

Genetic Engineering Notes

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Genetic engineering: a technique to change the characteristics of a plant, animal or micro-organism by transferring a piece of DNA from one organism to a different organism.

This is a complex process, so why would we do it? Genetic engineering is done to introduce a desirable characteristic or characteristics into a species, like disease resistance in crops for example.

Before we look at the process of genetic engineering there are some definitions that you **must** to know.

The Stages of Genetic Engineering

Stage 1: isolation

Restriction enzymes are used to isolate (find) the required gene from an organism. This cut leaves jagged edges of unpaired bases called sticky ends.

Stage 2: insertion into a vector

The gene is inserted into a vector. The vector (usually a bacterial plasmid or a virus) is cut open using the **same restriction enzyme**. This ensures the vector has matching **sticky ends**.

Stage 3: transformation and reproduction

The gene and the open plasmid are joined together using an enzyme called Ligase. This creates recombinant DNA. The recombinant vector is then inserted into the target cells (for example bacteria). The bacteria reproduce by binary fission, creating millions of clones that can produce the desired protein.

Bacteria will just take on a plasmid, it's something they do naturally. The bacteria reproduce by binary fission, creating millions of clones that all contain the new gene. These bacteria now possess the instructions to make the desired protein (for example, insulin), which can be collected and purified.

Exam note: if we are genetically engineering a multicellular organism (like a plant or an animal), you must state that the vector inserts the gene into the target cells **at an early stage in their development** (for example into an egg cell or a very early embryo).

This ensures that as the organism grows, every single cell in its body will contain the new gene and show the desired characteristic!

Advantages of Genetic Engineering

Genetic engineering is really handy and allows us to do some really cool things like...

1. **Make human insulin to treat diabetes.** Before being able to make human insulin, we used pig insulin to treat diabetes. It worked okay, as it's close enough to human insulin but some people had allergic reactions to it and some people refused to use it for religious reasons.
2. **Genetic engineering is a faster and more efficient way of getting the same results as selective breeding.**
3. **Add a gene to wild rice that makes it produce beta carotene.** Beta carotene is needed by humans in order to make vitamin A, which is essential for good vision.
4. **It can improve disease resistance in plants.** Insect resistance from *Bacillus thuringiensis* can be inserted into the plants. The plant produces toxins, which would discourage insects from eating the crop. This can increase the yields of crops and feed more people.
5. **Produce crops that are resistant to insect attack or are herbicide resistant, this produces increased yields.** Herbicide resistance allows those plants to survive, but the weeds are killed by the herbicide, therefore less herbicide is needed.

Disadvantages of Genetic Engineering

1. It is a technology that can be easily abused – transplanted genes may get out into the environment. For example, a herbicide-resistance gene in a crop could accidentally be transferred to wild weeds, creating superweeds.
2. It may have negative consequences when interacting with other species.
3. It could adversely affect food chains. For example, crops engineered to produce toxins might accidentally kill harmless or useful insects, like bees and pollinators.
4. Some people believe it is not ethical to interfere with nature in this way. Also, genetically engineered crop seeds are often more expensive and so people in developing countries cannot afford them.

Overview of Genetic Engineering

The figure below shows an overview of genetic engineering for the production of human insulin.

