

# Differentiation = Making specialized cells

11-14

## What is a stem cell?

### What the photo shows

A lump of metal and lots of different kinds of screws.

### Things to think about

Lumps of metal that start off the same can be made into lots of different kinds of screws.

Stem cells that start off the same can divide to make different kinds of specialized cells.

Specialized cells each do their own job in the body.

Skin cells, blood cells and nerve cells are all specialized cells.

Making different kinds of cells is called differentiation.

1. Embryonic stem cells can make **all the different types** of cell in your body.
2. Tissue stem cells can **only make a few other types** of cell. Skin stem cells only make skin cells. Blood stem cells only make blood cells. Blood stem cells do NOT make skin cells.



[www.eurostemcell.org](http://www.eurostemcell.org)

# Your body needs stem cells

11-14

## What is a stem cell?

### What the photo shows

Red blood cells.

### Things to think about

Red blood cells only live for 100 days. Blood stem cells make millions of new red blood cells every day.

You lose hundreds of dead skin cells every day. Skin stem cells make new skin cells.

Sometimes cells in your body die or get damaged. Stem cells make new, healthy cells to replace them.

Your body needs stem cells all your life. So, it is important your stem cells do not run out!

Stem cells can make more of themselves. This is called self-renewal.

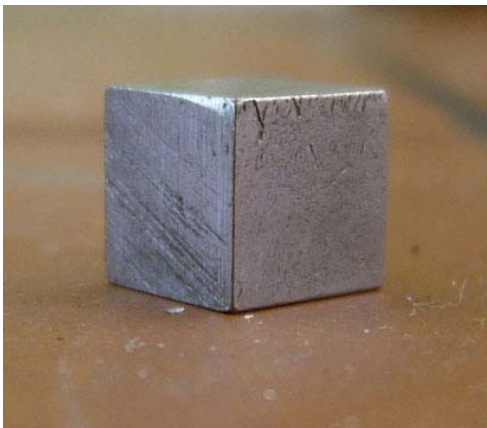


[www.eurostemcell.org](http://www.eurostemcell.org)

# Differentiation = Making specialized cells

11-14

What is a stem cell?



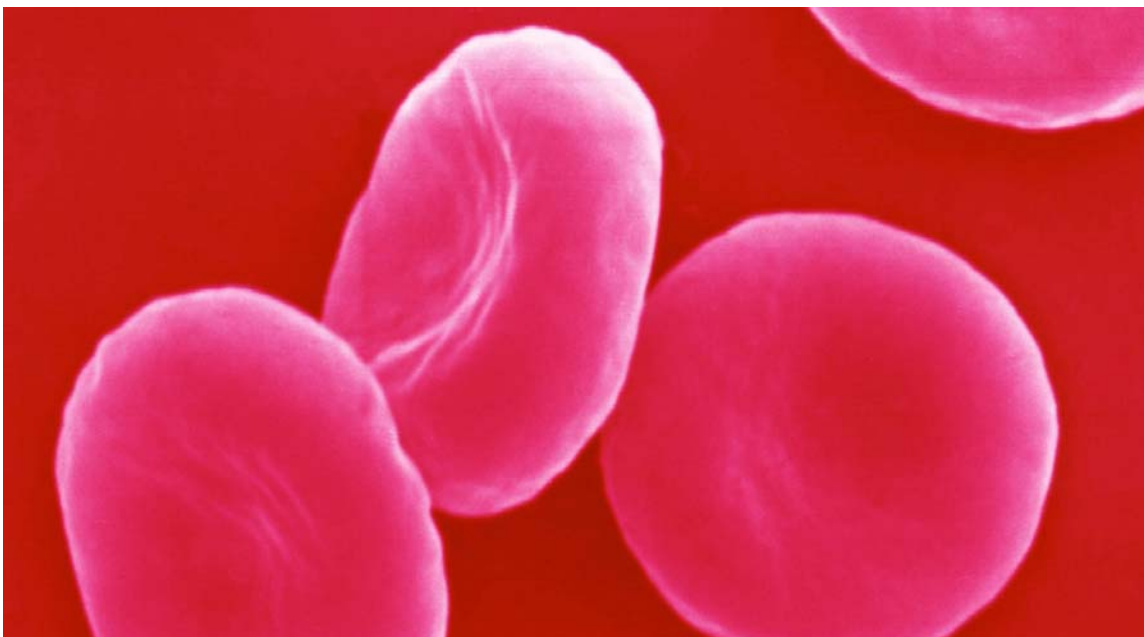
Screws: JM <http://www.logodesignweb.com/stockphoto>

[www.eurostemcell.org](http://www.eurostemcell.org)

# Your body needs stem cells

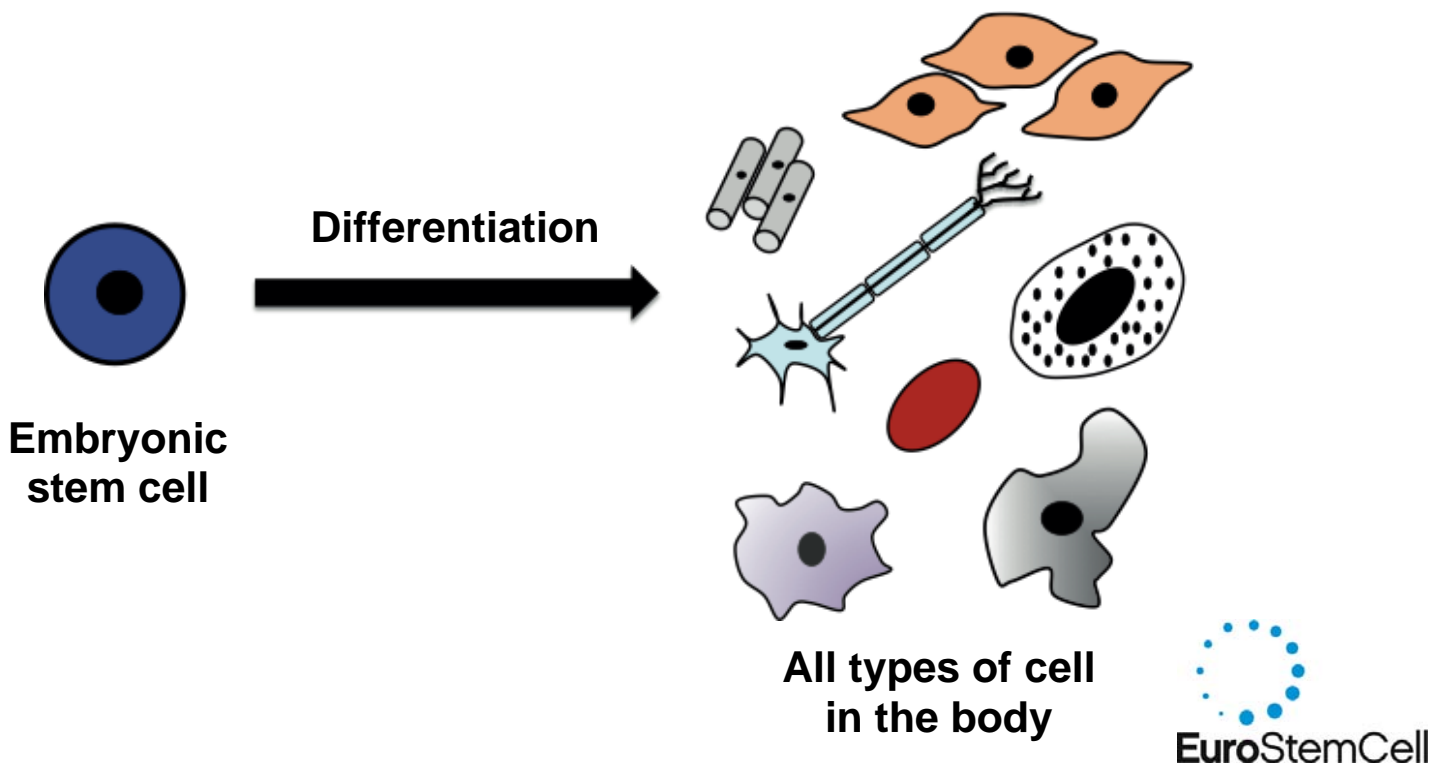
11-14

What is a stem cell?

