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# TEACHER'S NOTES

## TREATMENTS OF THE FUTURE

### OVERVIEW

Aimed at **key stage 4** pupils. This is a worksheet that introduces stem cells and how they could treat genetic conditions.

### LEARNING OBJECTIVES

- To understand that stem cells are 'master cells' that can create other more specialised cells
- To understand that embryonic stem cells are derived from unborn embryos
- To be aware of the ethical considerations of using embryonic stem cells
- To understand that new techniques allow so-called 'inducible pluripotent stem cells' or 'iPS cells' to be created.
- To be aware of the benefits and drawbacks of iPS cells, both from a scientific and an ethical perspective

### CURRICULUM LINKS

- KS4:** Human health is affected by a range of environmental and inherited factors, by the use and misuse of drugs and by medical treatments
- KS4:** the use of contemporary scientific and technological developments and their benefits, drawbacks and risks
- KS4:** to consider how and why decisions about science and technology are made, including those that raise ethical issues, and about the social, economic and environmental effects of such decisions

### Activity

- Show one of the films from [www.genesareus.org](http://www.genesareus.org) to enable pupils to understand more about what it is like to live with a genetic condition.
- Give students the worksheet and ask them to answer questions 1-8. This could lead into a class discussion about some of the controversial issues.

### ANSWERS

1. Approximately how many types of cells are in humans?

a) 200

2. List as many types of differentiated cell as you can

Pupils should attempt to identify different types of cell from around the body (for example, skin cells, muscle cells, nerve cells, blood cells, cells in the retina, liver cells, etc.)

3. Fill in the table below

Cell type	Ability to renew itself	Ability to create new types of cell
Totipotent stem cell	Unlimited	Unlimited
Pluripotent stem cell	<b>Unlimited</b>	Slightly limited
Multipotent stem cell	<b>Unlimited</b>	<b>Limited</b>
Differentiated cell	<b>None</b>	<b>None</b>



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### ANSWERS

continued

#### 4. Do you think that scientists should be able to undertake research on ES cells? What, if any, restrictions might you enforce?

There are no right or wrong answers to this question – students' feelings may vary quite widely. Students might feel strongly about the moral status of the embryo and therefore be against ES cell research. Currently, the UK is one of the most permissive countries to carry out ES cell research. Even so, all ES cells must be destroyed within 14 days of starting to use them (but original stores of ES cells can be stored, frozen in liquid nitrogen, indefinitely).

Pupils should suggest where they think restrictions should lie, such as how far the embryo is allowed to develop, where the embryos are sourced from and whether people should be paid to donate embryos for research.

#### 5. Why might iPS cells be less controversial than ES cells?

Because no embryos are destroyed when creating iPS cells – adult cells are simply 'reprogrammed'.

#### 6. If a clinical trial was run in the future to test iPS cells as a treatment, how do you think people would feel about participating?

Some people might be excited to be accessing a new treatment. Some people might feel hesitant about using a new technology and have lots of questions before participating. Some people might feel proud to be able to help test a treatment that could save thousands of lives.

#### 9. What factors might influence their decision to take part in the trial?

Pupils could mention lots of different factors including: how sick someone is; how old they are; what other treatments are available to help them; safety information about the new treatment; what risks were involved; how much money they would be given for participating.

#### 10. Complete the table below:

Statement	True or false?
You find stem cells in the bone marrow	True
Stem cells were discovered in the 1990s	False
The majority of human cells are differentiated	True
Stem cells are involved in growth and repair	True
Plants have stem cells	True
You can find stem cells in umbilical cord blood	True

### FURTHER information



Further information on stem cells available from the EuroStemCell project along with educational resources, such as films and discussion activities  
[www.eurostemcell.org](http://www.eurostemcell.org)

FOR MORE RESOURCES GO TO [WWW.GENESAREUS.ORG](http://WWW.GENESAREUS.ORG)

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# TREATMENTS OF THE FUTURE

Stem cell treatments could potentially be used to treat many genetic conditions. They are already being used for a small number of disorders, but there are high hopes to treat a wide range of illnesses with stem cells in the future. Lots of scientists are doing research on stem cells, but it is likely to be many years before many of these potential treatments become available.

