MYP 4 UNIT 1
LESSON 6

Specialised cells, unspecialised cells, differentiation and Stem cell in animals.

Outcome

- I can describe examples of specialised cells in humans and plants, and explain how unspecialised cells become specialised.
- I can explain what stem cells are, and give examples of where they are found in animals.

Keywords

specialised cell

unspecialised cell

multicellular

differentiation

gene

embryo

embryonic stem cell

adult stem cell

Keywords

A **specialised cell** has adaptations to carry out a particular function in a multicellular organism.

An **unspecialised cell** has no specific function, but has the capability to turn into different types of cells.

Animal, plants and fungi can be **multicellular**; made of more than one cell.

Differentiation is the process of an unspecialised cell becoming a specialised one through the mechanism of turning genes on and off.

A **gene** is a short section of DNA that carries the genetic code to produce a protein.

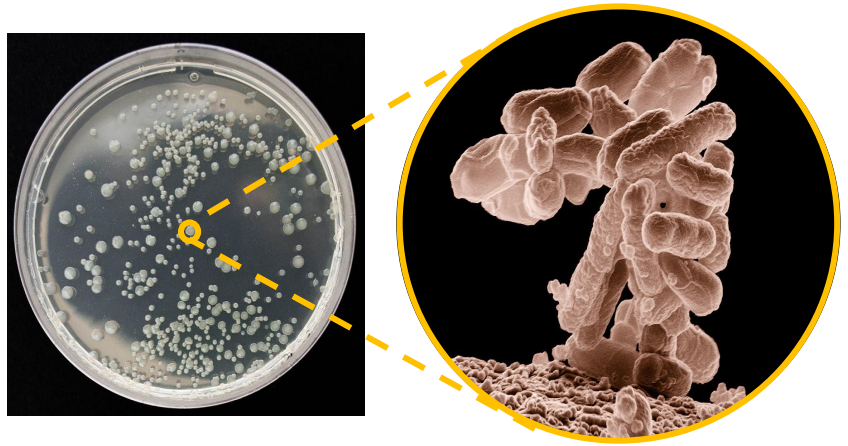
Keywords

unspecialised cell	A cell with no specific function, but has the capability to turn into different types of cells.
embryo	Is formed from a zygote by cell division; it is the early stages of development.
embryonic stem cell	A cell from an embryo which can differentiate into any type of cell.
differentiation	The process of an unspecialised cell becoming specialised through the mechanism of turning genes on and off.
adult stem cell	Can differentiate into related cells.

Specialised cells in multicellular organisms

Explanation

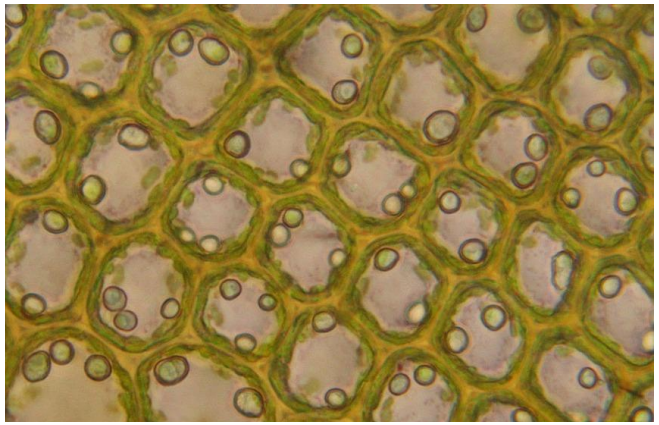
Some organisms, such as bacteria, some fungi, some plants and some animals live as a single cell and are called unicellular organisms.



magnified bacteria colony

Some organisms are made of more than one cell, these are called **multicellular** organisms.

They are usually much larger than unicellular organisms, and can be made up of millions of cells.



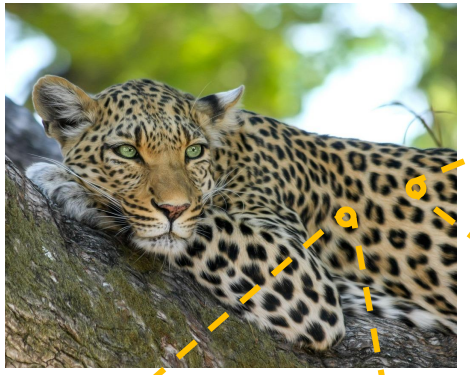
cells of a multicellular plant seen through a microscope

Specialised cells in multicellular organisms

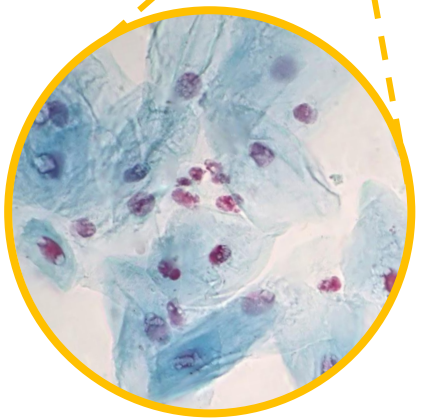
Explanation

Animals, plants and fungi can all be **multicellular.**

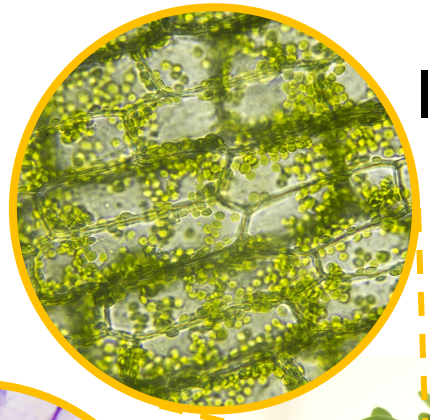
Different types of cells are found in different parts of the organism.