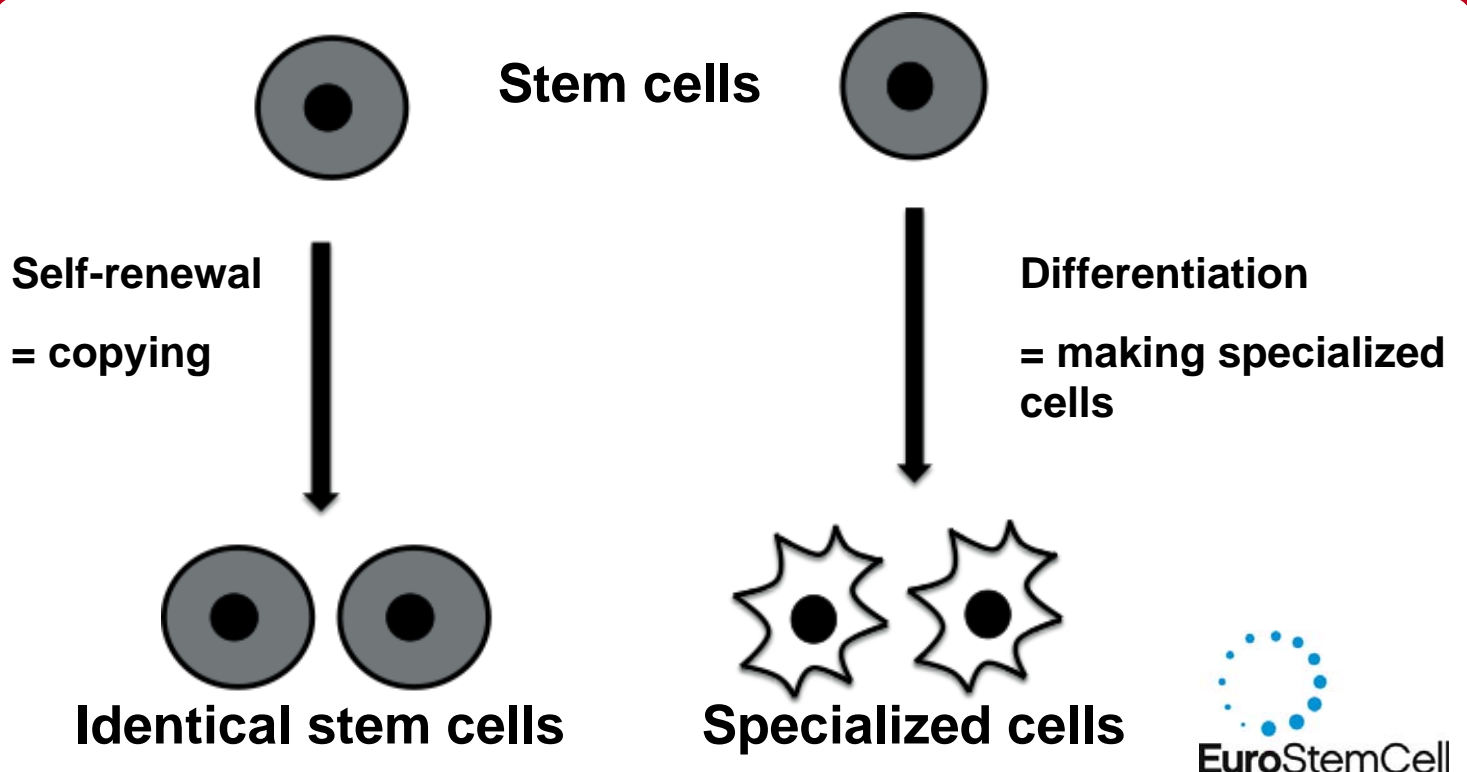


David Gregory and Debbie Marshall / [Wellcome Images](http://www.wellcomeimages.org)

[www.eurostemcell.org](http://www.eurostemcell.org)



[www.eurostemcell.org](http://www.eurostemcell.org)



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Look at the cards you have been given and read the information.

Make a poster or presentation to explain the most important facts to other students in your class. **Your poster or presentation MUST answer all the questions below.**

### Questions

1. What 2 things can stem cells do?
2. Why do our bodies need stem cells?
3. Name 2 kinds of stem cell and say what they can do.

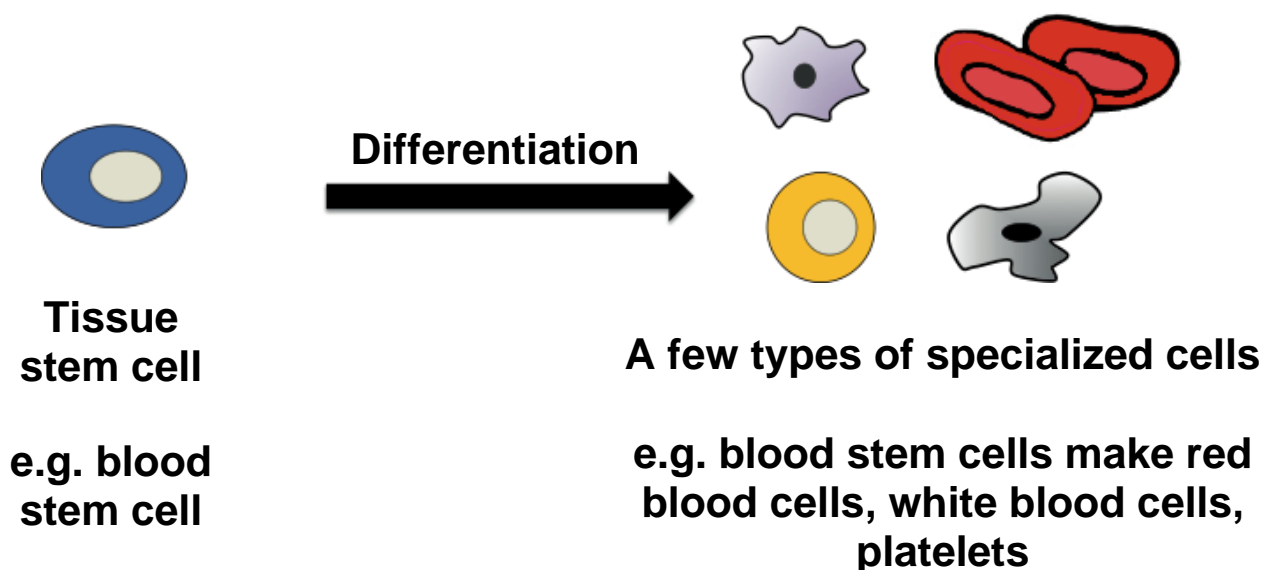
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[www.eurostemcell.org](http://www.eurostemcell.org)

# Tissue stem cells



[www.eurostemcell.org](http://www.eurostemcell.org)



# Embryonic stem cells come from a blastocyst

11-14

Where do embryonic stem cells come from?



