COSMOS LESSONS

Biology

Cell Division: Shocking tails

This lesson is all about how cells grow and replace themselves.

In this lesson you will investigate the following:

- Different types of cells
- The importance of mitosis
- Mitosis as a cellular event - stages in mitosis
- What happens when mitosis goes wrong?

So, let's get dividing!

This is a print version of an interactive online lesson. To sign up for the real thing or for curriculum details about the lesson go to **www.cosmosforschools.com**

Introduction: Cell division (P1)

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"Gotcha!" screeched the hawk as it swooped down and clamped its pointed beak on the lizard's tail, catching it by surprise. "Oh no you don't!" hissed the lizard in reply, detaching its tail as it darted under a bush, leaving the hawk hungry and confused.

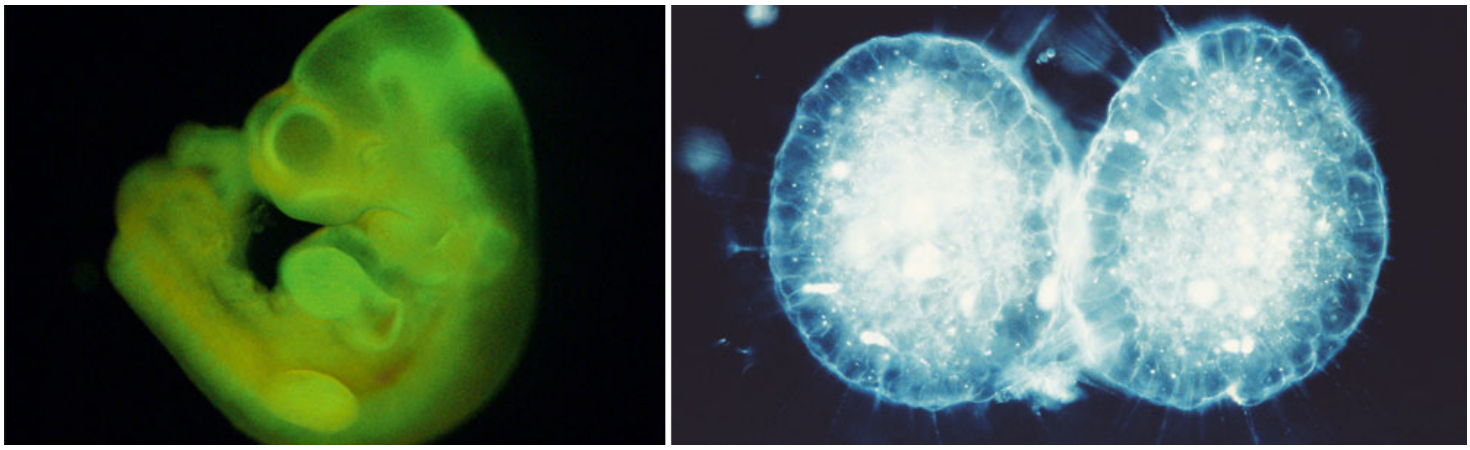
Have you ever wondered why it is that a lizard can regrow a lost tail but that people can't regrow lost fingers? Lizards, along with some amphibians like salamanders, regrow their tails via a special process called regeneration, and some scientists think that someday it will be possible for humans to regenerate lost limbs as well.

When a lizard or salamander loses its tail, the event stimulates ordinary cells to become stem cells – special cells that can change into any type of cell in the body. This process doesn't happen in humans and seems to be the critical difference in regeneration ability, but scientists don't yet know what triggers the change.

One Japanese scientist thought she had found a way to make ordinary cells become stem cells simply by splashing them with a little acid. The discovery offers a possible explanation for the lizard tail mystery.

But there is some doubt. Other scientists have not been able to reproduce the results from her experiment. Nevertheless while we might not know if acid-shocking ordinary cells can turn them into stem cells for a while, most scientists are convinced that one day we will be able to use stem cells to grow any part of the body we need.

Read or listen to the full *Cosmos* Magazine article here.