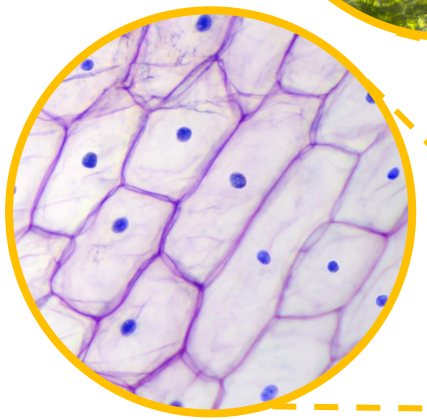
blood cells



skin cells



leaf cells

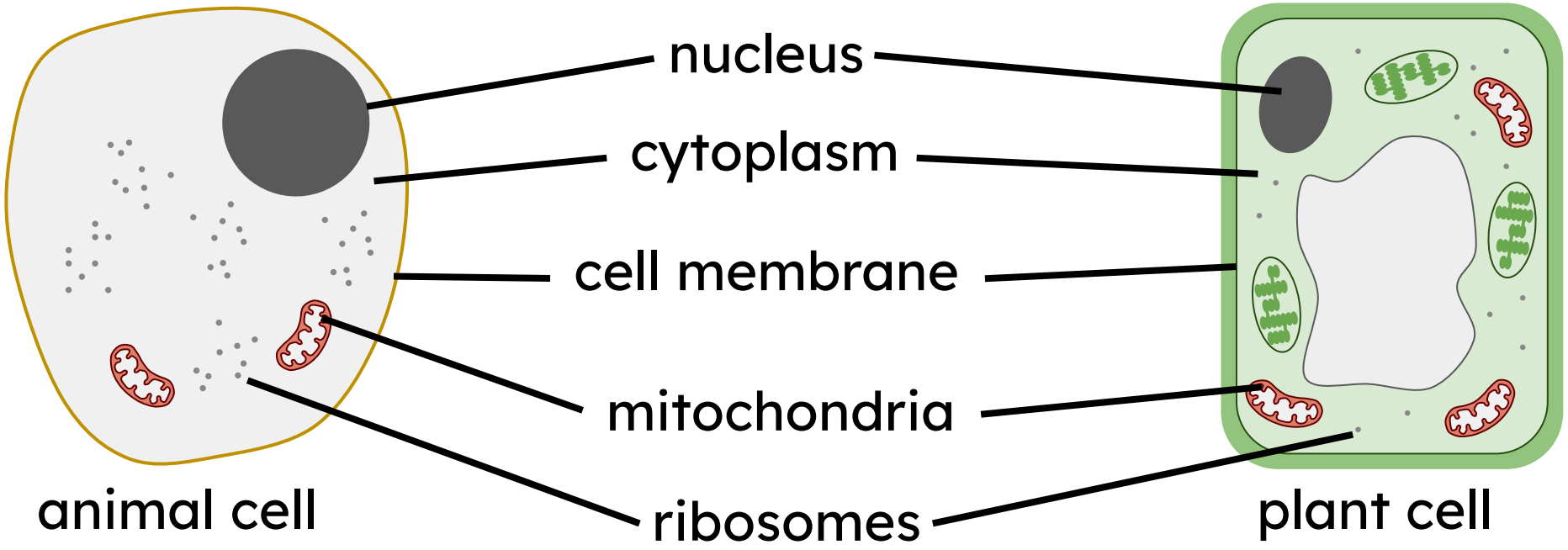


root cells

Specialised cells in multicellular organisms

Explanation

These diagrams are models of animal and plant cells and their structures; but not all animals and plant cells are exactly like this.



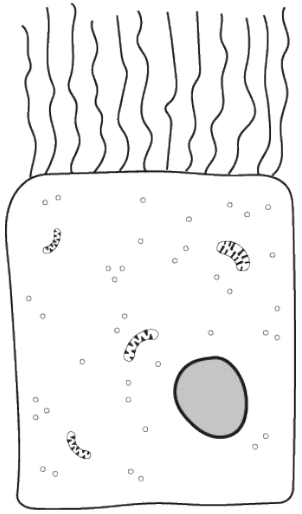
Most cells are adapted to their function; they are **specialised.**

Specialised cells in multicellular organisms

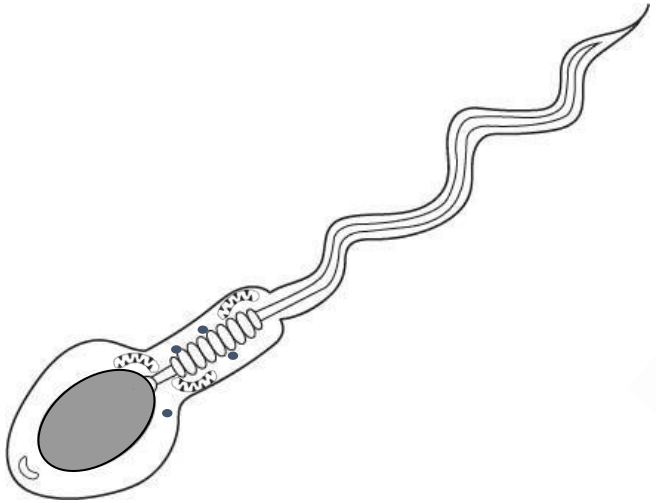
Explanation

Multicellular organisms are often complex, therefore the different functions of the organism are carried out by different organs, tissues and cells.

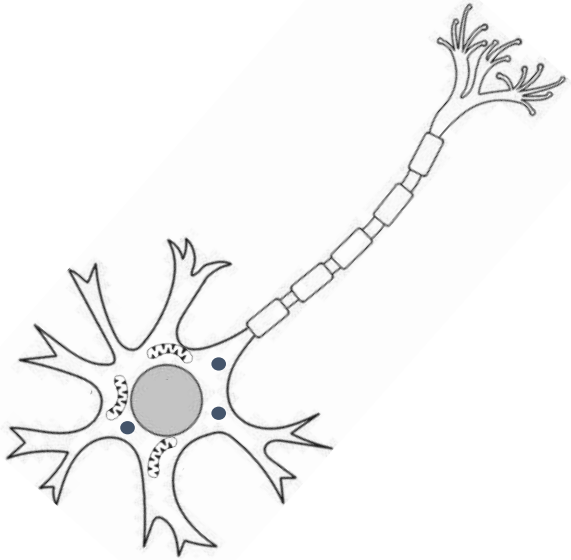
This organisation has evolved as organisms have become larger and to better aid survival.