Yorgos Nikas/[Wellcome Images](#)

[www.eurostemcell.org](http://www.eurostemcell.org)

# Growing cells in the lab

11-14

Where do embryonic stem cells come from?



[Wellcome library](#), London

[www.eurostemcell.org](http://www.eurostemcell.org)



# Embryonic stem cells come from a blastocyst

11-14

Where do embryonic stem cells come from?

## What the photo shows

A human blastocyst on the tip of a pin. The colours have been added to help you see the image clearly.

## Things to think about

A sperm fertilizes an egg.

The fertilized egg divides into 2, then into 4, then into 8, then into . . . . .

A blastocyst is when the egg has divided into about 100 cells.

Embryonic stem cells come from the blastocyst.



[www.eurostemcell.org](http://www.eurostemcell.org)

# Growing cells in the lab

11-14

Where do embryonic stem cells come from?

## What the photo shows

Embryonic stem cells in a flask.

## Things to think about

Cells from the blastocyst are put in a flask with the food they need.

The cells divide and multiply.

Scientists can grow lots of embryonic stem cells this way.

Growing lots of cells in the laboratory is called cell culture.

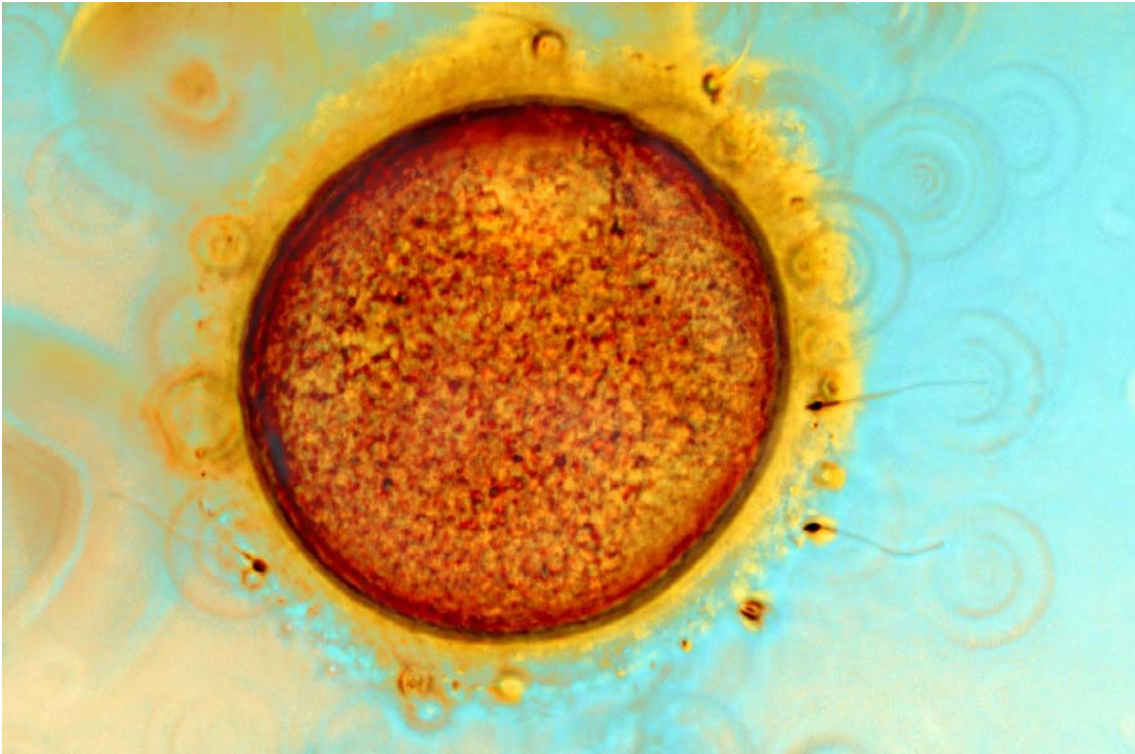


[www.eurostemcell.org](http://www.eurostemcell.org)



# IVF embryos in research

Where do embryonic  
stem cells come from?



Spike Walker/ [Wellcome Images](https://www.wellcomeimages.org/)

[www.eurostemcell.org](http://www.eurostemcell.org)

# IVF embryos in research

Where do embryonic stem cells come from?

## What the photo shows

Human egg and sperm.

## Things to think about

Not all people can make babies (reproduce) easily. IVF (in vitro fertilization) can sometimes help.

1. Egg cells are taken from the mother.
2. Sperm cells are taken from the father.
3. The sperm and eggs are mixed in a dish to make embryos.
4. A healthy embryo is put into the mother's womb.

The other embryos can be frozen and stored. Sometimes the mother and father let scientists use the embryos for research.



[www.eurostemcell.org](http://www.eurostemcell.org)

# Your task

11-14

Where do embryonic stem cells come from?

Look at the cards you have been given and read the information.

Make a poster or presentation to explain the most important facts to other students in your class.

**Your poster or presentation MUST answer all the questions below.**

## Questions

1. Where do embryonic stem cells come from? Think about the stages of human development from an egg and sperm to an adult.
2. Where can scientists get embryonic stem cells for research? What is IVF?
3. How do scientists grow enough cells for their research?

