NIHR | University College London Hospitals Biomedical Research Centre

Teacher's guide: key points and keywords in the video with timecodes

Below is a simplified summary of the key points and keywords in the video, with accompanying timecodes. Key words are highlighted in bold. It may help the teacher to read this guide before watching the video.

0:05
You are a 4 billion year old meat robot

- Composed of 30 trillion cells
- Each cell has its own tasks
  - Example cells: Brain cells, White blood cells, Liver cells (EXTRA CREDIT: name another, what do we call a collection of cells that allocate tasks to achieve a function/task?)

0:25
Missions of the cell in regard to **DNA:**

- safeguard the **code**
- duplicate
- pass it on

0:35
What happens every time that the **code** is copied?

- **Errors** happen. This is due to the length of the **DNA**

0:40
What can happen with these **errors**?

- Makes the robot/cell *less* good at it **surviving**
- Makes the cell *better* at its **function**/surviving.

0:45
What do we call the passing of this **glitch** in the code on? **Evolution**

1:20
Copying error leads to the cell to dividing uncontrollably. This grows and multiplies into a tumour leading to **cancer**.

1:40
Biohackers are going into the patients' own **DNA** and **reprogramming** the **immune system** to recognise **cancer** cells and destroy them.

2:19
Security team in place to battle the invaders (**bacteria**, **viruses** and **fungi**) - The **immune system**

2:23
Top guards are **white blood cells** (check IDs) - What do they do?

- Trawl insides checking the IDs of the cells they pass

Check for what? Protein fragments on the cell surface called **antigens**

2:37
There are two types of cells **T-cells** and **B-Cells**

T-Cells check the **antigen** IDs using special claws that lock with a particular **antigen**.
What do they do if they find a match?

2:50
They attach and release toxic chemicals that burst open the invading cell's membrane

2:55
B-Cells create **antibodies**, which are like little claws that latch perfectly onto a particular **antigen** marking them for destruction

3:14
These two work together and are brilliant at spotting **pathogens** that invade, however they are not so good at spotting your own cells that have gone rogue

- Why are **T** and **B-cells** not good at recognising **cancer** cells?
  - Not **programmed** to attack them
  - **Cancer** cells are essentially your own cells

3:29
The usual ways to attack cancer are to

- cut tumour out
- treat with **chemotherapy**
- treat with **radiotherapy**

3:55
What type of cancer is Acute Lymphoblastic **Leukaemia**?
A **blood cancer**, starts in your **white blood cells**

Biohackers are reprogramming **immune system** to recognise particular **antigens** on the **cancer** cells.

4:14
You need millions of a patient's **T-Cells** for the reprogramming and therapy
How do you get it to do something different?

- **Reprogramme** it, replace the normal code with something new that you've designed.

4:30
Use a computer to put together their own sequence of bases that 'spell out' the **DNA**
Then they model what that new genetic code will do in a computer
Then make those sequences on a **DNA printer**

4:52
The new code has 3 key instructions:

1 How to recognise and kill a cancer cell (modify an antibody to new receptor that can detect the particular antigen on the specific cancer)

2 Tells it to make **copies** of itself when it finds that **cancer** cell

3 Tells it to **survive** in the patient's body

5:25
To get the new code into the patient's t-cells you need a **vector**
What is a **vector**? - something that will easily infect the patients' **T-Cells** and carry the bespoke designed DNA in with it.

5:50
The name chimera comes from an ancient Greek fire-breathing monster that had three parts

- Lion head
- Goat body
- Serpent tail

What is a chimera?

- Something that contains two or more different tissues or cells

6:00
So a **CAR-T Cell** is a chimera as it is part **T-Cell**, and part antibody (from the **B-Cell**)

6:06
CAR T-Cells are multiplied up

- Mild dose of chemotherapy to wipe the existing t-cells
- Insert the modified **CAR T-Cells**
    - follow their normal **DNA programming** to move and search

6:29
They're now on a mission to find the cancerous cells and destroy them.

6:40

CAR T-Cells are like living drugs which makes them different to conventional approaches in that:

- They don't get used up or excreted
- They live in a patient's bloodstream for years.

6:50

CAR T-Cells are expensive, why?

- They are bespoke to the patient

How do you think that this might be made cheaper? Extra credit, or discussion point. Relates to Quiz

- Automation
- Robotics
- AI

It's difficult to get them to work with common cancers like breast/lung **cancers** as you need to find a specific **antigen** to target. This is much easier with blood cancers, and so the first cancers to be targeted in this way are blood cancers (**Acute Lymphoblastic Leukaemia**).

7:23

The survival rate for **Acute Lymphoblastic Leukaemia** has improved hugely, nearly all patients go into remission and most patients stay in remission.

- Why do they stay in remission?
  - Cells last in the body, **replicate** once they find a cancer cell
  - They've been **engineered** to survive