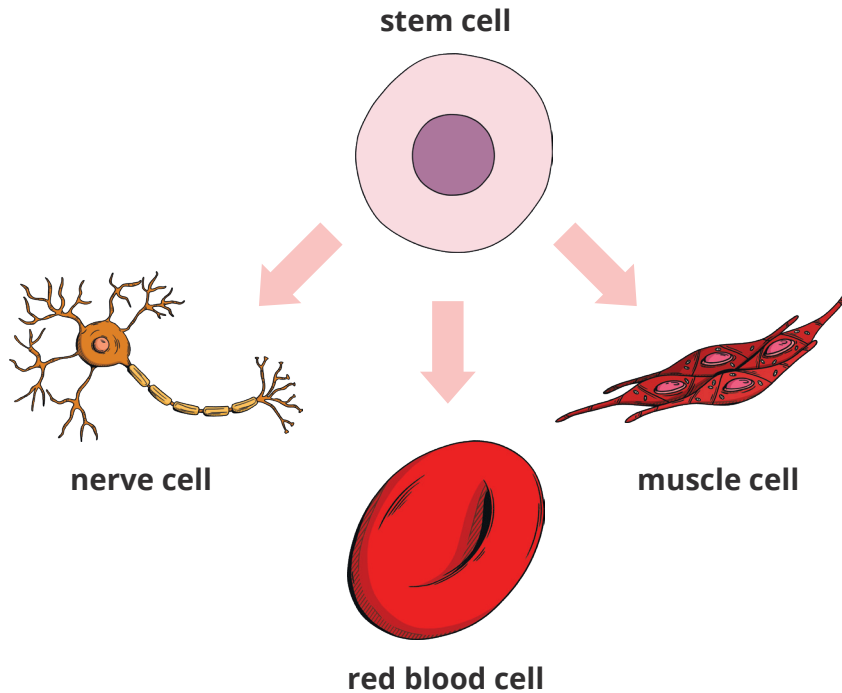


# Stem Cells

## What Are Stem Cells?

All complex organisms are made up of a variety of different types of cells. These specialised cells all differentiate from one type of cell. This type of cell is called a stem cell.

Stem cells are undifferentiated cells that can give rise to many more cells of the same type and from which specialised cells, such as nerve cells or muscle cells, can arise through differentiation. Differentiation is the process of a cell becoming adapted to carry out a specific function.



## Where Do Stem Cells Come From?

There are two main types of stem cells: embryonic stem cells and adult stem cells.

### Embryonic Stem Cells

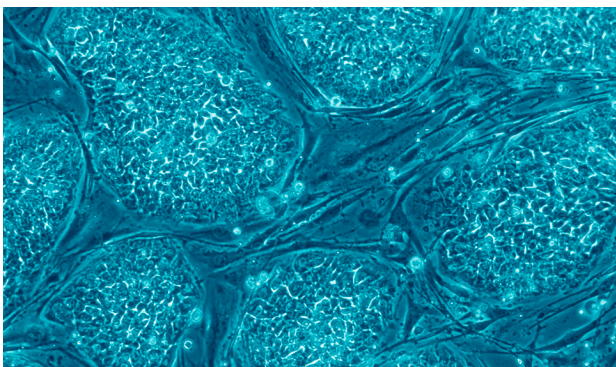


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Embryonic stem cells are found in the blastocyst stage of early human embryos (around three to five days old). An embryo develops from an egg cell that has been fertilised by a sperm cell. Embryonic stem cells have the potential to differentiate into any type of cell.

### Adult Stem Cells

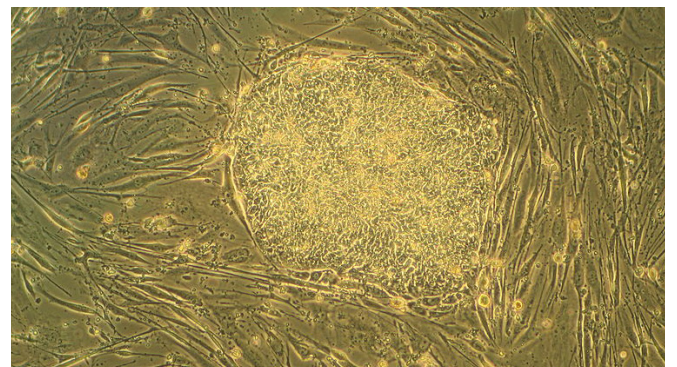


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Adult stem cells are the few cells which remain able to differentiate even once the organism is fully developed. They are found in small numbers in adult tissues such as bone marrow. Adult stem cells can only differentiate into a small number of different types of cells. For example, bone marrow stem cells give rise to blood cells.