## Hints and tips for posters

- Stick the photos and diagrams onto your poster. You don't have to use them all if you don't want to.
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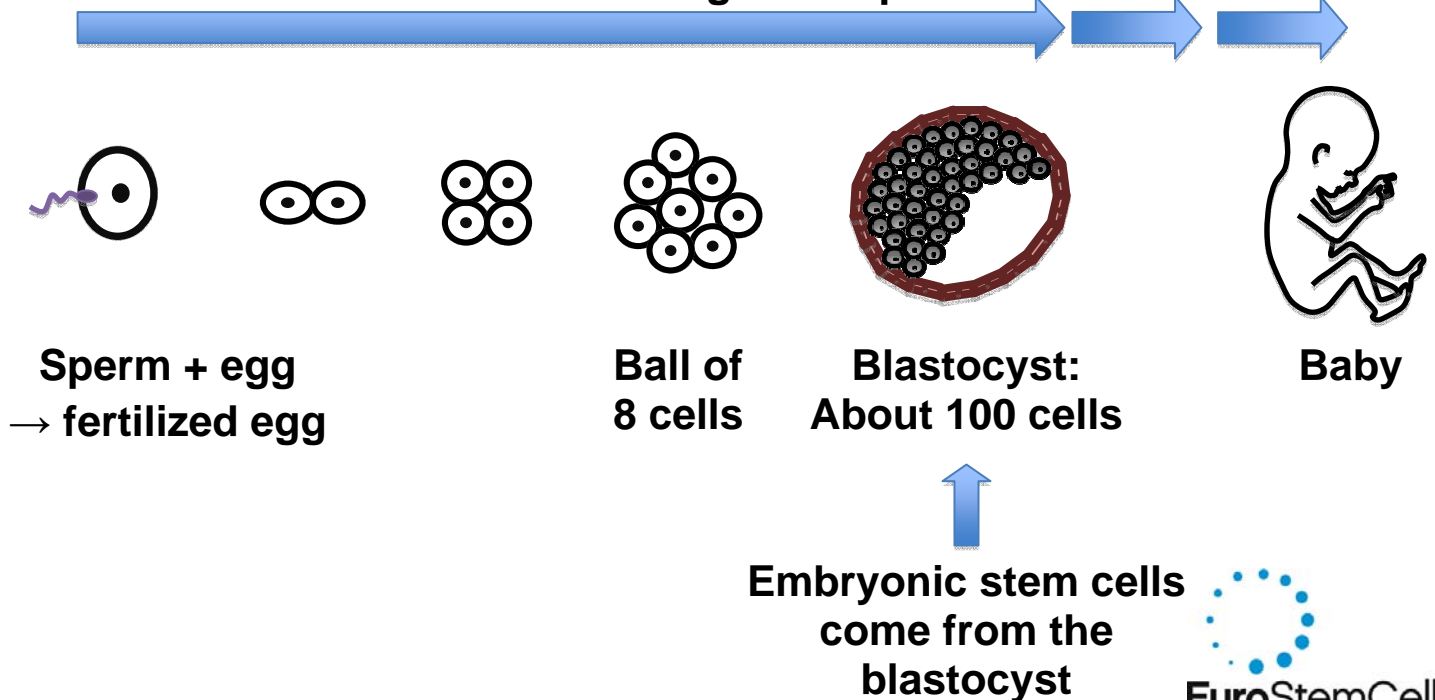
[www.eurostemcell.org](http://www.eurostemcell.org)

# Human development

11-14

Where do embryonic stem cells come from?

Cells divide during development



Embryonic stem cells  
come from the  
blastocyst



[www.eurostemcell.org](http://www.eurostemcell.org)



# Understanding disease

11-14

Why bother with stem cells?



# Testing drugs

11-14

Why bother with stem cells?



# Testing drugs

11-14

Why bother with  
stem cells?

## What the photo shows

Medicines.

## Things to think about

Scientists could use stem cells to test new drugs:

1. Use stem cells to grow a lot of specialized cells, e.g. nerve cells, blood cells or liver cells.
2. Add new drugs to the specialized cells.
3. See what the drugs do to the specialized cells.

This kind of testing might help reduce the need for animal testing.



[www.eurostemcell.org](http://www.eurostemcell.org)

# Understanding disease

11-14

Why bother with  
stem cells?

## What the photo shows

Scientist using a microscope.

## Things to think about

Some diseases are caused by faulty genes.

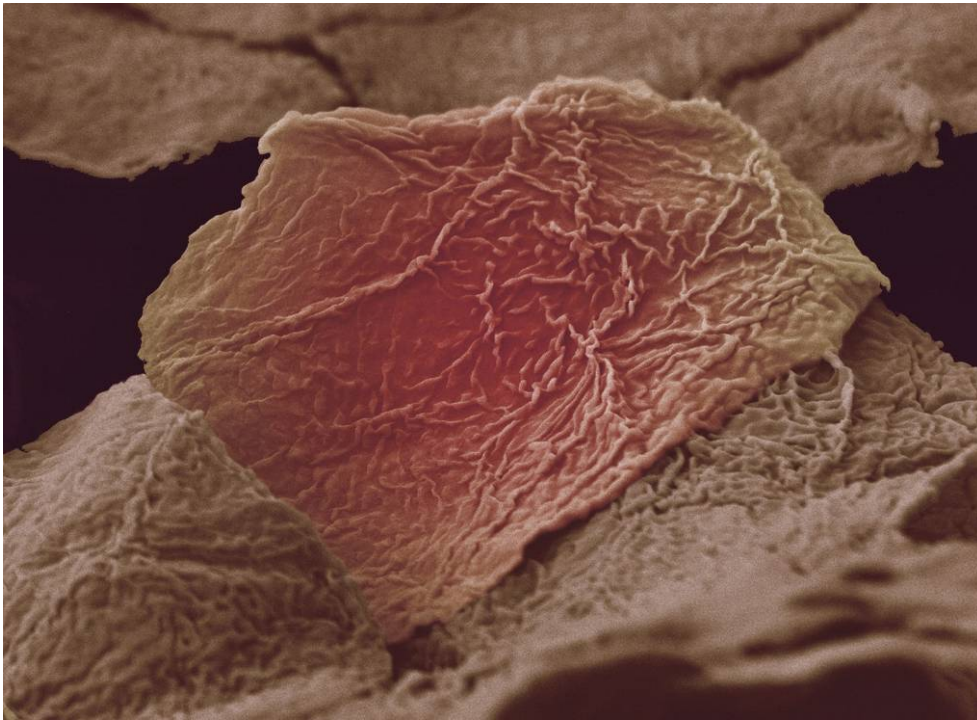
Scientists could use stem cells to learn about these diseases:

1. Grow stem cells with faulty genes.
2. Use the stem cells to grow specialized cells with faulty genes, e.g. nerve cells, blood cells or liver cells.
3. Investigate why the specialized cells do not work properly.



[www.eurostemcell.org](http://www.eurostemcell.org)





Anne Weston / [Wellcome Images](https://www.wellcomeimages.org/)

[www.eurostemcell.org](http://www.eurostemcell.org)



### What the photo shows

Skin cells from a patient who has been burned.

### Things to think about

Stem cells are used to make new skin for patients with bad burns:

1. Take a few stem cells from unburned skin.
2. Use these stem cells to grow new skin.
3. Put the new skin back onto the patient in the burned area.

In the future, we might use stem cells to grow new cells for other parts of the body.

