Gene Technology

Gene technology	What is it?	How it works?	Other information
Microarray technology	A ‘microarray’ can be thought of as a miniature spotting tile with thousands of ‘spots’ on it. It looks like a glass slide but it has thousands of DNA probes attached to it. One ‘spot’ contains many copies of a DNA probe, with a unique base sequence. Each spot contains copies of a different probe.	- DNA probes added to the chip robotically and information about each one and its location on the chip is held in a computer file. - Individual’s DNA amplified by PCR, digested using restriction enzymes, made single-stranded and a label is added. The label may be fluorescent or chemiluminescent - Once the labelled sample DNA has been prepared, it can be added to the microarray - The single- stranded DNA will only bind on the spots where complementary probes are located and because of the label, the chip can then be digitally analysed to indicate where binding has occurred. - This information, along with the data on which probe is found where on the chip, can be used to determine an individual’s base sequence for the gene of interest.	Genes can be switched on or switched off in cells and sometimes changes in which genes are switched on in a tissue can result in disease.
Genetic fingerprinting	A technique for analysing and comparing the DNA of individuals	- Sample DNA which may have been amplified using PCR is cut into smaller fragments using restriction enzymes. - The fragments are added to an agarose gel and separated by size, using gel electrophoresis. - The DNA in the gel is made single-stranded and copied onto a nitrocellulose sheet. - Labelled DNA probes are added to the plate and bind via base pair complementarity. - A detection system is used to visualise where binding of probes has occurred, using the label.	Allows the profiles produced to be useful in crime scene analysis and paternity disputes and other situations where relatedness is to be proved or disproved.

Gene Sequencing

An organism's genome can be defined as all of the genetic material (DNA) which the organism has in one set of chromosomes
Techniques have been used to determine the order of the bases A, T, G and C in the genomes of many different species, a process known as genome sequencing.
Knowledge of the sequence of bases in a particular gene enables the primary structure of the protein encoded by that gene to be worked out.

Social & ethical implications of gene sequencing

Such kits enable consumers to obtain a report on various aspects of their genome, including whether they carry genes which may increase their risk of developing diseases later in life and how they metabolise various common medications. There are concerns about the release of this information to individuals, with little or no guidance on the nature of risk for example, or on the alleles which an individual may test positive for. Furthermore, there are concerns over who else might request access to the information; for example doctors, family, insurance providers and potential employers.

Pharmogenetics

Pharmacogenetics is the tailoring of drug treatments to individuals, based on their genotype.
Due to genetic variation, people can respond differently to certain drugs. This can mean a drug that is very useful in treating certain conditions in some people can be ineffective or even dangerous in others.
Alternatively, it can mean that the dose required to successfully treat a condition can vary with genotype.

Therapeutic genetic modification

1. The use of genetically modified viruses to treat cancer

In 2015, a study was published which had used genetically modified herpes (cold sore) virus to treat malignant melanoma. The genetic modifications to the virus were as follows:

1. It could no longer make a protein which normally enables the virus to reproduce inside healthy cells. Hence, it was unable to cause cold sores. However, since cancer cells themselves produce this protein, the virus was only able to reproduce inside cancer cells.
2. The viral gene which normally inhibits antigen- presentation on virus-infected cells was disrupted, so that the infected cells become more 'visible' to the immune system.
3. It had a human cytokine gene inserted into it —- triggers an immune response to the infected cells.

2. The use of GM viruses to treat bacterial infections

Viruses have been genetically modified to improve the efficacy of antibiotics against bacterial infections. Some antibiotics target bacterial DNA, but bacteria have a defence mechanism which helps them repair DNA targeted by these antibiotics. The GM viruses disrupt this DNA repair action, allowing the antibiotic to get to work. In one study, mice treated with both GM virus and antibiotic had an 80% survival rate compared with a 20% for those treated with antibiotic alone.

3. Gene therapy: update

Many scientists have continued to work on the technique, refining and developing it in light of previous findings and in 2011 it was reported that it had been used to successfully treat haemophilia B. Haemophilia B is a sex-linked blood clotting disorder, caused by a recessive allele found on the X-chromosome. The usual treatment involves injection with Factor IX, the clotting factor which is not produced in sufferers.

In the gene therapy trial, patients were injected with viruses which acted as vectors for a healthy copy of the gene for Factor IX. The viral vector delivered the healthy gene to cells in the liver, where the gene then successfully directed the synthesis of Factor IX.