology and agriculture: Gene silencing can be used to develop crops with improved traits, like increased shelf life, nutritional value, or resistance to pests.

Genome editing is a group of technologies that allow scientists to change an organism's DNA by adding, removing, or altering it at specific locations. A prominent tool is CRISPR-Cas9, which uses a protein (Cas9) and a guide RNA to cut DNA at a targeted site, allowing for precise edits to be made. This technology is used in various fields, including agriculture for crop improvement and medicine for developing new therapies.

Targeting: CRISPR-Cas9 uses a piece of guide RNA to find a specific DNA sequence in the genome.

Cutting: The guide RNA directs the Cas9 enzyme, which acts like molecular scissors, to cut the DNA at that precise location.

Editing: Once the DNA is cut, scientists can then:

Disable a gene.



Remove a segment of DNA



Insert a new piece of DNA



Replace a segment of DNA

Applications and examples

Agriculture: Genome editing can introduce desirable traits, such as developing crops that are more nutritious or disease-resistant.

Medicine: It is being explored for treating genetic diseases by correcting the underlying mutations.

Research: Genome editing is a powerful tool for understanding gene function in both humans and other organisms.

Key technologies

CRISPR-Cas9: A fast, cheap, and accurate system that has revolutionized the field.

TALENs (Transcription Activator-Like Effector Nucleases): An earlier genome editing tool that was used to develop the first genome-edited food product commercially sold in the United States.

ZFNs (Zinc Finger Nucleases): Another established genome editing technology.

Neither gene silencing nor genome editing is universally superior; the "better" method depends on the specific scientific or therapeutic goal. Genome editing (like CRISPR) is superior for permanently changing a gene's sequence to correct a mutation, while gene silencing (like RNAi) is more suitable for temporarily reducing a gene's activity for studies where a permanent change could cause cell death or other issues.

Genome editing

Mechanism: Permanently alters the DNA sequence by cutting both strands at a specific location and allowing the cell's repair mechanisms to make changes.

Best for

1. Correcting a genetic mutation in monogenic diseases.
2. Creating a permanent knockout of a gene for long-term studies.
3. Introducing specific, permanent mutations to study their effect.

Advantages

1. Precision and efficiency with tools like CRISPR.
2. Can create permanent, predictable changes to the DNA.

Disadvantages

1. Off-target mutations can occur.
2. The permanent knockout may be lethal to the cell.

Gene silencing and genome editing which is best? Advantages and disadvantages

Mechanism: Reduces or "silences" a gene's expression without changing the DNA sequence, typically by interfering with the messenger RNA (mRNA) that carries the genetic instructions.

Studying the effects of a gene by temporarily "turning it down".

Situations where a permanent knockout might lead to cell death or reduced fitness.

High-throughput screening projects where transient effects are sufficient.

Advantages

- Reversible and controllable effects.
- May be more suitable if the gene's permanent removal is detrimental.

References

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- Less likely to cause irreversible cell damage than a permanent knockout.

Disadvantages

- Effects are often temporary.
- Can be difficult to achieve complete silencing.
- May lack target specificity in some cases.

Gene silencing is best for temporarily decreasing gene expression, while genome editing is best for permanently altering or correcting a gene's DNA sequence. Gene silencing is ideal for research and treating conditions where a controllable, reversible effect is needed, such as some cancers or neurodegenerative disorders. Genome editing is suited for cures where a permanent change is desired, like in curing genetic diseases such as sickle cell anemia and beta-thalassemia. Choose genome editing if you need a permanent, permanent change to the DNA sequence, such as fixing a specific mutation or creating a permanent knockout. Choose gene silencing if you need a temporary effect, such as studying a gene's function without permanently altering it, or if a permanent knockout would cause cell death.

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