

Lesson 3: Science

Aim

To become familiar with the properties, functions and potential therapeutic benefits of stem cells

Objectives

- To read and respond to information on stem cells
- To differentiate between the various sources of stem cells
- To prepare a proposal for a research project into Huntington's disease

Curriculum Links

How Science Works

4b: 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

GCSE Specifications

AQA: 10.8: Societal aspects of science, 10.9: limitations of scientific evidence

Edexcel: Topic 4: Use, misuse and abuse, Topic 8: Designer Products

Twenty First Century: Module B2: Keeping Healthy

Materials

Science Information Sheets 1 and 2 (1 of each per student)

White-board and pen

Activities

1. In groups of 3 or 4, give the students 5 minutes to discuss and write down 3 statements about stem cells. These may be definitions, or things they have heard, read or seen in the media. Compare the groups' statements, noting any similarities/ differences.

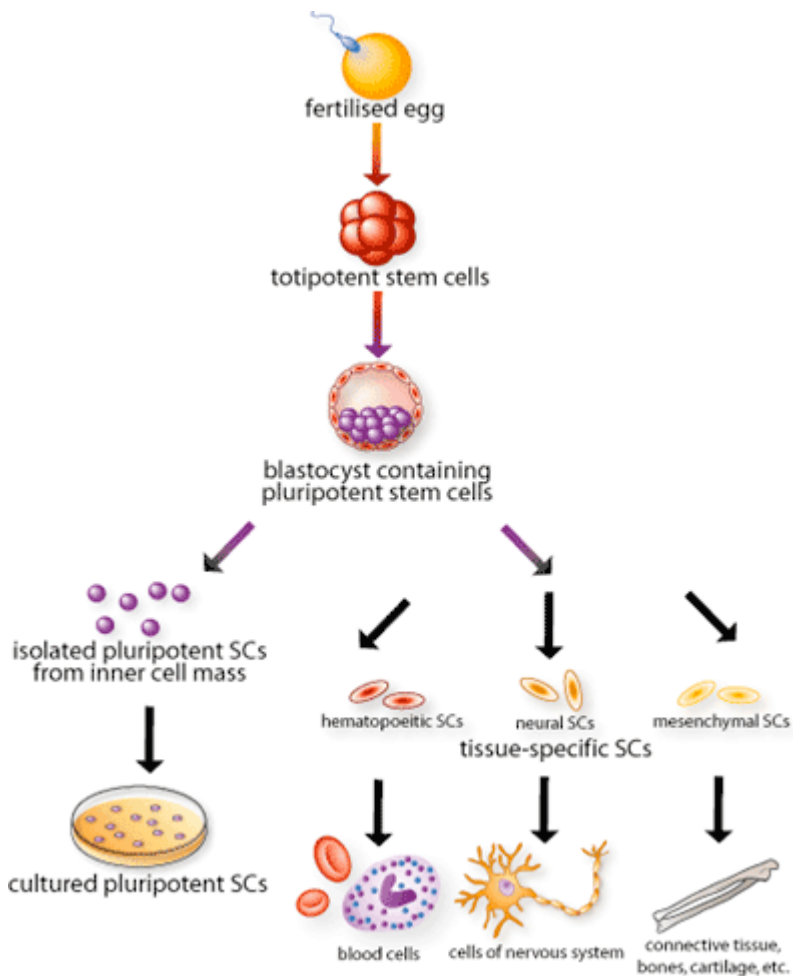
2. Ask the students to read *Information Sheet 1: Stem Cells*, answering the following questions in pairs:
 - What is the function of stem cells in the body?
 - Name the 2 different types of stem cells. What is the difference between them?
 - How can stem cells be used medically?
 - Name 3 sources of stem cells used for research.
 - How many cell types are there in the body?
 - Why is the use of ES cells a contentious issue?
3. After 10 minutes, check the answers as a group and discuss any misunderstandings. How do the students' first impressions of stem cells (the statements they made at the beginning of the class) compare with what they have learnt?
4. Ask the class to close their eyes. Explain that you are going to say a word, and when you tap them on the shoulder they will say the first word that comes into their head in response to that word. When all the students have closed their eyes, say 'hereditary disorder'. After eliciting responses from several students, ask them to open their eyes and discuss their responses as a group.
5. Can the class name any hereditary disorders? eg. Cystic Fibrosis, Huntington's Disease, Cerebral Palsy, Spina Bifida.
6. Ask the students to read *Information Sheet 2: Huntington's Disease*.
7. Ask the students to form groups of 3 or 4. They are a group of research scientists trying to find a therapy for Huntington's disease. They hope that the implantation of stem cells into damaged areas of the brains of HD sufferers will reduce symptoms and may even lead to a cure for the disease.
8. The scientists need to write a project outline as part of their application to use stem cells and for funding from the University. The document should contain the following information:
 - A brief outline of the objectives of the research (what they wish to achieve)
 - A brief description of Huntington's disease and why this research is important
 - Why they wish to use stem cells for the research
 - Where they will source the stem cells from; will they use ES or TS cells, and what are the reasons for their choice?
 - Conclusion

Give the group at least half an hour to work on this task You may wish to set it as home-work, and in the next lesson have each group present their proposal to the class.