Left: A mouse embryo claimed to have been grown from blood cells that turned into stem cells after being shocked with acid. Right: Two adjoining blastocysts, the precursors to embryos where cells are continually dividing. Credits: Haruko Obokata / Riken & Biophoto Associates / Getty Images.

Question 1

Propose: Some of the cells in your body last for years, while others divide every day. Suggest two types of cells in your body you think would divide frequently and two types that you think would divide slowly, if at all. Justify all of your choices.

Gather: Cell division (P1)

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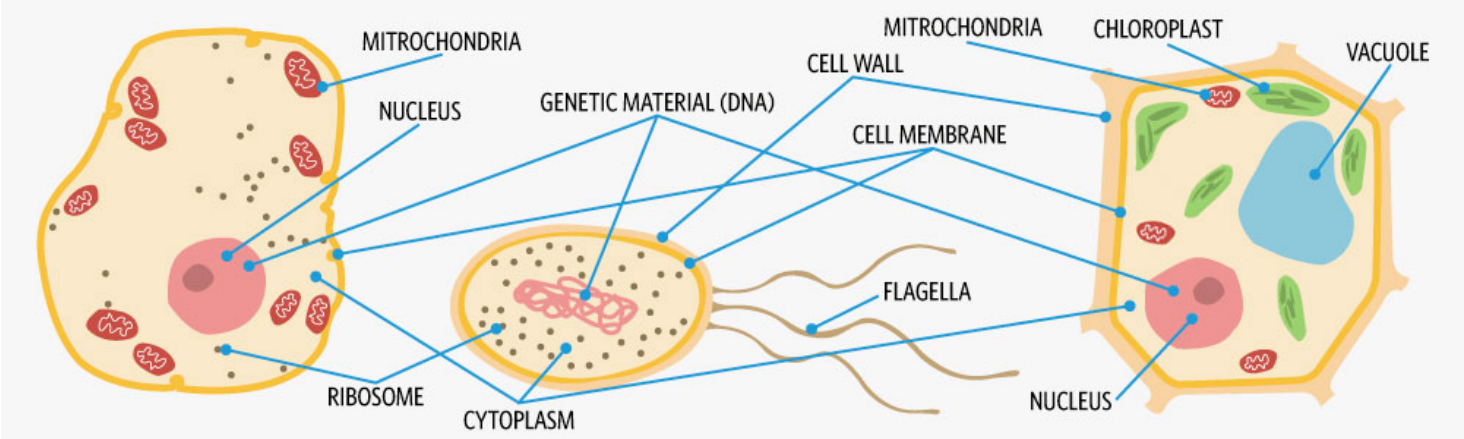
Different types of cells