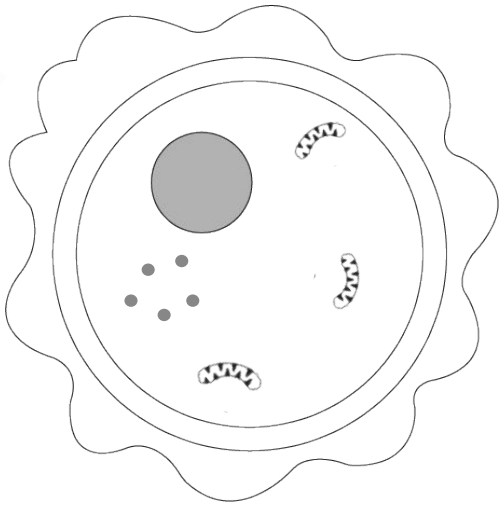
airway lining cell



sperm cell



nerve cell



egg cell

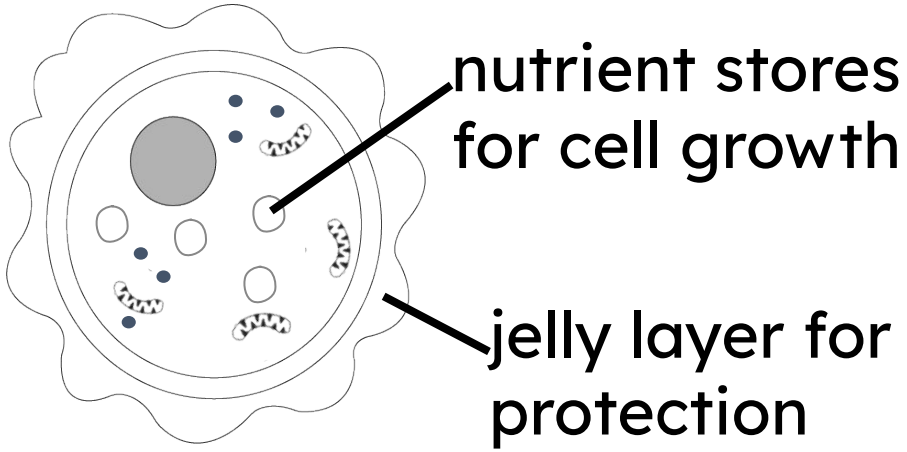
Specialised cells in multicellular organisms

Explanation

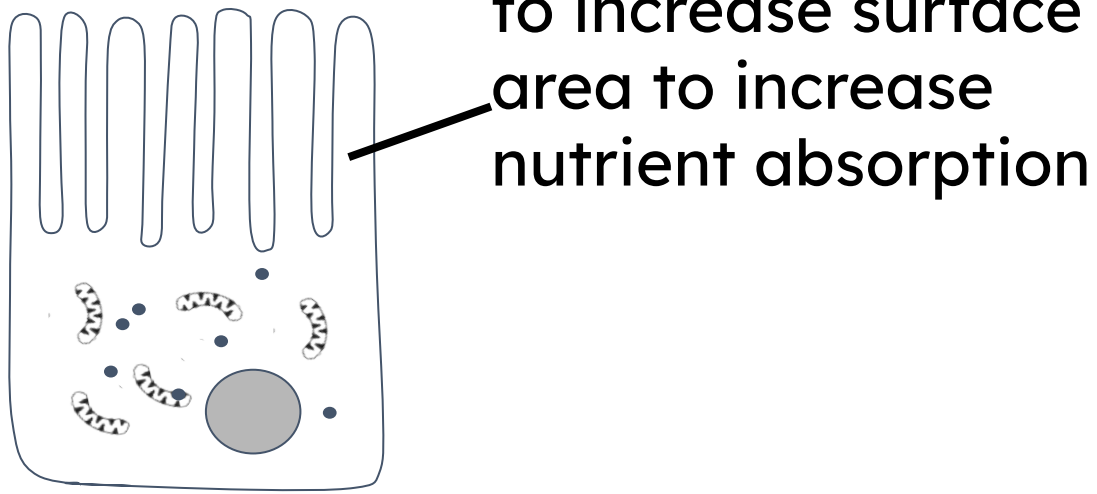
Animal cells share common structures, but some have additional structures that make them better adapted for their role in the organism. They are called **specialised cells** and can vary in their:

- shape
- number of internal structures
- types of internal structures

Examples:



egg cell



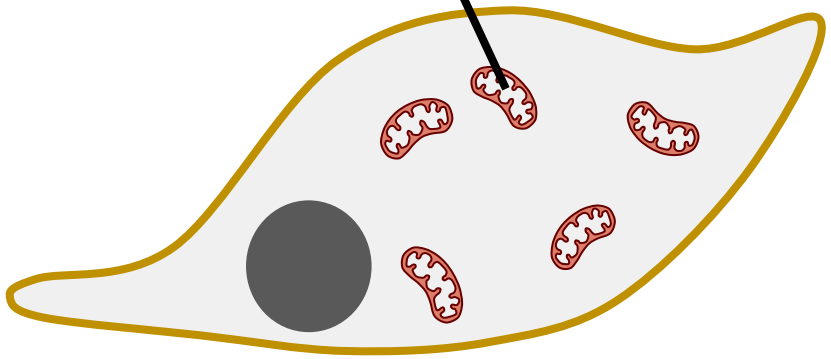
intestine (epithelial) cell

Specialised cells in multicellular organisms

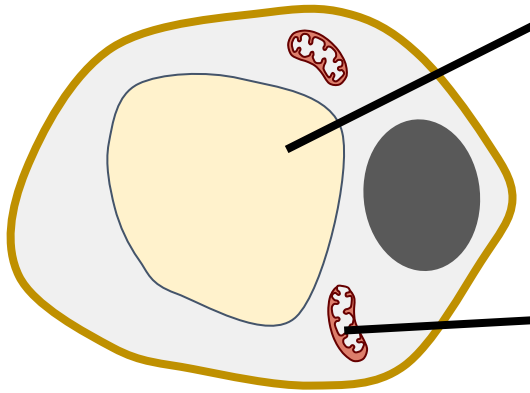
Explanation

Adaptations make cells **specialised** for their functions.