Science Information Sheet 1: Stem Cells

What are stem cells?

Stem cells are cells which are undifferentiated and therefore do not have any specialized physiological function (unlike, for example, a red blood cell which is specialized to carry oxygen through the blood stream). They play a central role in the normal growth, development, maintenance and repair of tissues and organs in the body through their ability to produce cells which can be differentiated into other, specialized cell types such as skin, liver or bone. They can also produce copies of themselves.

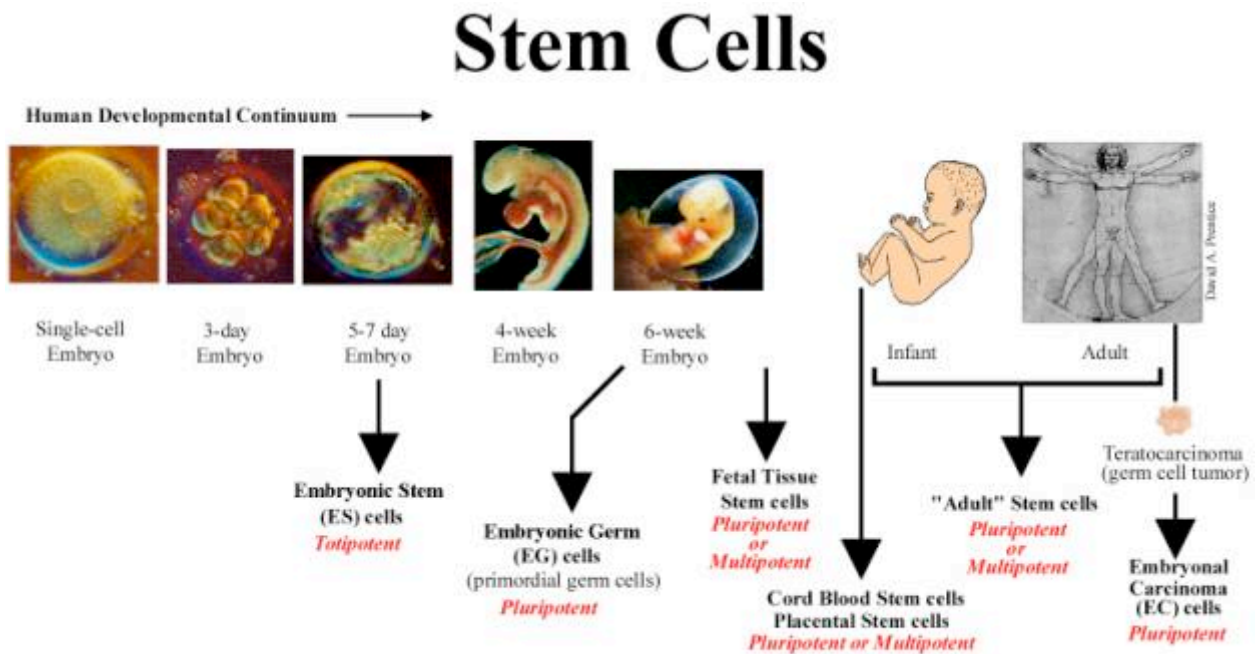


Where are they found?

Stem cells are found at the earliest stages of the developing embryo. These are known as embryonic stem or ES cells. Stem cells are also found in many tissues of the developing

foetus and adult body, these are called tissue stem or TS cells. Stem cells have been found in the early embryo, foetus, placenta and umbilical cord, and in many tissues of the adult body including bone marrow, blood, skin, muscle, brain, cornea and retina of the eye and the lining of the gastrointestinal tract.

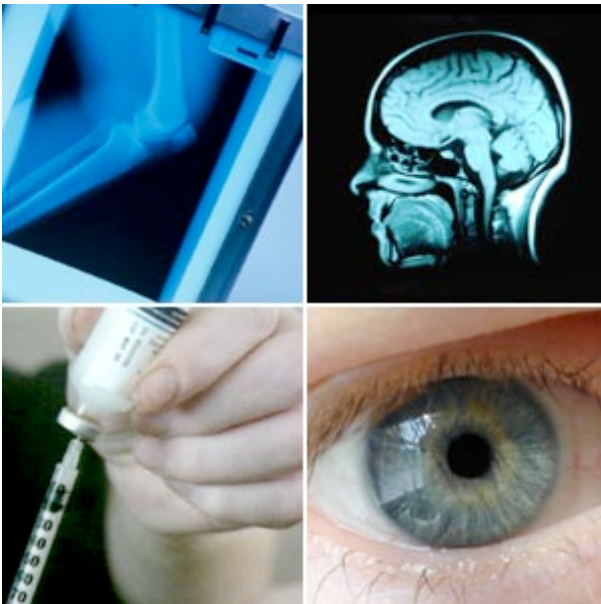
All stem cells have the potential to differentiate, but the number and types of cells they can give rise to depends varies according to the tissues and stages of development they are derived from. ES cells taken from the inner cell mass of a blastocyst (the collection of cells before the embryo embeds in lining of the womb) have the greatest potential to produce many types of specialised cells. TS cells found in adult tissue are more restricted as to which cell type they can produce. For example, stem cells found in the muscle will only give rise to muscle cells.