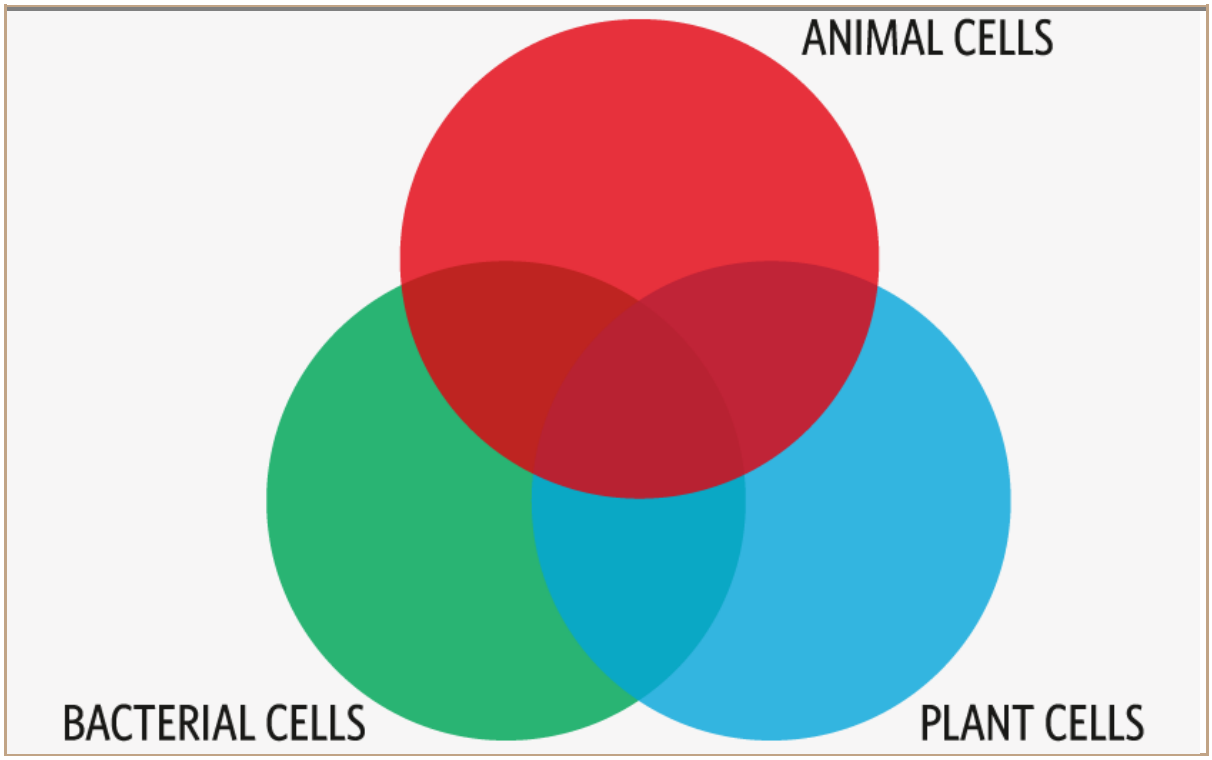
Every living thing is made up of cells. Cells are the smallest living units that are capable of reproducing themselves. Closely examine the following illustration before continuing.



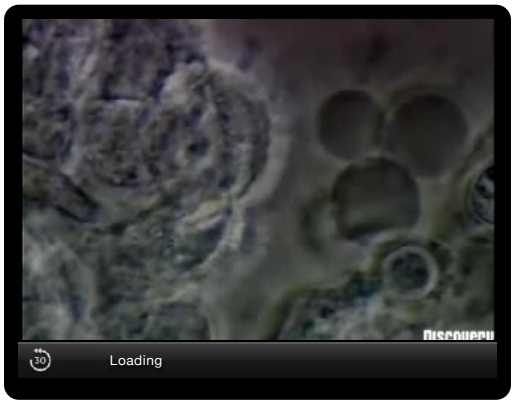
Left to right: Animal cell, bacterial cell and plant cell.

Question 1

Sort: Use the labelled diagrams above to construct a Venn diagram that shows the similarities and differences between plant, animal and bacterial cells.



Humans are made up of many different types of cells, each of which is specialised and performs a particular function. We have skin cells, muscle cells, blood cells, hair cells, bone cells, lung cells, nerve cells, and more. In fact there are more than 200 different types of cells in the human body.



Credits: Donna Forward / YouTube.

And did you know that each cell in your body was made from an already existing cell? Cells divide by a special process called *mitosis* whereby two identical daughter cells are made from one parent cell.

Why is mitosis so important?

In multicellular organisms, such as humans and plants, cell division by mitosis allows the production of new cells for growth and to replace dying cells.

To grow in size from a baby to a teenager all of your cells had to go through many cycles of cell division to increase the cell count. In fact, mitosis occurs during the division of all cells in the body except in the production of reproductive cells (eggs and sperm). For example, without cell division your bones would not be able to elongate and your hair would not be able to grow out. Each of these ***growth*** processes occur by mitosis.

Credit:iStock

Sadly our cells don't last forever – any damaged or dying cells must be replaced with genetically identical cells so that the tissue can be repaired. Scientists estimate that the number of cells an adult human loses per day is roughly 60 billion. Fortunately, in that same day, about 60 billion cells divide, replacing those that die. This tissue ***replacement*** process occurs by mitosis.

