Original Paper

ISSN: 2321-1520

CRISPR : An Overview

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Received Date: 21-12-2016

Published Date:1-3-2017

Absract

Since 2012, CRISPR molecule has been found to be fast, easy & cheap method of tinkering with genetic code of plant, animal and human beings.The technique can be used by any good laboratory to treat human diseases and generate designer babies which might actually lead to a generation of super-humans. It's no wonder that the technology is highly debated but is undoubtedly a doorstep of genetic revolution.

What is it?

CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeat. They were first discovered in most primitive life forms known to us – bacteria.

Bacteria, in order to fight infection of virus, has unique organization of short, partially palindromic repeated DNA sequences in genome.If viral infection threatens bacteria, this naturally evolved immune system of repeated sequence and spacer destroys genome of invading virus and there by protects bacteria from viral infection.

How does it work?

Along with CRISPR sequence, there is also a set of genes that code for enzymes that can cut spacer DNA sequence (spacer DNA sequence occurs between two repeats and is generally derived from invaded virus) which are referred to as cas or crisper associated sequence. Together CRISPR-Cas sequence of bacterial DNA precisely cuts genome at specific places and prevent

their propagation.

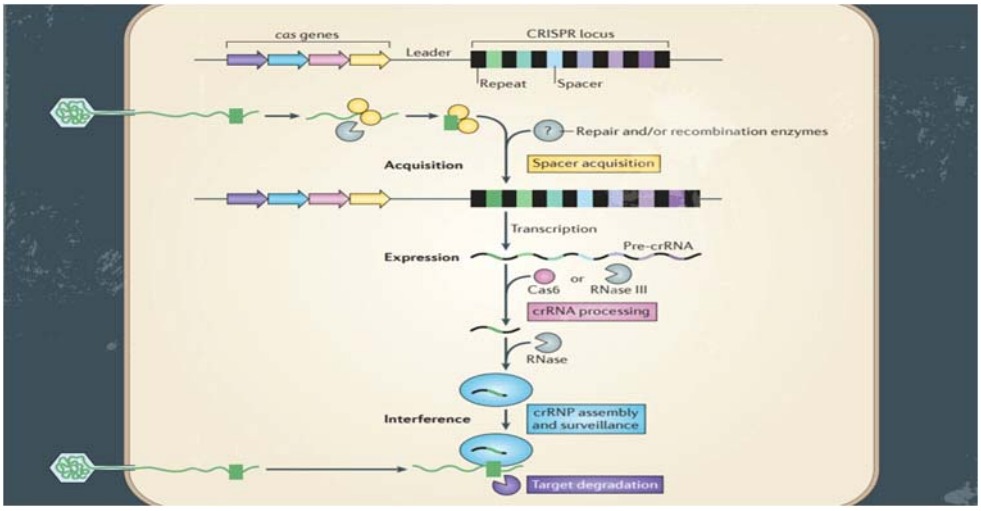
Scientists and Researchers have now developed tools to engineer this bacterial immune machinery to cut and insert any desired DNA sequence in higher organisms including humans.

In a way, this cutting edge genome editing is similar to proof reader in printing press. That is, this technique can be used to modify sequence so as to correct faulty genes.

Technicalities

In order to use CRISPR-Cas system in nonbacterial cells just two components are required: a Cas enzyme to snip target DNA—for example, inside a gene of interest—and an RNA molecule, called guide RNA (gRNA), which binds the target through complementarity. The gRNA is a shorter version of the CRISPR RNA made in bacterial cells. It forms a complex with Cas and directs the enzyme to the correct cleavage location. The DNA break usually causes mutations that inactivate the gene.

But researchers can also wield the tool for gene correction and gene regulation by mixing in additional components or tweaking the activity of Cas.



A schematic diagram to explain working of CRISPR -(Origene Calendar, Nature Reviews)

Salient features

- Zinc finger nucleases (ZFN)&Transcriptional activator-like effector nuclease (TALENS) currently practiced alternative to CRISPR are less accurate, costly and time intensive as they are based on trial and error method to edit specific gene
- CRISPR is much faster at producing genetically modified mice. Genetically modified mice are most common model to study human disease. Generally traditional breeding method is used which is very time consuming and tedious.
- CRISPR can be used to modify multiple genes at once. This is useful for studying diseases which involve more than one gene.

Application

- *In industry* – CRISPR based immunity can be employed to make these cultures more resistant to viral attack , which would otherwise impede productivity and can thus improve sustainability and lifespan.
- *In laboratory* – researchers have learned how to exploit CRISPR technique to make precise changes in genes of diverse organisms like fruit flies, fish, mice, plants and even human cells. Specific change in one gene allows scientist to understand association between a given gene and it's consequence to the organism.
- *In medicine* – one application is for treatment of genetic diseases. It can also be used for infectious diseases by making specific antibiotics which affect only disease causing bacteria and leave healthy bacteria unaffected.

Ethical Issue

Scientists in China reportedly carried out first experiment using CRISPR to alter DNA of human embryos. Scientists in London have been granted permission to edit genome of human embryo for research by UK Human Fertilization and Embryology Authority (HFEA).

These events rang ethical alarm bells, not only from NGOs but also from prominent scientists and experts in bioethics becausedata as of now does not guarantee safety and fear of unknown consequences is always there.

This technique may also be used by parents to create smarter, taller, stronger kids which would result in generation of super humans.

One one side CRISPR can aid in treatment of heritable genetic disease however it might also create unwarranted changes in germ cells which would be then introduced in human population.

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