In order to understand the role of stem cells we need to think about how we developed as an embryo. We all started our lives as a single cell. That cell divided to create two cells, which divided to create four cells, to eight and so on. In the first few days of the development of an embryo all of its cells are essentially identical. However, it is obvious from looking at someone that they contain a huge array of specialised cells – skin cells, muscle cells, nerve cells, blood cells and so on. Once a cell has become specialised, it is known as a differentiated cell.

- 1 Approximately how many types of cells are in humans?
  - a) 200
  - b) 2,000
  - c) 20,000
- 2 List as many types of differentiated cell as you can

As an adult, our differentiated, specialised cells are unable to divide and replace themselves. Instead, we rely on stem cells to help us generate new cells.

There are three different types of stem cell:

- ★ **totipotent stem cells** can give rise to every single type of cell needed by the developing embryo;
- ★ **pluripotent stem cells** can give rise to every type of cell found in adults;
- ★ **multipotent stem cells** are found in adults and give rise to a restricted set of closely related cells.

- 3 Fill in the table below

Cell type	Ability to renew itself	Ability to create new types of cell
Totipotent stem cell	Unlimited	Unlimited
Pluripotent stem cell		Slightly limited
Multipotent stem cell		
Differentiated cell		

Only a few populations of multipotent stem cells are found in adults. For example, in the bone marrow, there are stem cells that are able to make all the different blood cells. These are called haematopoietic stem cells and bone marrow transplants are already used successfully to treat some conditions, such as sickle cell anaemia and leukaemia.



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# TREATMENTS OF THE FUTURE

Embryonic stem (ES) cells are pluripotent stem cells that are taken from an embryo when it has between 50 and 150 cells. ES cells are controversial because they can only be taken from embryos that will be destroyed. Many groups believe that destroying an embryo is unacceptable, so this research is banned in some countries and tightly regulated all over the world.

However, for scientists ES cells are extremely important – they are helping scientists understand how we develop and they could also offer new treatment options for a range of diseases. For example, progressive neurodegenerative diseases like Huntington's disease, Parkinson's disease and Alzheimer's disease are all characterised by the loss of neurons in certain parts of the brain. If these neurons could be replaced, these conditions could, potentially, be cured.

- 4** *Do you think that scientists should be able to undertake research on ES cells? What, if any, restrictions might you enforce?*

Because of the various restrictions put on ES cell research and the ethical considerations around using ES cells, scientists have long tried to find another way of creating stem cells.

Recently, scientists discovered how to take a differentiated adult cell and turn it into a stem cell. For a long time it was believed that once a cell had differentiated it could not then become a stem cell again. However, by using genetically engineered viruses to turn on specific genes in an adult cell, it is now possible to create so-called 'inducible pluripotent (iPS) cells'. This is an amazing discovery, but it is still being researched and is not safe to use in patients. One major concern about using any stem cell-based therapy is their ability to divide indefinitely, which could lead to cancer. There are also worries about the fact that iPS cells have been created artificially; the cells have been reprogrammed using genetically engineered viruses and there could be unpredictable side-effects from this approach.

- 5** *Why might iPS cells be less controversial than ES cells?*
- 7** *What factors might influence their decision to take part in the trial?*
- 6** *If a clinical trial was run in the future to test iPS cells as a treatment, how do you think people would feel about participating?*
- 8** *Complete the table below:*

Statement	True or false?
You find stem cells in the bone marrow	
Stem cells were discovered in the 1990s	
The majority of human cells are differentiated	
Stem cells are involved in growth and repair	
Plants have stem cells	
You can find stem cells in umbilical cord blood	

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