more mitochondria to provide energy for muscle contraction



muscle cell



fat cell

fat cells have a structure that allows them to store fat

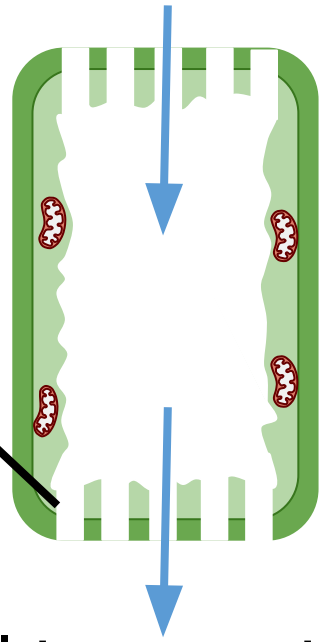
fewer mitochondria because the cell needs less energy

Specialised cells in multicellular organisms

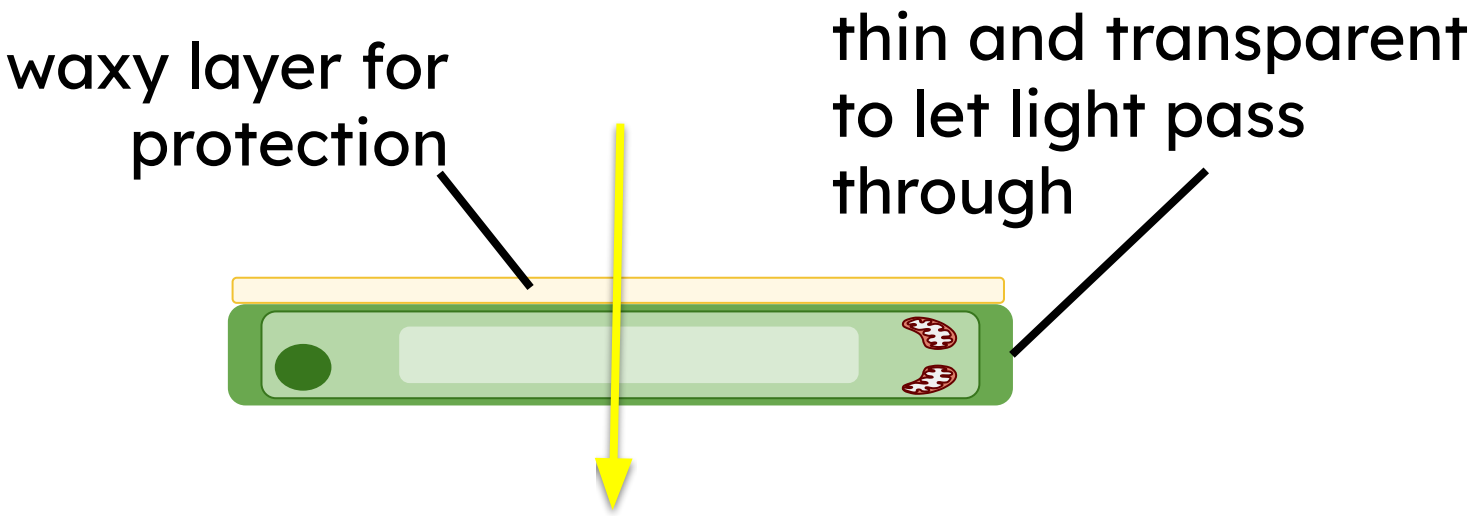
Explanation

Plants are also **multicellular**. The **specialised cells** below do not contain chloroplasts as their functions do not involve photosynthesising.

A phloem cell has no nucleus. This provides extra space for moving sugars.



a phloem cell transports the plant's sugars



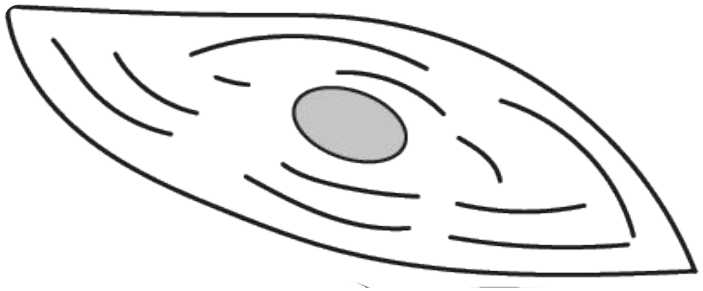
an epidermal cell from the surface of the leaf

Differentiation

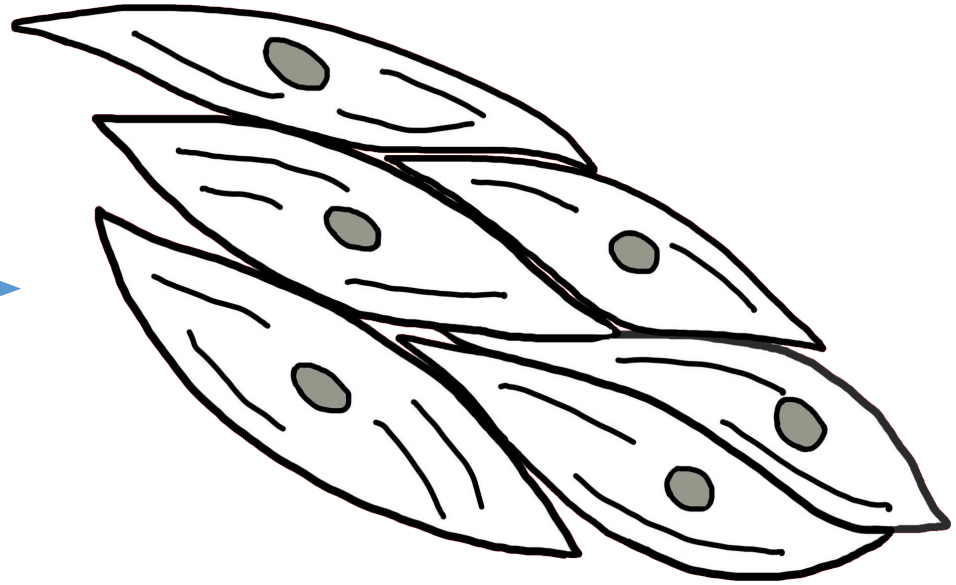
Explanation

In a **multicellular** organism, a group of **specialised cells** with the same structure and processes work together to carry out the same function.