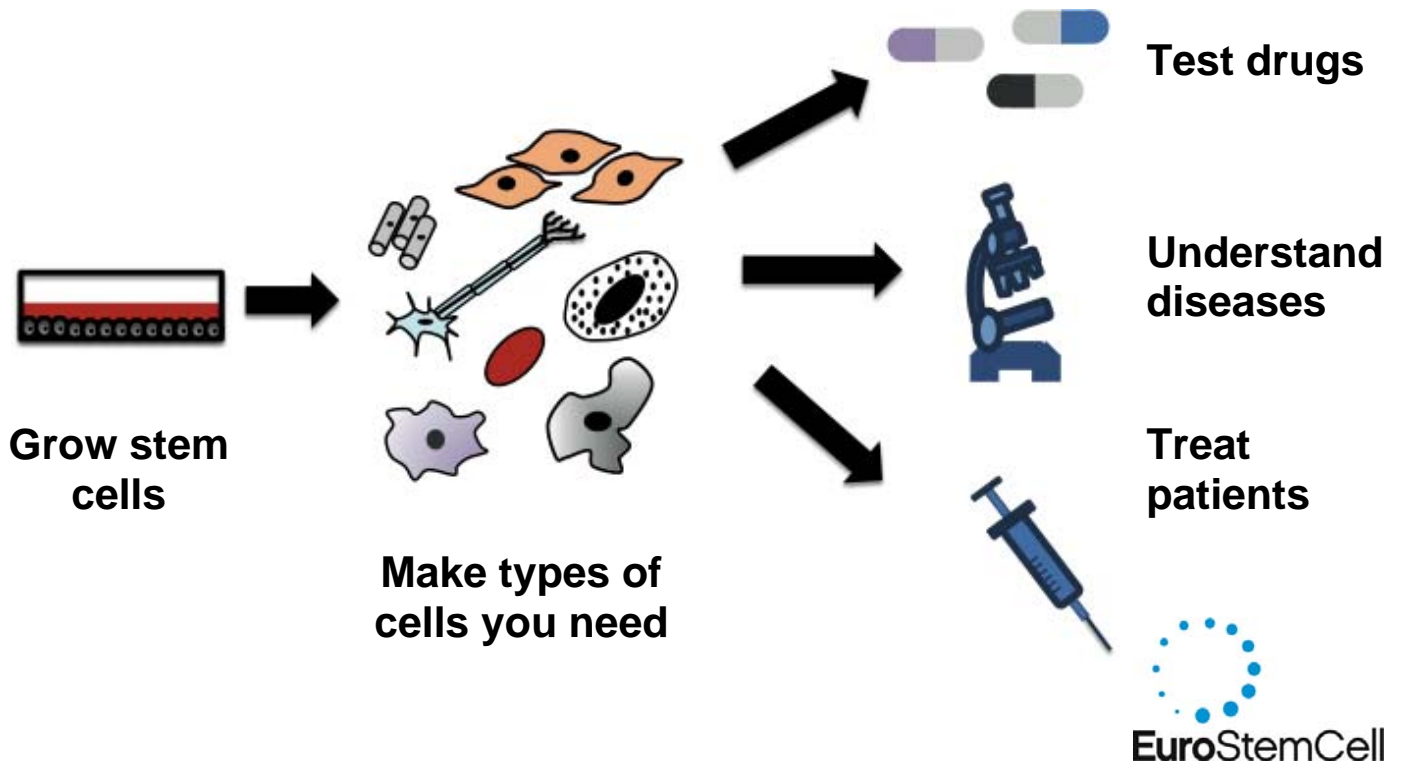
Scientists want to learn to grow healthy cells for patients with diseases like diabetes, Parkinson's disease or liver disease.



[www.eurostemcell.org](http://www.eurostemcell.org)

# How stem cells could be used

Why bother with stem cells?



[www.eurostemcell.org](http://www.eurostemcell.org)

## Your task

Why bother with stem cells?

Look at the cards you have been given and read the information.

Make a poster or presentation to explain the most important facts to other students in your class.

**Your poster or presentation MUST answer all the questions below.**

### Questions

1. How are stem cells used to treat patients now?
2. How might stem cells be used to treat patients in the future?
3. Name 2 more ways stem cells could be used.

### Hints and tips for posters

- Stick the photos and diagrams onto your poster. You don't have to use them all if you don't want to.
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EuroStemCell

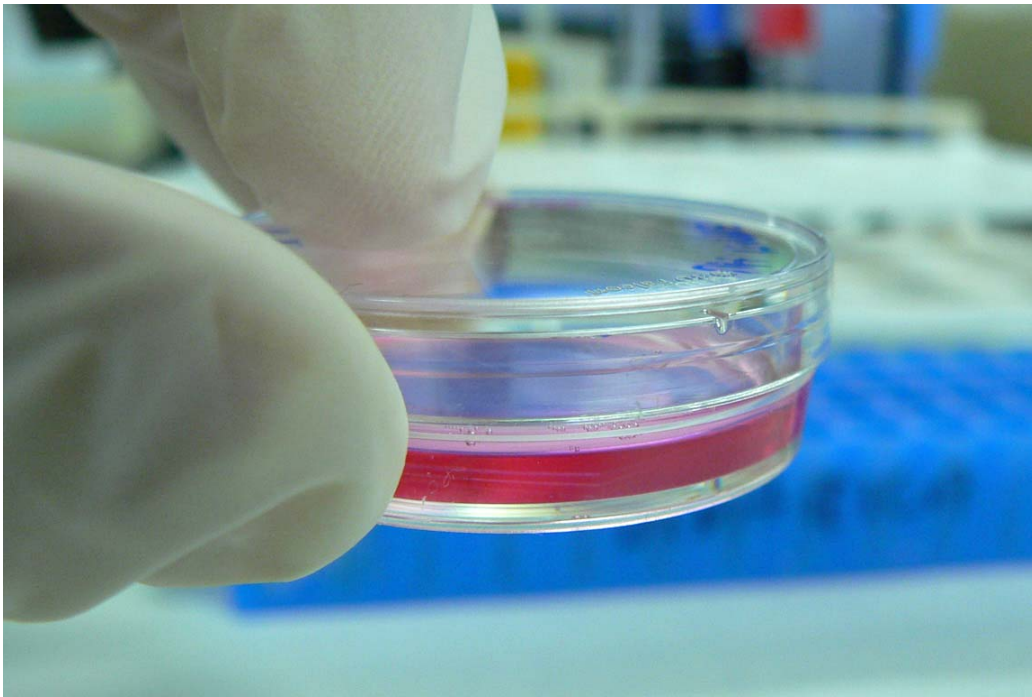
[www.eurostemcell.org](http://www.eurostemcell.org)



# Reprogramming cells

11-14

Making stem cells



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[www.eurostemcell.org](http://www.eurostemcell.org)

# iPS cells in medicine

11-14

Making stem cells



[Wellcome library](#), London

[www.eurostemcell.org](http://www.eurostemcell.org)

## What the photo shows

Dish containing stem cells being grown in a laboratory.

## Things to think about

Scientists can now make stem cells from specialized cells:

1. Three or four genes are added to specialized cells such as skin cells.
2. These genes are very carefully chosen.  
They instruct the skin cells to behave like embryonic stem cells.
3. A new type of stem cell is formed.  
The new cells are called induced pluripotent stem cells (iPS cells).

This is called genetic reprogramming.

iPS cells can make all the different kinds of cell in the body  
– just like embryonic stem cells.



[www.eurostemcell.org](http://www.eurostemcell.org)

# iPS cells in medicine

## What the photo shows

A man with diabetes injecting himself with insulin.

## Things to think about

In the future, iPS cells may help treat diseases like diabetes. We might be able to:

1. Take some tissue skin cells.
2. Add particular genes to make them into iPS cells.
3. Use the iPS cells to grow new, healthy specialized cells.
4. Put the new specialized cells into the patient to replace their faulty cells.