In single-celled organisms, such as bacteria and amoeba, cell division creates new organisms that are ***clones*** of the original. This process is technically called asexual reproduction or binary fission in bacteria, rather than mitosis, since these types of cells do not have a nucleus.

Question 2

Calculate: If the rate of mitosis in the human body is 60 billion (which can also be written as 6×10^{10} or 60,000,000,000) cells per day, calculate how many cells are produced in one hour.

Credits: Dan Izzo / YouTube.

Question 3

Calculate: A species of bacteria can clone itself by binary fission every 20 minutes. Starting with one bacterial cell, and assuming that none die, calculate how many bacterial cells there will be after three hours?

Question 4

Recall: In the early development of a multicellular organism, such as a plant growing from a seed, the cells grow in size but the number of cells remains constant.

- [ ] True
- [ ] False
- [ ] I don't understand the question

Question 5

Recall: Mitosis occurs during the division of all cell types in the human body.

- [ ] True
- [ ] False
- [ ] I don't understand the question

Question 6

Recall: After mitosis, the two daughter cells end up with exactly the same quantity of genetic information as the parent cell.

- [ ] True
- [ ] False
- [ ] I don't understand the question

Question 7

Recall: Lizard tails are entirely made up of special cells called stem cells.

- [ ] True
- [ ] False
- [ ] I don't understand the question

Process: Cell division (P1)

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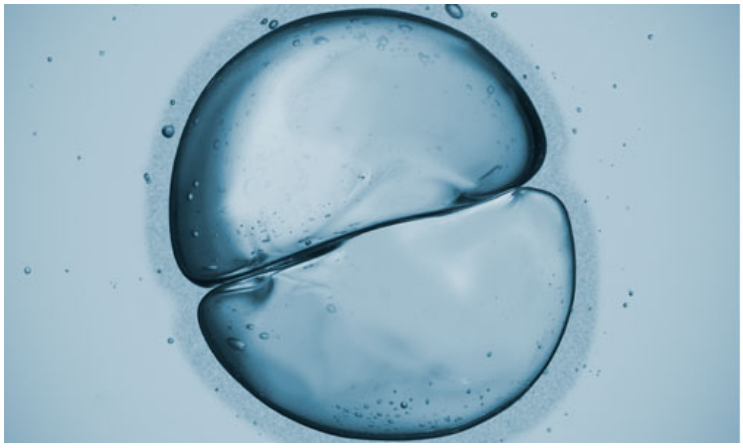



Left: When one cell becomes two. Cells in the final stages of cell division. Right: Microscopes are essential for studying and understanding cells. Credit: iStock

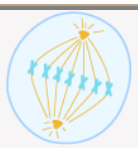
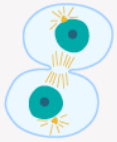
Mitosis – step by step

Scientists can actually watch cells divide under the microscope. By carefully observing what happens they have been able to determine the process of division and the different stages involved.

Credit: Iovnon / YouTube.