This is called a tissue. Cells can divide to form cells of the same type by mitosis.



a smooth muscle cell



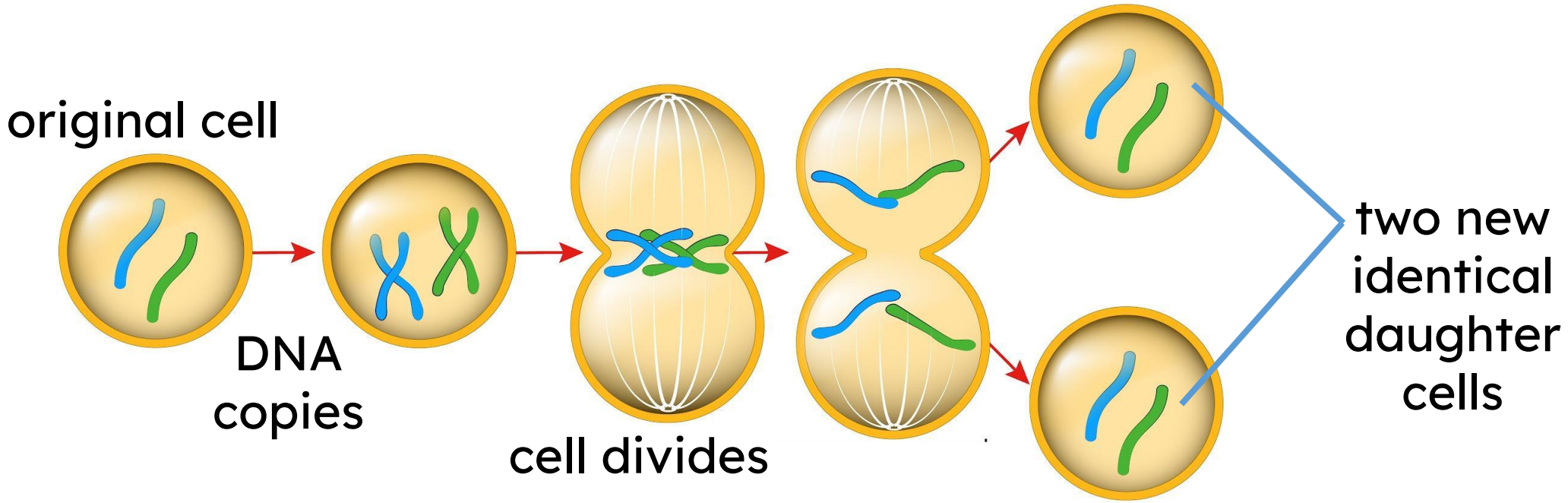
smooth muscle tissue

Differentiation

Explanation

Mitosis is a type of cell division which produces two identical daughter cells, therefore, when a cell divides, each new cell produced has the same genetic information.

New **specialised cells** can be formed by mitosis to make tissues.



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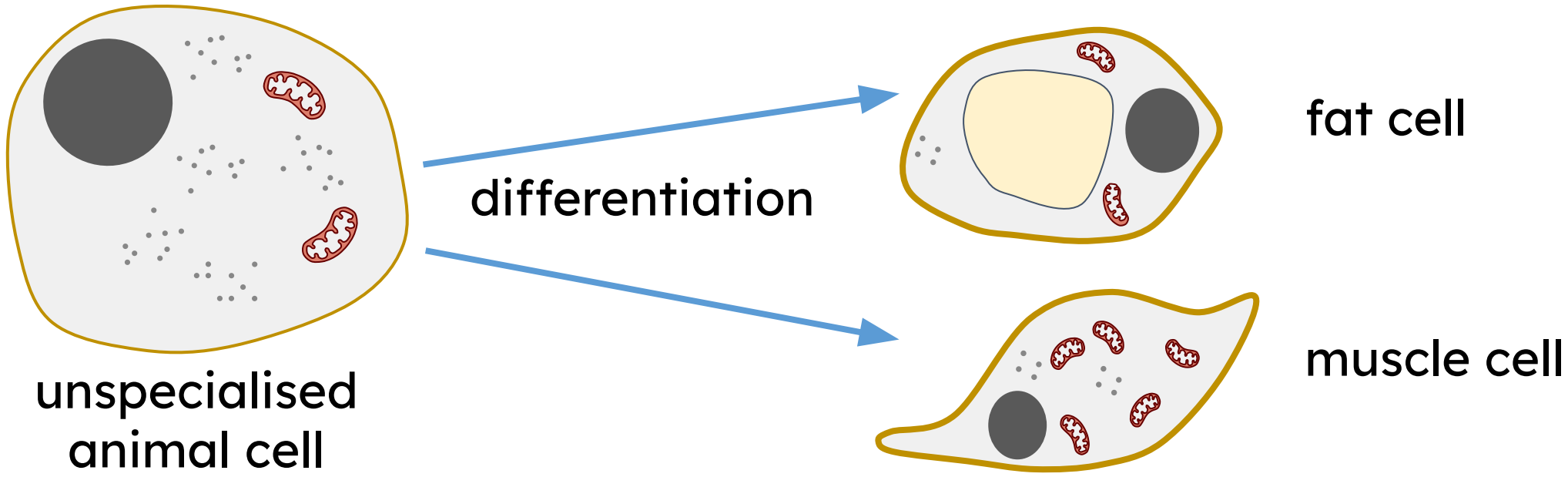
Differentiation

Explanation

Unspecialised cells are those with no specific function and therefore have not developed adapted structures or processes that make them specialised.

