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CRISPR-CAS9

THE FUTURE OF GENETIC ENGINEERING

WHAT IS IT?

A revolutionary genome editing technique that can modify any region of the genome of any species with high precision and accuracy without harming other genes.

HOW DID IT BEGIN?

1987
First report on CRISPR was published

2000
CRISPR was found to be present throughout prokaryotic cells

2002
"CRISPR" name was coined

2008
CRISPR was found to act upon DNA targets

2013
First demonstration of CRISPR-cas9 genome editing

2014
Genome-wide functional screening with Cas9

2015
Cancer cells reversed to normal cells using CRISPR-cas9

HOW DOES IT WORK?

STEP 1: FORMATION OF THE EDITING COMPLEX

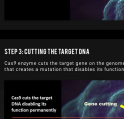
Cas9 enzyme pairs with guide RNA, which carries a sequence matching that of the target gene.

STEP 2: PAIRING WITH THE TARGET GENE

The complex (Cas9, gRNA and the complementary sequence) binds precisely to the target gene in the genome.

STEP 3: CUTTING THE TARGET DNA

Cas9 enzyme cuts the target gene on the genome. The cell attempts to repair the DNA but that creates a mutation that disables its function permanently.

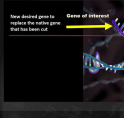


STEP 4: INSERTING A NEW GENE

A short fragment of DNA or the desired gene with a specific function is then inserted to fill the gap and replace the original gene.

STEP 5: PRODUCTION OF THE DESIRED PROTEIN

The new gene is now ready to produce the desired protein in the cell, or in a test tube



WHAT CAN WE DO WITH CRISPR-CAS9?

DELETING A GENE

Undesirable genes can be deleted from the genome allowing researchers to study their functions specific genes and learn about what happens to the cell when these genes are not in the genome.

ADDING A NEW GENE

Desirable genes can be added into the genome allowing researchers to study their functions within the cells. These genes can also add new functions to the cell.

ACTIVATING DEAD GENES

Genes that are essential for various functions but no longer function can be reactivated using CRISPR-Cas9 system.

CONTROLLING GENE ACTIVITY LEVEL

Genes are more active than normal can controlled to be produce just the right amount of proteins, which will help maintain the balance within the cell under desired conditions.

WHY CRISPR-CAS9 IS SO IMPORTANT?

HUMAN HEALTH

CRISPR-Cas9 system will revolutionize gene therapy and make it possible to treat large number of diseases that would be impossible to treat without this technique. This includes diabetes, cancer, cystic fibrosis and sickle-cell anemia.

NEW MATERIALS

Manipulating biological circuits using CRISPR-Cas9 will facilitate the generation of useful synthetic materials that could useful in various applications such as viral drug delivery and the production of biosensors

DRUG DEVELOPMENT

Engineering cells to optimize high-yield generation of drug precursors in bacterial factories could significantly reduce the cost and accessibility of useful therapeutics

RESEARCH APPLICATIONS

CRISPR-Cas9 system will allow the creation of new animal and cellular models, which will help us learn more about diseases and test new drugs and vaccines on these models.

AGRICULTURE

CRISPR gene editing tools can edit crops without harming other genes, which will help confer resistance to infections and harsh environments, improving global food security.

BIOENERGY

Sustainable and cost-effective biofuels are attractive sources for renewable energy, which could be achieved by creating efficient metabolic pathways for ethanol production in algae or corn.

SOURCES:

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- Development and Applications of CRISPR-Cas9 for Genome Engineering (2014), Patrick D. Hsu, Eric S. Lander and Feng Zhang
- Distinct E. coli RecBCD nuclease complexes regulate cell behaviour through mRNA processing or 5'rc and p120 catalytic activity (2015), Antonis Kourtidis et al.