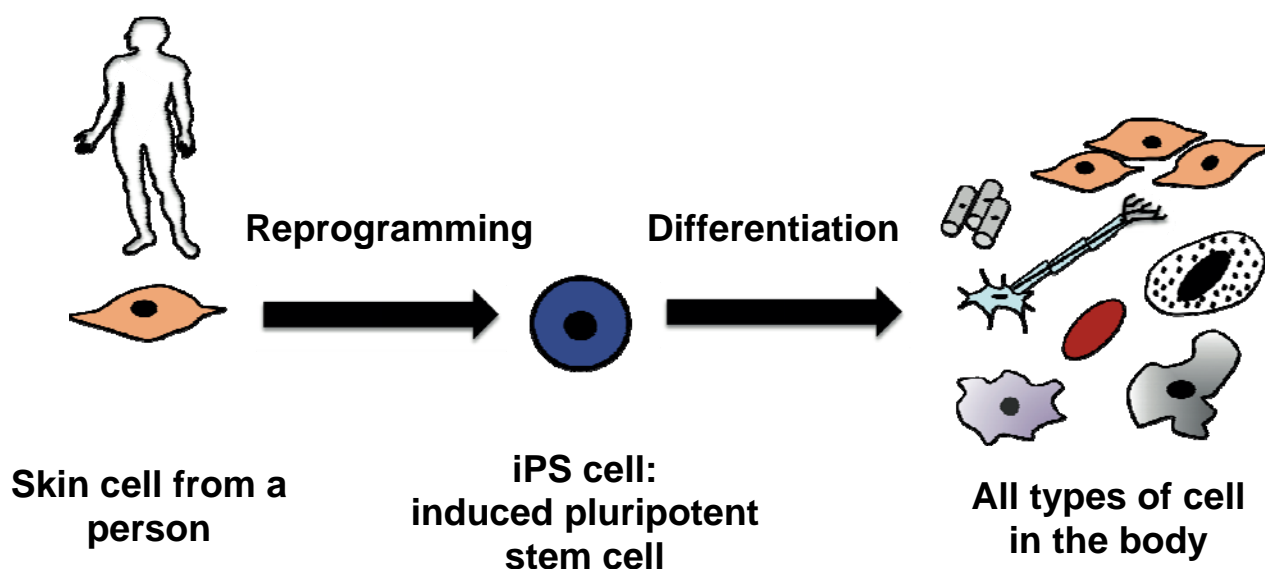


[www.eurostemcell.org](http://www.eurostemcell.org)

# Turning skin cells into stem cells

11-14

Making stem cells



[www.eurostemcell.org](http://www.eurostemcell.org)

## What does *pluripotent* mean?

11-14

Making stem cells

Stem cell scientists use particular words to describe what stem cells can do.

### **Multi**potent

Multi = more than one  
Potent = powerful

**Multipotent** stem cells have the power to make a few types of specialized cells.

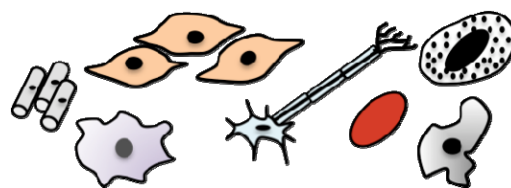


Tissue stem cells are multipotent.

### **Pluri**potent

Pluri = many  
Potent = powerful

**Pluripotent** stem cells have the power to make ALL types of specialized cells in the body.



Embryonic stem cells are pluripotent.



[www.eurostemcell.org](http://www.eurostemcell.org)





Look at the cards you have been given and read the information.

Make a poster or presentation to explain the most important facts to other students in your class. **Your poster or presentation MUST answer all the questions below.**

### Questions

1. What does 'pluripotent' mean?
2. What is an iPS cell and how are iPS cells made?
3. How could iPS cells be used in medicine?

### Hints and tips for posters

- Stick the photos and diagrams onto your poster. You don't have to use them all if you don't want to.
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# Activity overview

Students aged 16+ work in groups to prepare presentations to inform their classmates about a particular aspect of stem cell science.

## Learning objectives

### All students:

- Understand that stem cells can both self-renew and differentiate, unlike specialised cells
- Understand that there are different types of stem cells, and describe some key features of tissue and embryonic stem cells
- Consider the potential applications of stem cell research, including the use of cells in therapy, drug testing and disease modelling
- Consider induced pluripotent stem cells as an example of new technology and discuss their potential applications

## Timing

1.5 to 2 lessons (95 to 120 mins). **OR** may be adapted to create a shorter lesson or extended project.

## Materials per group of 3-4 students

- A set of cards from one of the four themes (one of each provided; photocopy as needed):
  1. **What is a stem cell?** What stem cells can do; types of stem cell
  2. **Where do embryonic stem cells come from?** The blastocyst; cell culture; IVF
  3. **Why bother with stem cells?** Applications now and in the future
  4. **Making stem cells** Induced pluripotent stem cells (iPS cells); students working on this theme may need more time and/or support
- A Questions card
- Poster-making materials or access to computers with PowerPoint (optional)

# Lesson plan

## Introduction

Briefly introduce key concepts: What is a stem cell and how are stem cells different from specialized cells? What types of stem cell are there? How might stem cells be used? You could use the 15-min film, *A Stem Cell Story* available online at [www.eurostemcell.org/films](http://www.eurostemcell.org/films) or order a DVD.

20 mins

## Group work preparing presentations

Students prepare a 5-minute presentation explaining the key points on a set of activity cards from one theme. Their presentation MUST answer the three questions on the *Your task* card. Every member of the group must deliver part of the presentation. Photocopied cards could be cut up and glued onto large sheets to make posters to be used in the presentations. Or ask students to prepare a PowerPoint for presentation next lesson. **Less able students:** Download worksheets from [www.eurostemcell.org/toolkititem/all-about-stem-cells](http://www.eurostemcell.org/toolkititem/all-about-stem-cells) to provide a structure for the presentation or poster. **More able students:** Ask students to set their own questions about their topic to test their classmates.

30-45 mins

## Talk stem cells

While each group presents their theme, the class listens and tries to write down answers to the relevant questions on the *Questions* card.

30-40 mins

## Plenary

Go through the answers to the questions as a class. You could run this as a competition, with groups working as teams to answer the questions and mark each others' answers.

15 mins

### What is a stem cell?

1. What 2 things can stem cells do?
2. Why do our bodies need stem cells?
3. Name 2 kinds of stem cell and say what they can do.

### Where do embryonic stem cells come from?

4. Where do embryonic stem cells come from? Think about the stages of human development from an egg and sperm to an adult.
5. Where can scientists get embryonic stem cells for research? What is IVF?
6. How do scientists grow enough cells for their research?

### Why bother with stem cells?

7. How are stem cells used to treat patients now?
8. How might stem cells be used to treat patients in the future?
9. Name 2 more ways stem cells could be used.

### Making stem cells

10. What does 'pluripotent' mean?
11. What is an iPS cell and how are iPS cells made?
12. How could iPS cells be used in medicine?