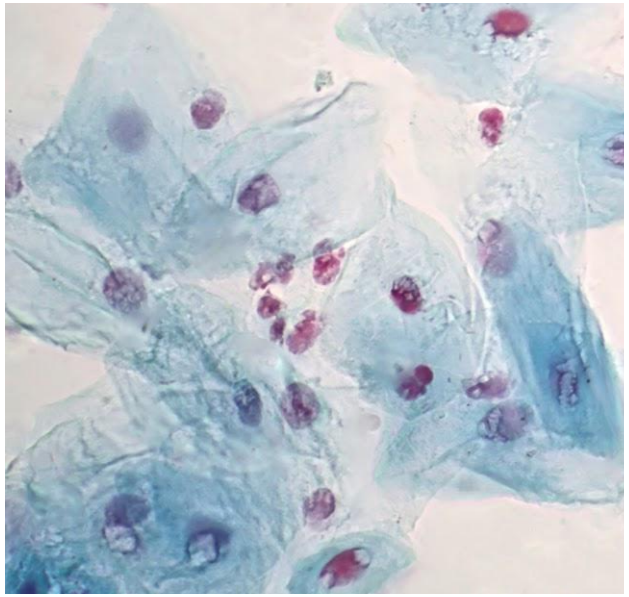
Unspecialised cells have the capability to turn into different types of cells in a process called **differentiation.**



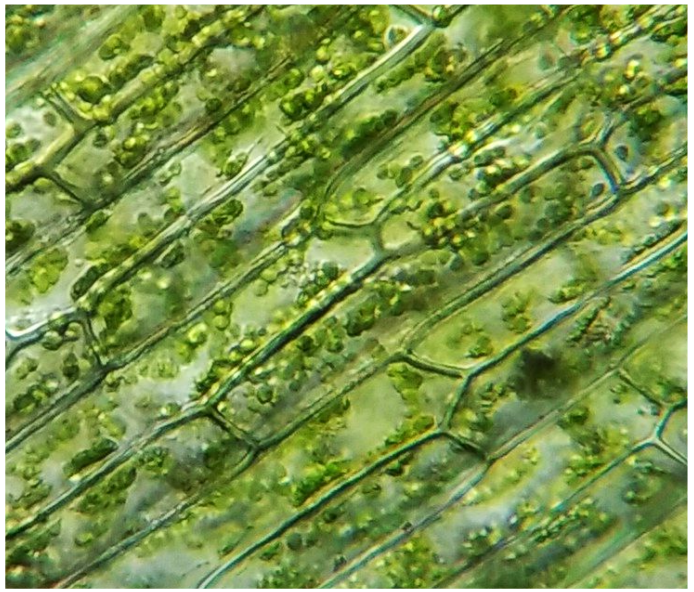
Differentiation

Explanation

Different tissues are made up of the same type of **specialised cell.**



Epithelial cells make up a tissue in animals that forms the top layer of skin.



Palisade cells make up a tissue in a plant leaf that traps sunlight.

Hyphae cells make up a tissue in fungi that forms strands so the fungi can spread.

Differentiation

Explanation

A group of different tissues that work together to perform a particular job are called an organ.

Organ:

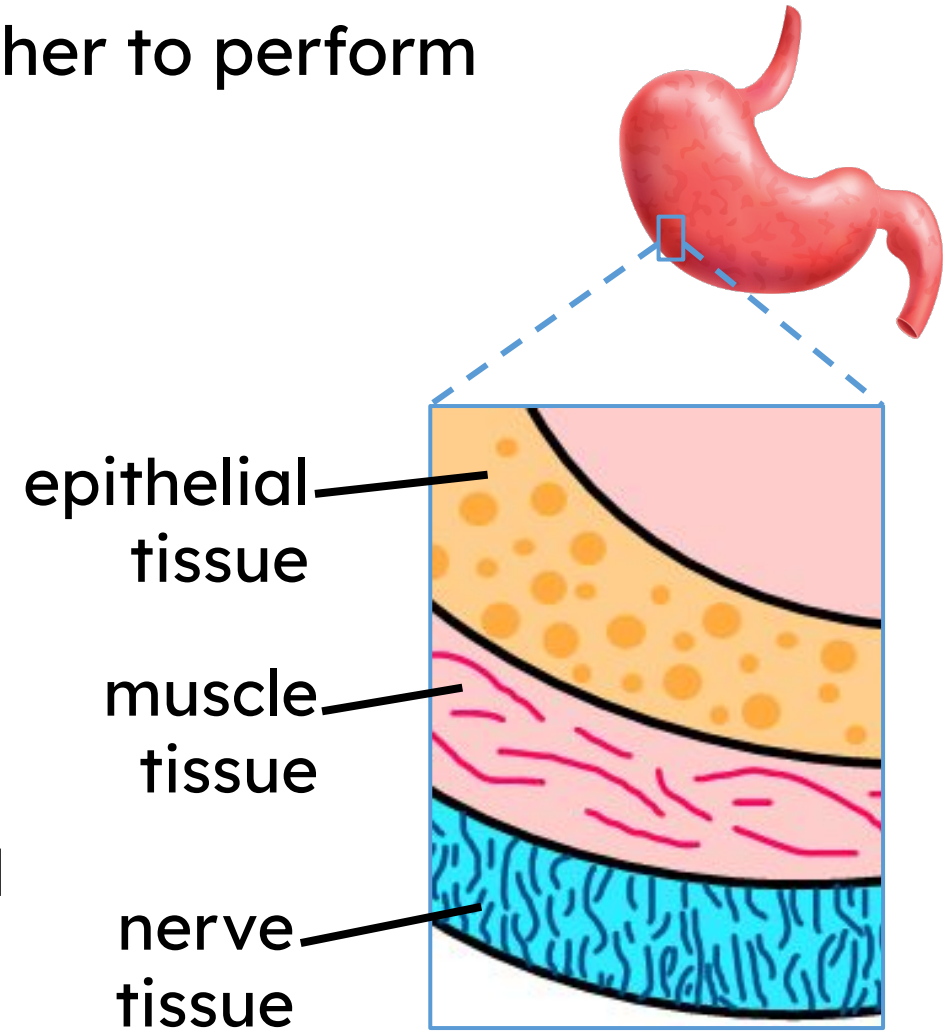
Stomach

Job:

Mechanical and chemical digestion

Tissues:

- epithelial tissue provides a protective barrier for the stomach
- muscle tissue contracts and relaxes to aid digestion
- nerve tissue sends and receives electrical signals from the brain to control digestion