## Uses of Stem Cells

A single isolated stem cell can be cloned in a laboratory to produce a group of identical stem cells. Stem cells have the potential to replace damaged cells in the body and therefore can be used to treat and cure disease. Scientists are already able to use bone marrow transplants to introduce donated adult stem cells into a patient's body as a way to replace faulty blood cells. The limitation of using adult stem cells in this way is that they are only able to reliably and safely differentiate into blood cells. Therefore, they are only useful in treating disease of the blood, such as myeloma, lymphoma and leukaemia. Similarly, adult stem cells found in other tissues are only able to differentiate into a few types of cells associated with the tissue in which they are found.

Scientists are making progress towards altering the genetic information of adult stem cells so that they behave more like embryonic stem cells. Therefore, differentiate into many more types of cells, but this is still being researched and investigated.

Research is also being conducted into the use of embryonic stem cells. Since they have the ability to differentiate into any type of cell, they could be used to potentially cure many more types of disease or injury, such as diabetes or paralysis.

## Therapeutic Cloning

As with organ donation, any cells which did not originate in the recipient's body may be recognised as foreign and therefore trigger an immune response in the body. This can result in the stem cells being attacked and destroyed by white blood cells. This is referred to as rejection.

Therapeutic cloning is the process of creating an embryo which has identical genetic material to the patient requiring the stem cell treatment. This means that the embryo would be able to provide cells for the patient which would not be recognised as foreign. However, there are risks associated with therapeutic cloning, such as viral contamination while cells are being grown in the lab, which may lead to a virus being transmitted to the patient.

## Issues Surrounding the Use of Stem Cells

Some people have ethical or religious objections to the use of stem cells. For example, people may disagree with the use of embryonic stem cells because they believe that an embryo is a potential human life and therefore should not be destroyed. During therapeutic cloning, a new embryo is created specifically to provide embryonic stem cells for a particular patient. As the embryo is not able to give permission, some people consider the use of these stem cells to be against the rights of the embryo.

Embryonic stem cells used in research are often obtained from embryos that are left over from IVF treatment, which would otherwise be destroyed. Embryonic stem cells can also be obtained after the birth of a baby from umbilical cord blood, which was previously considered a waste material and discarded. This can be collected easily and non-invasively, in a way that does not pose a risk to either the mother or baby.



The table summarises the advantages and disadvantages of using adult and embryonic stem cells.

	Adult Stem Cells	Embryonic Stem Cells
Advantages	<ul style="list-style-type: none"><li>• Less likely to be rejected when transferred to a patient.</li><li>• Have shown evidence of success in clinical applications.</li><li>• No major ethical concerns.</li></ul>	<ul style="list-style-type: none"><li>• Can be grown and maintained in cultures for a year or longer.</li><li>• There are tried and tested methods for successfully maintaining cultures of embryonic stem cells.</li><li>• Can differentiate to almost any cell type.</li><li>• Studies of embryonic stem cells help scientists learn about the process of development.</li></ul>
Disadvantages	<ul style="list-style-type: none"><li>• Limited differentiation potential.</li><li>• Can only be grown in cultures for short durations.</li><li>• Only a small number remain in tissues, so they are difficult to locate and isolate.</li><li>• Technology to produce and grow the stem cells on a mass scale does not exist.</li><li>• It can be difficult to find suitable stem cell donors.</li><li>• Bone marrow donation can be painful for donors.</li></ul>	<ul style="list-style-type: none"><li>• The process for generating cloned cells from embryonic stem cells is inefficient and does not always produce viable cells.</li><li>• Cells may be rejected.</li><li>• Therapies using embryonic stem cells are still in the research phase and require extensive testing.</li><li>• Cells used in transplants that are taken directly from the culture can lead to the development of tumours or cancers in the patients, because of rapid cell division.</li><li>• An embryo is destroyed to obtain the cells.</li><li>• There are wellbeing risks to the embryo donor as the process is physically intrusive and can be emotionally stressful.</li></ul>