NIHR | University College London Hospitals Biomedical Research Centre


## Teacher guidelines

This video provides an introduction to the immune system and CAR T-cells, and a detailed examination of genetic engineering and use of CAR T-cells. The video helps to teach students about human defence systems, communicable disease, discovery and development of drugs, DNA structure, evolution and genetic engineering. See below for details of how the video relates to different sections of the curriculum.

Before playing the video, we recommend handing out the worksheet and having a discussion centred around the keywords. The keywords are to be used to fill the blanks in exercise A of the worksheet. It may also be helpful to watch the video a second time after the quiz to re-affirm the key learning objectives.

**Objectives:**

By the end of this lesson, students will understand:

- What the immune system is, and the roles played by the white blood, b- and t-cells
- How B and T-cells target pathogens
- That DNA is copied when cells divide
- That errors are made during copying of the DNA
- How errors occurring during DNA duplication can lead to the evolution of new cell functions
- That genetic engineering can have medical use, with CAR T-Cells as an example

**Keywords – see also 'Teacher's guide: key words and …'**

**DNA -** DNA is the chemical made of four bases (nucleotides A T G C) that contains the genetic information.

**Duplicating -** In reference to DNA replication; cells duplicate their DNA when they divide, so that each new cell has its own copy of all of the genetic information (genome).

**Glitches/Errors -** Glitches, or errors occur when copying DNA

**Evolution -** Evolution is the change in inherited characteristics of a population over time through the process of natural selection, which may form a new species; evolution occurs when a glitch/error in copying the DNA leads to a change in a cell's function that gives it a better chance of surviving.

**Cancer -** Cancer is caused by cells starting to divide uncontrollably, forming tumours

**Engineered -** In the context of genetic engineering; Genetic engineering is where a gene with a desirable characteristic is isolated and inserted into another organism or cell. In the case of CAR T-Cells, genes useful for making cells survive, identify specific cancers and replicate upon detecting a cancer cell are inserted into a patients T-Cells to tackle their own cancer cells specifically.

# How the video is relevant to sections of the AQA GCSE Biology Curriculum (8461)

**Key Ideas (section 4.8):**

- Life processes depend on molecules whose structure is related to their function
- The characteristics of a living organism are influenced by its genome and its interaction with the environment.
- Evolution occurs by a process of natural selection and accounts both for biodiversity and how organisms are all related to a varying degree

**4.3 Infection and response**

**4.3.1.1 Communicable (infectious) disease**

Pathogens are microorganisms that cause infectious disease. Pathogens may be viruses, bacteria, protists or fungi. They may infect plants or animals and can be spread by direct contact, by water or by air.

The video relates to the function of the Immune system, and need for White blood B- and T-cells.

**4.3.1.6 Human defence systems**

White blood cells help to defend against pathogens

White blood B- and T-cells are key immune defence cells. B-Cells create antibodies which tag pathogens to be degraded by macrophages.

T-cells recognise specific protein antigens and destroy pathogens by targeting their cell membrane

**4.3.1.9 Discovery and development of drugs**

-New drugs are extensively tested

The video touches on the new techniques that are being developed beyond classical chemical treatments for cancer.

## 4.6 Inheritance, variation and evolution

### 4.6.1.5 DNA Structure

- DNA contains four bases, A, C, G and T.
- Students should be able to explain how a change in DNA structure may result in a change in the protein synthesised by a gene.
- Mutations occur continuously. Most do to alter the protein, or only alter it slightly so that its appearance or function is not changed.

The video helps give context to how random mutation occurring during copying of the DNA drives evolution and how mutations can cause the uncontrolled cell division in cancer.

### 4.6.2.2 Evolution

The theory of natural selection states that all species of living things have evolved from simple life forms that first developed more than three billion years ago.
Students should be able to explain how evolution occurs through natural selection of variants that give rise to phenotypes best suited to their environment

The video shows the evolution of the ‘meat robot’ composed of individual robotic cells that have gained function through random mutation. These random mutations (glitches, copy errors) lead to their increased survival, and selection.

### 4.6.2.4 Genetic Engineering

- Students should be able to explain the potential benefits and risks of genetic engineering in agriculture and in medicine and that some people have objections.
- In genetic engineering, genes from the chromosomes of humans and other organisms can be ‘cut out’ and transferred to cells of other organisms.
- Modern medical research is exploring the possibility of genetic modification to overcome some inherited disorders.
- The vector is used to insert the gene into the required cells.

The production of CAR T-Cells requires vector-based insertion of the engineered DNA, and then delivery of the modified T-Cells into the patient.