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Differentiation

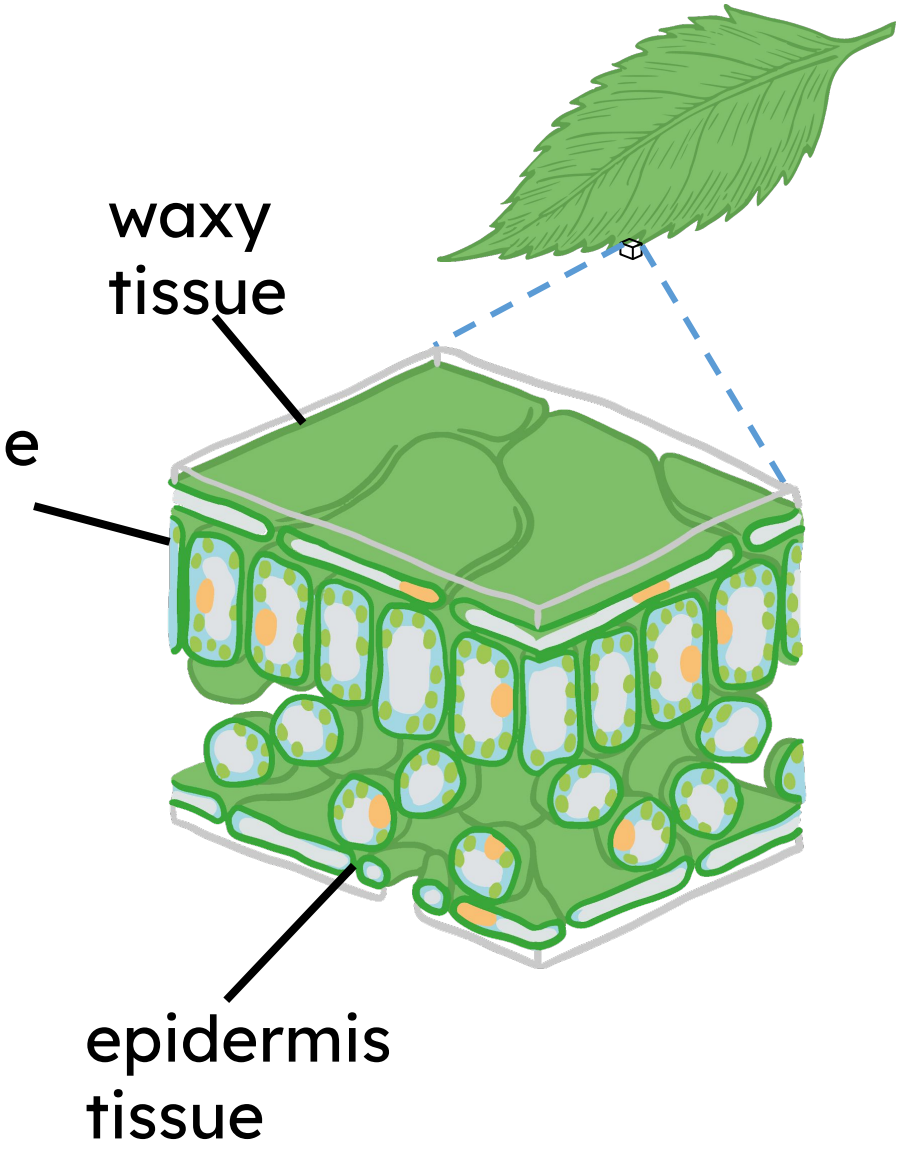
Explanation

An example of an organ from a plant:

Organ:
Leaf

Job:
Photosynthesis

Tissues:
- waxy tissue to protect the leaf
- palisade tissue to absorb sunlight
- epidermis tissue to control the movement of gases in and out



Differentiation

Explanation

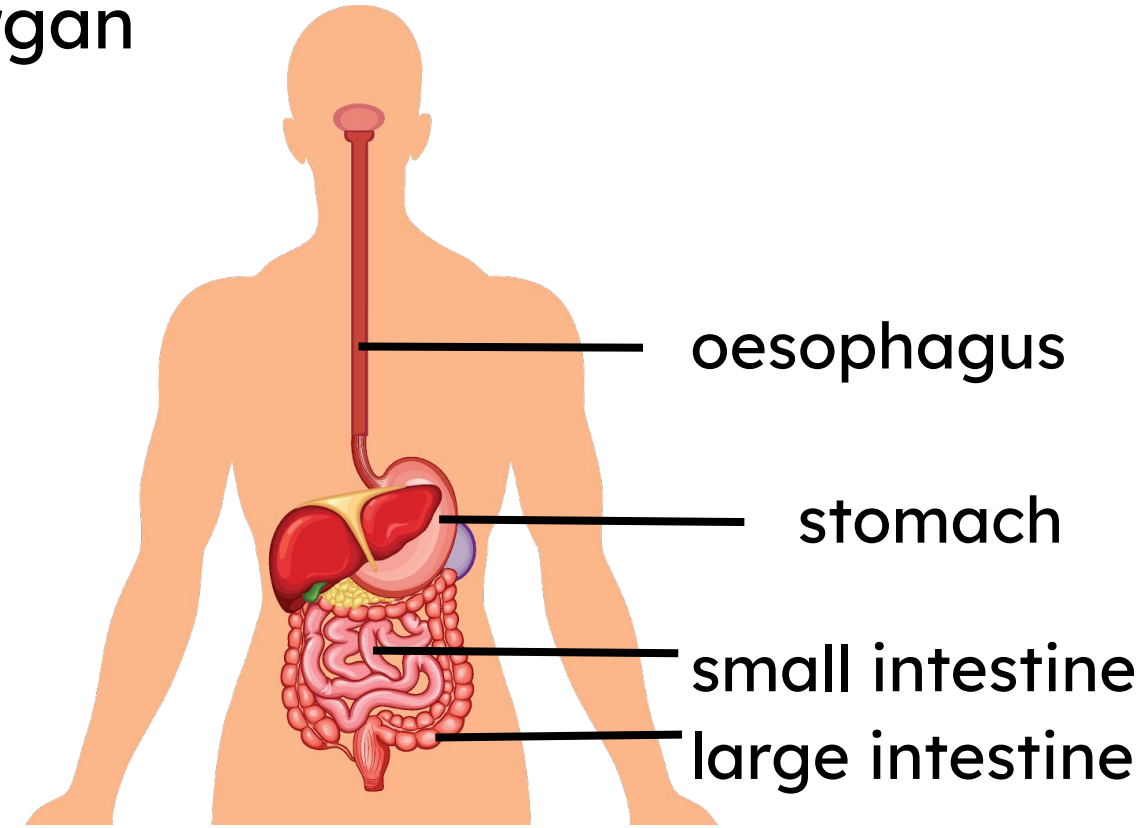
In a **multicellular** organism, these organs all have different functions.

