• Multipotent – Can only form a range of cells within a certain type of tissue.

Embryonic stem cells are totipotent and present in early stages of embryonic development. After seven days a mass of cells, called blastocyst, has formed and the cells are now in a pluripotent state. They remain in this state in the foetus until birth.

Tissues (adult) stem cells are Multipotent and present through life from birth. They are found in specific areas such as bone marrow. Stem cells can be harvested from umbilical cords of new born babies.

Stem cells are present in meristematic tissue in plants. Meristems are found wherever growth is occurring in plants e.g. tips of roots and shoots (apical meristems).

## The production of erythrocytes and neutrophils derived from stem cells in bone marrow

All blood cells are derived from stem cells in the bone marrow.

Erythrocytes have a short life span of about 120 days due to the lack of nucleus and organelles, so need replacing constantly. The stem cell colonies in the bone marrow produce approximately 3 billion erythrocytes per kg of body mass per day to keep up with the demand.

Neutrophils only live for about 6 hours and the colonies of stem cells in bone marrow produce in the region of 2.6 billion per kg per hour. This figure will increase during infection.

## The production of xylem vessels and phloem sieve tubes from meristems

Meristems are located sandwiched between the phloem and xylem tissue and is called vascular cambium. Cells originating from this region differentiate into different cells present in xylem and phloem tissues. In this way, the vascular tissue grows as plants grow. The pluripotent nature of stem cells in the meristems continues throughout the life of the plant.

## The potential uses of stem cells in research and medicine.

## The repair of damaged tissues, the treatment of neurological conditions such as Alzheimer's and Parkinson's, and research into developmental biology.

Stem cells can be used to treat diseases and areas such as:

- Heart disease muscle tissue is damaged as a result of a heart attack, normally irreparably med some success
- Type 1 diabetes insulin-dependent diabetes, the body's own immune system destroys the insulin-producing cells in the pancreas; patients have to inject insulin for life; tried with some success
- Parkinson's disease symptoms (shaking and rigidity) caused by it death of dopamine-producing cells in the brain;
- drugs currently only delay the progress of the disease Alzheimer's disease brain cells are destroyed as a risult of build-up of abronnal proteins; drugs currently only alleviate symptoms
- causing blindnessee the Iderly and diabetics; currently researching use of stem Macular degeneration – respects 200 cells in treatment and e P rosults are very encouraging. • Birth defects – already successfully reversed p evious untreatable birth defects in model organism such as mice
- Spinal injuries restored some movement to the limbs of rats with damaged spinal cords using stem cell implants.
- Treatment of burns stem cells grown on biodegradable meshes that can produce new skin for burn patients, quicker than taking a graft from another part of the body
- drug trials potential new drugs can be tested on cultures of stem cells before being tested on animals and humans
- Developmental biology study of changes that occur as multicellular organisms grow and develop form a single cell, e.g. fertilised egg, and why thing sometimes go wrong.

Stem cells in bone marrow have been used for many years. More recently, the use of embryonic stem cells in therapies and research has led to controversy.

Embryos were originally donated from those left over after fertility treatment but the removal of stem cells causes the destruction of embryos, although techniques are being developed which allow stem cells to be removed without damage to embryos. Life beginning at conception means that using embryos is really murder. There is lack of consensus as to when the embryos itself has rights, and also who owns the genetic material that I being used for research.

The use of umbilical cord stem cells overcomes this because there is greater availability of cord cells so you are more likely to find donors. It is easier to harvest and there is no pain for the donor. The cells are at their earlier stage of development so can be stored for future use and slightly mismatched cord cells work almost as well as using bone marrow cells.

However umbilical cord stem cells are multipotent, not pluripotent like embryonic stem cells, thus restricting their usefulness and adult tissue stem cells are more likely to have acquired mutations.

Induced pluripotent stem cells (iPSCs) are adult stem cells that have been genetically modified to act like embryonic stem cells and so are pluripotent.

The use of plant tissue stem cells doesn't raise the same issues as animal cells.