THREE TECHNOLOGIES THAT CHANGED GENETICS

Genome editing uses enzymes that are targeted to sequences of DNA to make cuts. These cuts are then repaired by the cell's machinery. This technology allows scientists to disrupt or modify genes with unprecedented precision. By **Amy Maxmen**, infographic by **Denis Mallet**.

DOUBLE-STRANDED BREAK

All three of the main genome-editing tools (ZFNs, TALENs and CRISPR-Cas9) create a break across both strands of DNA at a specific location, which is repaired in one of two ways to either 'knock out' or 'knock in' a gene.

Non-homologous end joining for gene knock out

DNA is repaired in an error-prone manner — by either adding or removing bases — so that the gene can no longer be translated.

Homology-directed repair for gene knock in

A DNA template, or 'homologous sequence', accompanies the DNA-cutting enzyme so that the repair results in an altered or an inserted gene.

LEGAL STATUS

Countries are grappling with how to appropriately regulate human germline editing. As of December, before a Washington DC meeting organized by UK, US and Chinese scientific societies, at least 29 countries have banned germline modification.

POPULARITY

The newest of the three main gene-editing tools, CRISPR-Cas9, has spread far and wide. Massachusetts-based Addgene, a non-profit plasmid repository that distributes CRISPR-Cas9 editing kits to 83 countries, sends the largest proportion of its kits to US researchers.