Manipulating genomes

Uses and ethics of genetic engineering

An animal or plant which has been genetically engineered is referred to as a **genetically modified organism (GMO)**.

These are some of the specific examples and the associated ethics behind them which you need to know.

1. Insect-resistance in plants e.g. soybean plants.
A gene from the bacterium *Bacillus thurinigiensis (Bt)* codes for a protein which is toxic to insects that feed on soybean plants. If this gene is transfected into a soybean plant allowing the plant to produce that toxin it can provide insect resistance.

A positive of doing this is that it reduces the use of pesticides farmers use making it better for the environment. However, there are a number of negatives. One of these is that it may encourage **monoculture** which reduces biodiversity meaning the whole crop may be vulnerable to other diseases etc.

Another negative would be the risk of the gene for herbicide resistance being passed onto other plants/crops e.g. weeds.

2. GM animals to produce drugs aka 'pharming'.
This involves injecting a gene which codes for a protein of therapeutic interest into an embryo e.g. a goat embryo. Often these proteins are too large to be produced by a bacterium. The goat embryo would be implanted into a surrogate female and the offspring would produce the protein.

If this is done to multiple goat embryos selective breeding could then be used to selective offspring which produce milk containing the protein. This can be extracted from the milk and then used to produce a drug.

A positive of this method is the fact that the drugs can be made in large quantities compared to other methods giving large availability. A negative could be that it causes harmful side-effects in the animal and the subsequent issues of using animals as 'assets' rather than living organisms.

3. GM pathogens for research.
This involves engineering pathogens to be used to find treatments for diseases/to make vaccines. For example, the poliovirus has been shown to attack tumour cells. If the virus was engineered to not cause a disease but still attack tumour cells this could be a potential cancer treatment.

The largest positive of this method is that it could mean diseases which were very difficult to treat previously can now be treated. However, a concern regarding this is the safety aspects of working with pathogens and the risk of disease spreading. Mutations may also mean that the engineered pathogens 'revert' back to the original form.

Finally, the use of pathogens in research has to follow strict protocols as they can be used maliciously to create agents for biowarfare.

Subtitle 'Issues relating to patenting and technology transfer'

Scientists working for different institutions on genetic engineering often collaborate and share knowledge/skills. This allows the development of GM products to be faster. The sharing of knowledge/skills is called **technology transfer**.

Some companies choose to obtain a form of legal protection called a **patent** if a new product is developed. This means, by law, they can control who uses the product and for how long.

A positive of patenting is that the owner of the patent gets money from that GM product being sold e.g. seeds which give insect resistant plants. This encourages scientists to compete to come up with new ideas and products speeding the rate of development.

An issue of patenting is that some people e.g. farmers may not to be able to afford patented genetically modified products such as GM seeds. This means these GM seeds would only be available to those who can afford them. Some people believe that the rules regarding patenting should be 'relaxed' for those from poorer countries for example.

Gene therapy

Gene therapy involves altering the alleles inside of cells to cure genetic disorders. If the genetic disorder is recessive this involves inserting a dominant allele.

Somatic cell gene therapy is the alteration of genes inside body cells i.e. those most affected by a genetic disorder. These changes are not passed onto a person's offspring. An example of a disorder treated this way is the recessive disorder **cystic fibrosis**.

The epithelial cells lining the respiratory tract express a transmembrane chloride ion channel called CFTR which transports chloride ions out of the cell. This lowers mucus water potential causing water to move out by osmosis 'lubricating' the mucus. People with CF have non-function CFTR proteins.

To treat CF with gene therapy involves inserting a dominant CF gene into a vector (e.g. a virus or a type of vesicle called a **liposome**). The vector can then be placed into an aerosol inhaler and then the vector will transport the DNA into the nucleus of the epithelial cells to be expressed. Viruses insert the DNA directly into the person's genome.

Potential disadvantages of somatic therapy are:

- A virus may insert the DNA into the wrong location within the genome i.e. near a gene involved in cell division. This could affect gene expression and increase cancer risk.
- The person's immune system may identify the vectors as being foreign or a person may become immune to the virus used.
- The effects are only short-lived as the cells of the respiratory tract are replaced regularly hence the need for repeat treatments.

Germ line gene therapy involves altering the genome of gametes or zygotes. This means all of the cells of that individual will inherit the changes but offspring will also. Germ line therapy therefore uses viruses. Germ line therapy is a long-term solution as the treatment would not need to be repeated again.