How can they be used?

When cells of the body are damaged by injury or disease, they frequently cannot replace themselves. Stem cells have the capacity to replace damaged cells, and so form the

basis of regenerative medicine. Bone marrow transplants and skin grafts are both established examples of regenerative medicine using stem cells.



It is hoped that by transplanting the appropriate stem cells into the damaged part of an individual's diseased tissue, the transplanted stem cells would regenerate the various cell types of that tissue (for example the brain, bone marrow, the retina of the eye). Stem cells could also potentially be used in the laboratory to test the effects and side-effects of new drugs. Researchers are in the process of developing methods that allow them to accurately direct stem cells to produce the cell types that are specifically needed for transplantation and drugs testing. Stem cell 'lines' (the self-replenishing culture of cells resulting from one group of stem cells), once established, are very difficult to keep alive and need almost constant care and attention.

Where do they come from?

Below is a list of possible sources of stem cells that can be legally donated and used for research.

- surplus embryos discarded from in vitro fertilization (IVF) or preimplantation genetic diagnosis
- cells from aborted foetuses

- embryos created exclusively for stem cell research in a laboratory using IVF methods from donated sperm and eggs
- blastocysts created exclusively for stem cell research in a laboratory by somatic cell nuclear replacement (SCNT) using donated eggs and adult tissue. This means that the DNA of the egg is extracted and replaced by the DNA of cells from adult tissue
- embryos created exclusively for stem cell research by activating a human egg without a sperm (parthenogenetic)
- adult or foetal tissues containing TS cells
- umbilical cord blood containing TS cells
- hybrid or chimera cells, in which the nucleus of a cow or rabbit ovum is removed and replaced with a human nucleus or cell. **NOTE: the government has recently made it legal for researchers to make an application to carry out work on hybrid cells, and the house of Lords recently rejected on a call from Christian groups to ban such research**



Which to use, the ES cell or the TS cell?

Embryonic stem cells have huge therapeutic potential because they can give rise to any of the approximately 210 cell types of the body. It is widely agreed that tissue stem cells have limited therapeutic potential because they only give rise to the type of cell they originated from. However, scientists are investigating the possibility that TS cells could

exhibit plasticity, meaning that they would be able, under the right conditions, to give rise to cell types of a different tissue. As yet there is no definitive answer on this.

For some people the origin of ES cells will always be a sensitive issue, as they have to be collected from the human embryo, which is surrounded by complex ethical debate. At the present time, scientists are focussing research on both ES and TS cells.

Thanks to the Church of Scotland for their support and the information included in this document.

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Science Information Sheet 2: Huntington's Disease

Huntington's disease (HD), which is sometimes called Huntington's Chorea, is an hereditary disorder of the central nervous system. Huntington's disease usually develops in adulthood and can cause a very wide range of symptoms. The disease affects both men and women.

Huntington's disease is caused by a faulty gene on chromosome 4. The gene, which produces a protein called Huntingtin, was discovered in 1993.

In some way - which is not yet understood - the faulty gene leads to damage of the nerve cells in some areas of the brain, including the *basal ganglia* (a group of nuclei associated with a variety of functions including motor control, cognition, emotions and learning) and the *cerebral cortex* (an area at the front of the brain that plays a central role in complex brain functions including memory, attention, perceptual awareness, thought, language and consciousness). This leads to gradual physical, mental and emotional changes.

Each person whose parent has Huntington's disease is born with a 50-50 chance of inheriting the faulty gene. Anyone who inherits the faulty gene will, at some stage, develop the disease. A genetic test is available from Regional Genetic Clinics throughout the country. This test will usually be able to show whether someone has inherited the faulty gene, but it will not indicate the age at which they will develop the disease.

The early symptoms of HD include:

- slight, uncontrollable muscular movements
- stumbling and clumsiness
- lack of concentration
- short-term memory lapses
- depression
- changes of mood, sometimes including aggressive or antisocial behaviour

Later on in the illness people experience many different symptoms which may include:

- involuntary movements
- difficulty in speech and swallowing
- weight loss

as well as emotional changes resulting in:

- stubbornness
- frustration
- mood swings
- depression

Medication can be used to treat symptoms such as involuntary movements, depression and mood swings. Speech therapy can significantly improve speech and swallowing problems. A high calorie diet can prevent weight loss and improve symptoms such as involuntary movements and behavioural problems.

However, currently there is no cure for the illness.

Thanks to the Huntington's Disease Association for their support and the information included in this document. www.hda.org.uk

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