# All about stem cells

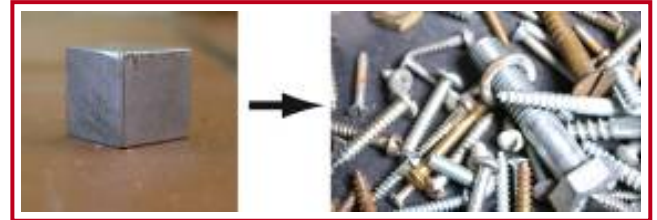
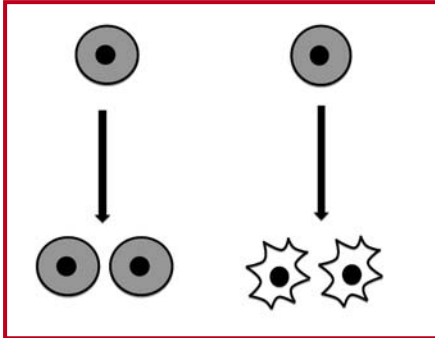
## Worksheets (optional)

### What stem cells can do

Stem cells can \_\_\_\_\_

Differentiation = \_\_\_\_\_

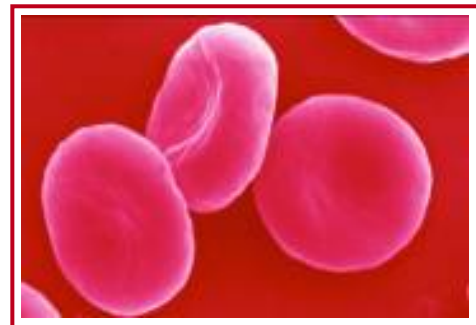
AND \_\_\_\_\_



### Your body needs stem cells

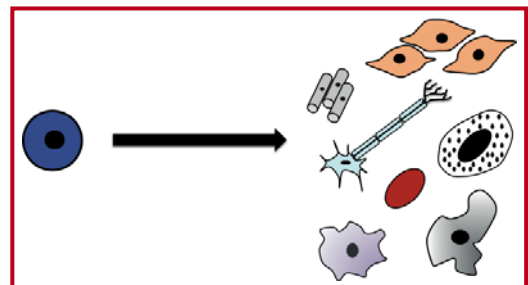
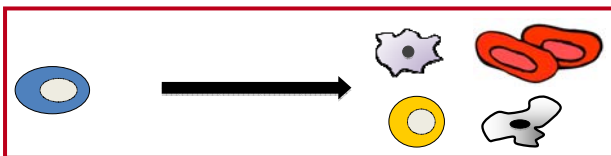
Stem cells make new, healthy cells to \_\_\_\_\_

Some cells in your body are replaced a lot.  
Red blood cells only live for about \_\_\_\_\_



Stem cells also \_\_\_\_\_  
so that your body never runs out of stem cells.

### Two kinds of stem cells



\_\_\_\_\_

can make ALL types of cell in your body

\_\_\_\_\_

can make a few types  
of specialized cells



# Where do embryonic stem cells come from?

11-14 worksheet  
All about stem cells

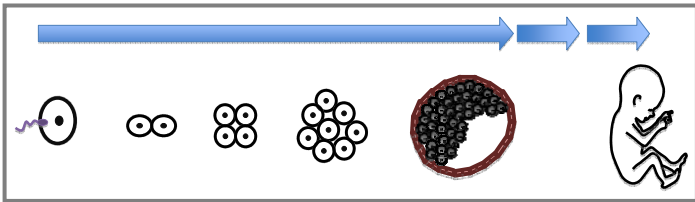
## Embryonic stem cells and human development

A sperm fertilizes an egg.

The fertilized egg \_\_\_\_\_  
to make 2 cells, then 4 cells, then 8...

A \_\_\_\_\_ is a ball of  
about 100 cells.

Embryonic stem cells come from the  
\_\_\_\_\_

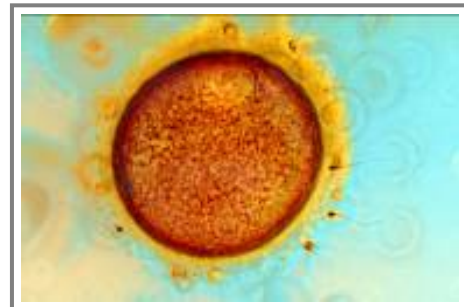


## IVF and stem cells

IVF stands for \_\_\_\_\_

It is used to make embryos for people who cannot  
\_\_\_\_\_ easily.

Sometimes the mother and father let scientists use  
some of the embryos for stem cell research.



## Scientists grow cells in the laboratory

Some cells are put in a flask with the food they need.

The cells \_\_\_\_\_

Scientists can grow a lot of cells like this.

Growing lots of cells in the laboratory is called  
\_\_\_\_\_



## Treating patients

Stem cells are used to grow new skin for people with bad burns. To do this we:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

In the future, we might use stem cells to

\_\_\_\_\_



## Understanding disease

Scientists could use stem cells to learn about diseases that are caused by

\_\_\_\_\_

They could:

- Grow specialized cells from the stem cells, for example \_\_\_\_\_
- Investigate \_\_\_\_\_



## Testing drugs



Stem cells could be used to test new medicines(drugs).

Scientists would:

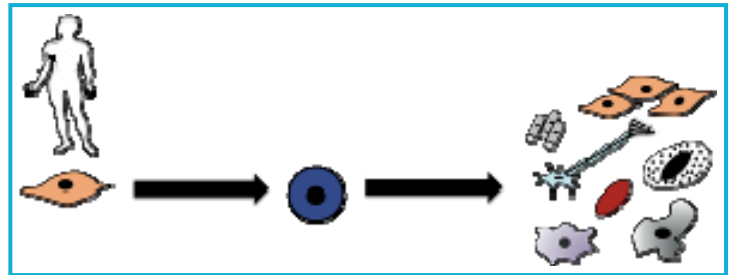
- Use stem cells to grow a lot of \_\_\_\_\_ cells, e.g. nerve cells, blood cells or liver cells.
- Find out what the new drugs do to these cells.

## Turning skin cells into stem cells

iPS stands for

\_\_\_\_\_

iPS cells are pluripotent. That means they can make \_\_\_\_\_



iPS cells are made by adding \_\_\_\_\_  
to specialized cells such as skin cells.

The process used to make iPS cells is called genetic \_\_\_\_\_



## iPS cells in medicine

iPS cells might be used to treat diseases such as

\_\_\_\_\_

Scientists would take skin cells from the patient and use them to make iPS cells.

Then they would use the iPS cells to grow

\_\_\_\_\_

for the patient.



# All about stem cells

## Poster templates (optional)

# What is a stem cell?

All about stem cells

## What stem cells can do

Stem cells can \_\_\_\_\_

Differentiation = \_\_\_\_\_

AND \_\_\_\_\_

## Your body needs stem cells

Stem cells can make new, healthy cells to

\_\_\_\_\_

Some cells in your body are replaced a lot.  
Red blood cells only live for about

\_\_\_\_\_

Stem cells also \_\_\_\_\_  
so that your body never runs out of stem cells.

## Two kinds of stem cells

\_\_\_\_\_ can make ALL types of cell in your body

\_\_\_\_\_ can make a few types of specialized cells



# Where do embryonic stem cells come from?

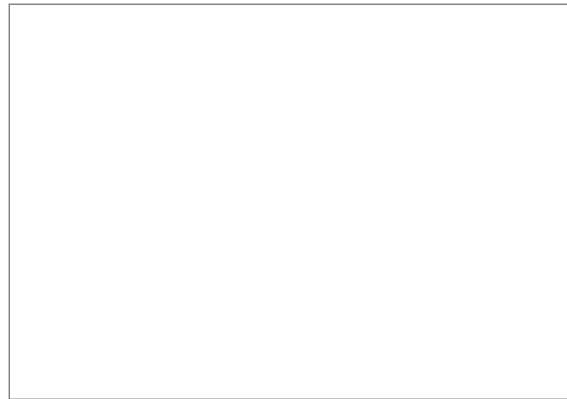
11-14 poster

All about stem cells

## Embryonic stem cells and human development

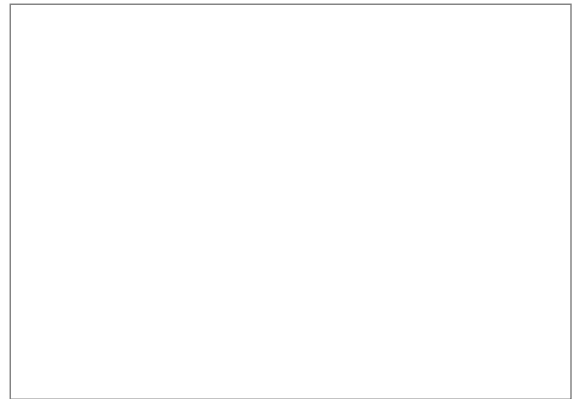
A sperm fertilizes an egg.

