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STEM CELLS

WHAT ARE STEM CELLS?

Stem cells are primitive cells that are responsible for creating various tissues and organs in the body. At an early stage in their development, stem cells are unspecialised. After birth, they only reactivate when new cells are needed e.g. after injury. Under certain conditions, they may become cells that can develop into almost all types of cells or tissue. They can also undergo self-renewal - that is they can divide to form further unspecialised stem cells.

WHERE DO THE CELLS COME FROM?

There are different sources of stem cells (see box 1). Much is made in the media of embryonic stem cells - cells that occur in the early (5 day) embryo when it is a tiny ball of around 100 cells called a blastocyst, before it implants into the wall of the mother's womb. Because stem cells can develop into most types of tissue, they hold out an exciting prospect of development of new cell treatments to replace damaged cells in the body that won't be rejected.

Box 1:

SOURCES OF STEM CELLS	NAME
Early human embryos	Embryonic stem (ES) cells
Aborted human fetuses	Fetal stem cells
Umbilical cord blood	Placental stem cells
Adult humans	Adult stem cells – bone marrow (or haematopoietic); skin; blood

Stem cells from the sources above differ in a number of ways - one way is the **Plasticity** of the cell - plasticity refers to the range of cell types that the cell can turn into. All embryonic stem cells have high plasticity as they develop into all the different organs and tissues of the early fetus - such as arms, legs, blood vessels, kidneys etc. It was thought that older cells and tissues such as adult stem cells had very limited plasticity but recent research has shown that adult cells also have plasticity and can even turn into cells of another type (e.g. adult nerve cells may be able to turn into blood cells) - a process called transdifferentiation. Proponents of transdifferentiation who claim cells can change, and opponents of transdifferentiation who claim that cells do not change and challenge its existence, hotly

contest research in this area.

USES OF STEM CELLS

Already stem cells are used in trials to treat adult neurological diseases such as Parkinson's disease and Huntington's disease (so-called fetal stem cell therapy where donated cells from an aborted or miscarried fetus are inserted into the brain and grow to replace the deficient chemicals produced in these diseases). Some cancers can also be treated by bone marrow stem cells, which are infused or transplanted into patients who have leukaemia or lymphomas. The stem cells replace the abnormal leukaemia cells with normal blood cells - these are called haematopoietic stem cells and have been in hospital use for over 3 decades.

ADULT VS. EMBRYONIC STEM CELLS

Adult cells grow much more slowly that embryonic cells - imagine watching a 2 year old boy who falls and grazes his knee and comparing the speed to which his graze heals to that of a 65 year old man. The younger cells have much more vitality and plasticity and will quickly heal whereas the older cells take a little longer. The same happens with fetal cells transplanted into the human brain in Parkinson's disease - they quickly grow to replace the older adult cells which are malfunctioning. Embryonic stem cells grow faster still, so researchers prefer to use embryonic cells for faster results.

IS RESEARCH ON STEM CELLS NECESSARY?

Despite all the research carried out on stem cells to date, little is known as to how and why embryonic cells grow much faster than adult cells. The House of Lords Select Committee on stem cells published a report in February 2002. The Committee anticipates that many advances in therapy will come in the future from research on embryonic stem cells. They concluded, however, that advances would not come from research on embryonic stem cells alone, and recommended that all routes to therapy should be kept open to ensure maximum medical benefit to include research on adult stem cells. This differs from the USA where adult stem cell research is seen as the main way forward, and embryonic stem cell research is prohibited.

THE ETHICAL FRAMEWORK

The main difference in approach between the UK and the USA lies in the ethical problems arising from embryonic stem cell creation. Embryonic stem cells are formed by growing a dividing fertilised egg in a test tube and then taking out the stem cells just before the stage when the early embryo would be implanting naturally into the womb (around 4 -5 days). Taking the cells from the early embryo allows a stem cell bank to be built up to store cell lines that can keep in storage for several years. This has the disadvantage that the early embryo dies in the process. Adult stem cell research avoids having to destroy embryos as cells are removed from adult tissues and is ethically acceptable. A cell nucleus taken from the early embryo can be inserted into another growing cell nucleus - so called **cell nuclear replacement or cloning**. Such cells can be used to replace cells not working in the body for

therapy - so called **therapeutic cloning**. If these cells were ever to be transplanted in to a mother's womb, this would lead to reproductive cloning. Although embryonic stem cell research is now legal in the UK, allowing creation of embryos up to the 14-day stage to produce stem cells, it is felt that sufficient safeguards are in place to prevent such reproductive cloning taking place. The UK however is still at the end of the moral spectrum being one of the few countries in the world to authorise the deliberate creation of embryos for research - a practice that runs against the European convention of human rights and biomedicine. The paradox in the USA however is that although they take a moral stance on creation of embryos, the legislation in several states allows execution of people on death row at the other end of life.

A consensus is growing that suggests research on adult and fetal cells is permissible as the ethics is analogous to transplantation work e.g. kidney donation - for example human kidney may be donated from one person to another if the donor is dead, but not if a human had been specifically conceived purely to donate both kidneys and die in the process. Embryonic stem cells may be used if they are currently in a stem cell bank but the deliberate production of fresh cells while sufficient banked cells are available would not be recommended (Nuffield report). Thanks to our understanding of human stem cells, thousands of transplant recipients survive. An open debate on the ethics of stem cells combined with very careful regulation of embryo research will ensure that knowledge continues to improve without infringement of the ethical and moral principles by which we live.

Useful References:

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