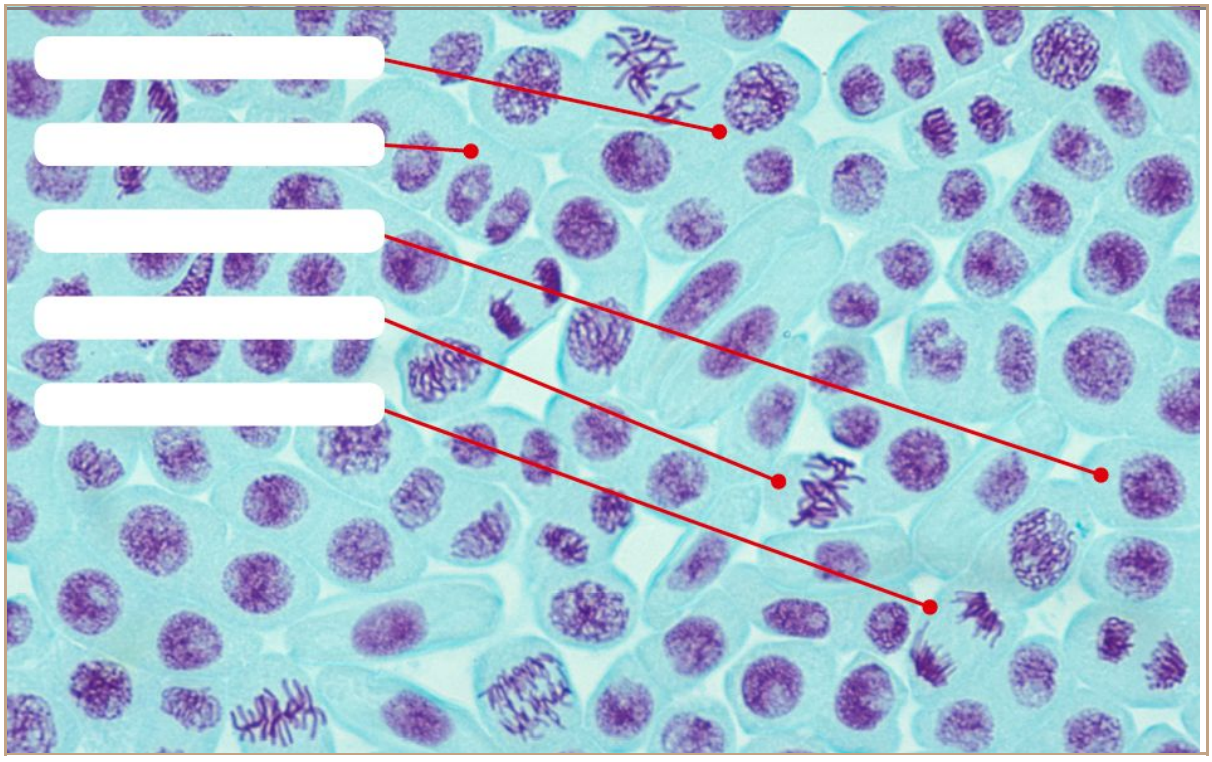
Question 1

Connect: With the help of the above video and an internet search, draw lines to match the name of each stage of mitosis with the appropriate description and illustration.

interphase		Long threads become visible in the cells, these are the chromosomes which carry the genetic information necessary to make the cell function and reproduce itself
prophase		The chromosomes move to the centerline of the cell and appears shorter and thicker
metaphase		The cell and all of its contents divides into two (daughter cells with identical genetic material to the original (parent) cell
anaphase		Cell contents appear fuzzy with no distinct chromosomes visible
telophase		Each chromosomome separates into two parts which move to opposite ends of the cell

Question 2

Distinguish: Use the text tool to label the various stages of mitosis in this photograph of dividing cells.



Question 3

Infer: Onion root tip cells are often used to observe cell division. Suggest why observing onion root tip cells are well suited to this purpose compared to any other part of the onion plant.

Question 4

Imagine: You are a sports commentator for your favourite sport. Write a ‘play by play’ account of what happens to a skin cell when it has been given the signal (starting whistle) to undergo mitosis.

Apply: Cell division (P2)