The fertilized egg \_\_\_\_\_  
to make 2 cells, then 4 cells, then 8...



A \_\_\_\_\_ is a ball of  
about 100 cells.

Embryonic stem cells come from the

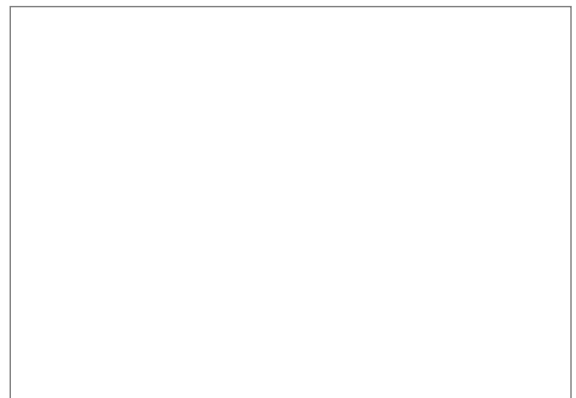


## IVF and stem cells

IVF stands for \_\_\_\_\_

It is used to make embryos for people who cannot  
\_\_\_\_\_ easily.

Sometimes the mother and father let scientists use  
some of the embryos for stem cell research.



## Scientists grow cells in the laboratory

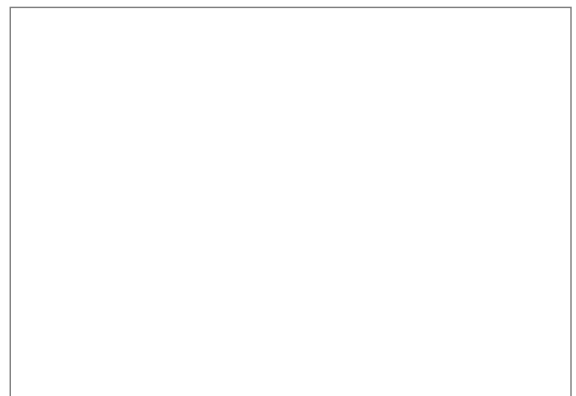
Some cells are put in a flask with the food they need.

The cells \_\_\_\_\_

Scientists can grow a lot of cells like this.

Growing lots of cells in the laboratory is called

\_\_\_\_\_



# Why bother with stem cells?

All about stem cells

## Treating patients

Stem cells are used to grow new skin for people with bad burns. To do this we:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

In the future, we might use stem cells to

\_\_\_\_\_



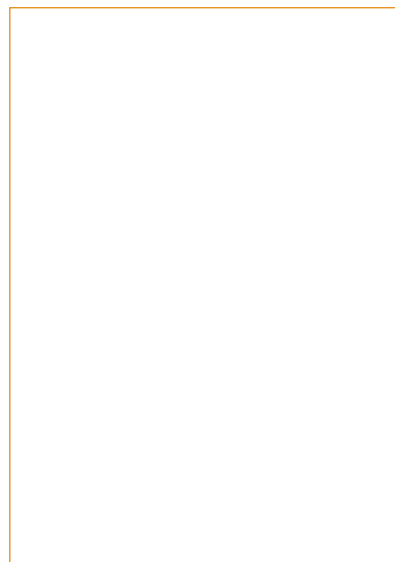
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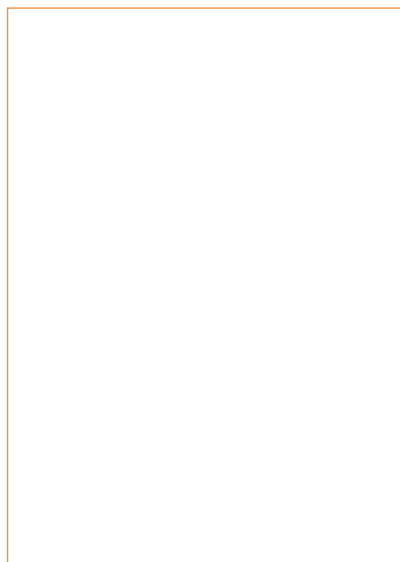
\_\_\_\_\_

They could:

- Grow specialized cells from the stem cells, for example \_\_\_\_\_
  - Investigate \_\_\_\_\_
- \_\_\_\_\_



## Testing drugs



Stem cells could be used to test new medicines (drugs).

Scientists would:

- Use stem cells to grow a lot of \_\_\_\_\_ cells, e.g. nerve cells, blood cells or liver cells.
- Find out what the new drugs do to these cells.



# Making stem cells

## All about stem cells

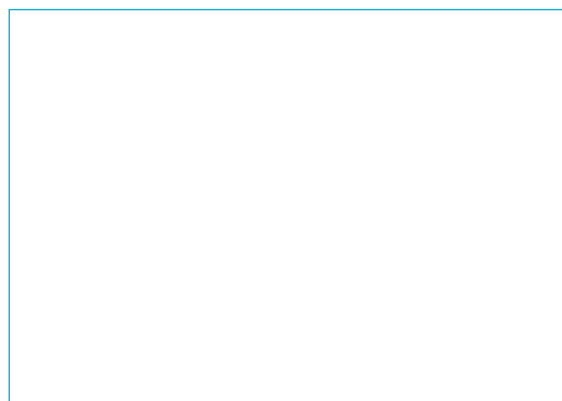
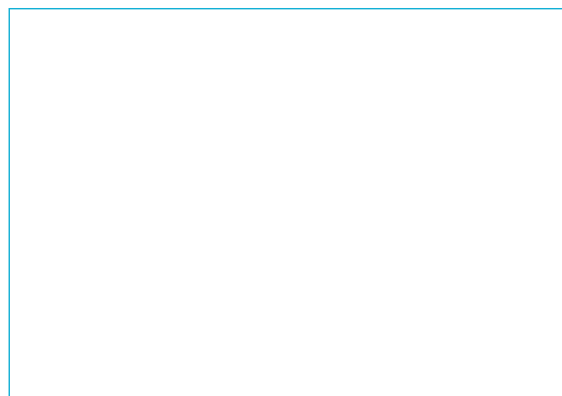
### Turning skin cells into stem cells

iPS stands for \_\_\_\_\_

iPS cells are pluripotent. That means they can make \_\_\_\_\_

iPS cells are made by adding \_\_\_\_\_ to specialized cells such as skin cells.

The process used to make iPS cells is called genetic \_\_\_\_\_



### iPS cells in medicine

iPS cells might be used to treat diseases such as \_\_\_\_\_

Scientists would take skin cells from the patient and use them to make iPS cells.

Then they would use the iPS cells to grow \_\_\_\_\_ for the patient.