COSMOS LESSONS

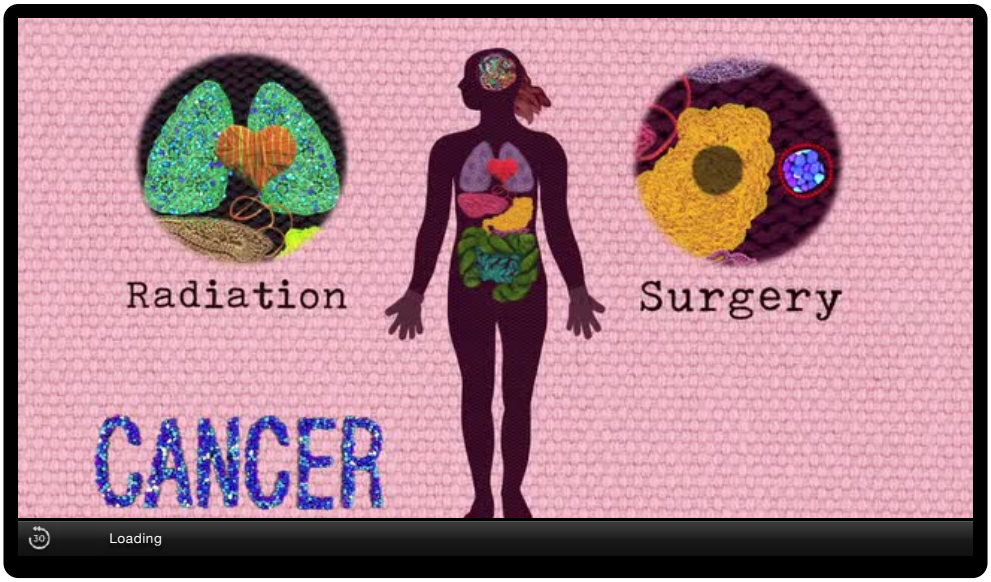
Cancer: Today's most wanted villain

Credit: iStock

Cells go through cycles, just like the seasons. Most cells in an organism go through a cycle of growth, development and division called the cell cycle.

Mitosis is just one part of the cell's cycle.

Cancer cells have lost the ability to control when to start and stop the different parts of the cell cycle. In fact, a cancer cell is something like a car with no brakes – it is difficult to stop it without modern technologies.



Credit: TedEd / YouTube.

Question 1

Imagine: You are a leading cancer doctor, also known as an oncologist, at a large nearby hospital. You are working on a project to raise public awareness of the different types of cancer affecting humans and the importance of early detection.

Using the project space below, design a large "WANTED" poster for one specific type of cancer cell affecting humans.

Examples of cancer cells for you to select from include a breast cancer cell, a pancreatic cancer cell, a cervical cancer cell, a bowel (colorectal) cancer cell, a lung cancer cell and a skin cancer cell.

You should include the following information on your poster:

- an electron micrograph or microscope image of the cancerous cells (not the tumour that can form)
- a description of the cancer cell with any distinguishing features, including a comparison with a normal non-cancerous cell of the same type
- a summary of how the cancer cells attack the body and spread
- statistics about the most common victims of the cancer (e.g. men vs women, young vs elderly, number of victims per year)
- details of the harmful effects that the cancer causes in humans
- a list of any preventative measures or treatments that help stop the spread of the cancer
- a description of warning signs in the body (what to look out for) and any recommendations that help with early detection of the cancer

You may find the following websites useful in your research:

- Australian Cancer Research Foundation
- Cancer Council FAQ
- Cancer Council Hope web page

Career: Cell division (P2)

Brought to you by Queensland University of Technology

When Freya Bruveris was fifteen years old, she did work experience at the Immunology and Stem Cell Laboratories at Monash University. It was during this week that she fell in love with the exciting world of cell biology.

Imagine peering down the eyepiece of a microscope to see a number of individual heart cells, each beating like a normal heart. For Freya, that sight was just one of the many great memories from her time at Monash University. What was even more impressive was that those beating heart cells had been created from human stem cells.

Freya studied a range of subjects in high school – including Biology, History, and Economics – but finally made up her mind in university that her true passion lay in scientific research. She wanted to create cells like those she had seen back in the stem cell lab. Now, Freya works in the Murdoch Children's Research Institute as a stem cell biologist.

Freya's goal is to discover the best way to turn human stem cells into blood cells. She spends six days a week at the lab overseeing her experiments and making sure that the stem cells are growing and dividing properly. If she is successful, her research will help countless people in the future. People in need of blood transfusions or bone marrow transplants will no longer have to wait for suitable donors— the blood cells they need can be created from their own stem cells.

For Freya, there is a lot to love about science. Whether it's learning new things and techniques, working together with other scientists or travelling all over the world to present her research, she enjoys every day of her job. It's the reason she works so hard, she says.

In her spare time, Freya loves to read. She especially enjoys reading cookbooks and testing out new recipes.

Question 1

Imagine: In her career profile, Freya tells of her love of cooking up new recipes. Describe how you think being a research scientist in a laboratory might be a lot like a chef in a kitchen.

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