Organs work together within an organ system.

An example of an organ system:

- the human digestive system

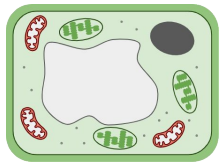
The organs of the digestive system work together to digest and absorb nutrients from food into the blood.

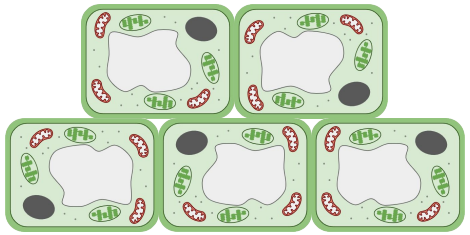


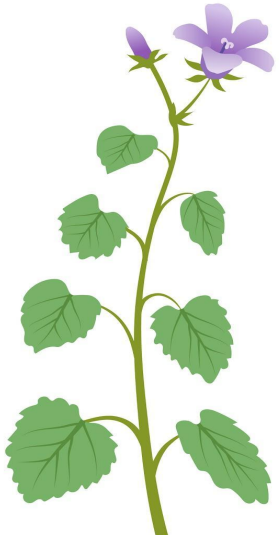
Differentiation

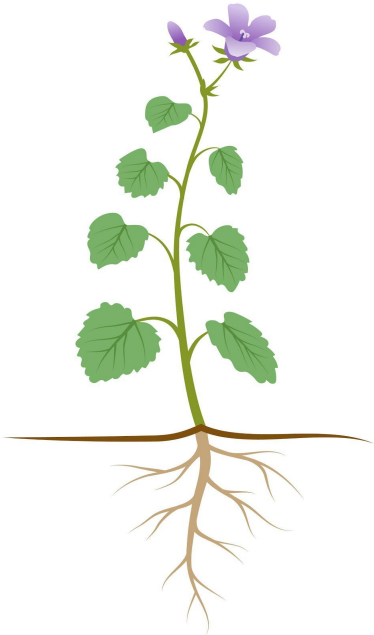
Explanation

In summary, large **multicellular** organisms are organised as follows:









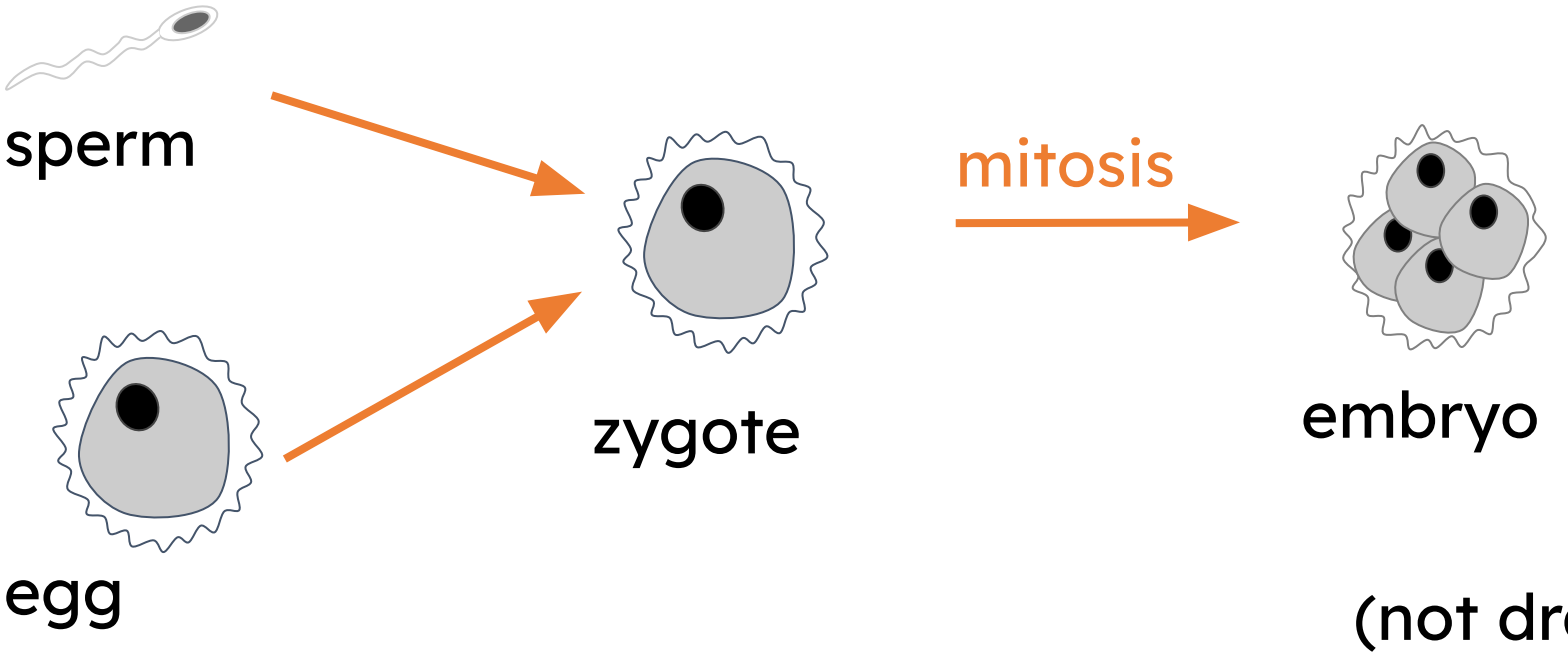
specialised cell → tissue → organ → organ system → organism

Differentiation and genes

Explanation

During sexual reproduction in humans, fertilisation produces a single cell (a zygote). This cell is **unspecialised.**

The zygote undergoes mitosis to form the embryo, where all the cells are identical copies.



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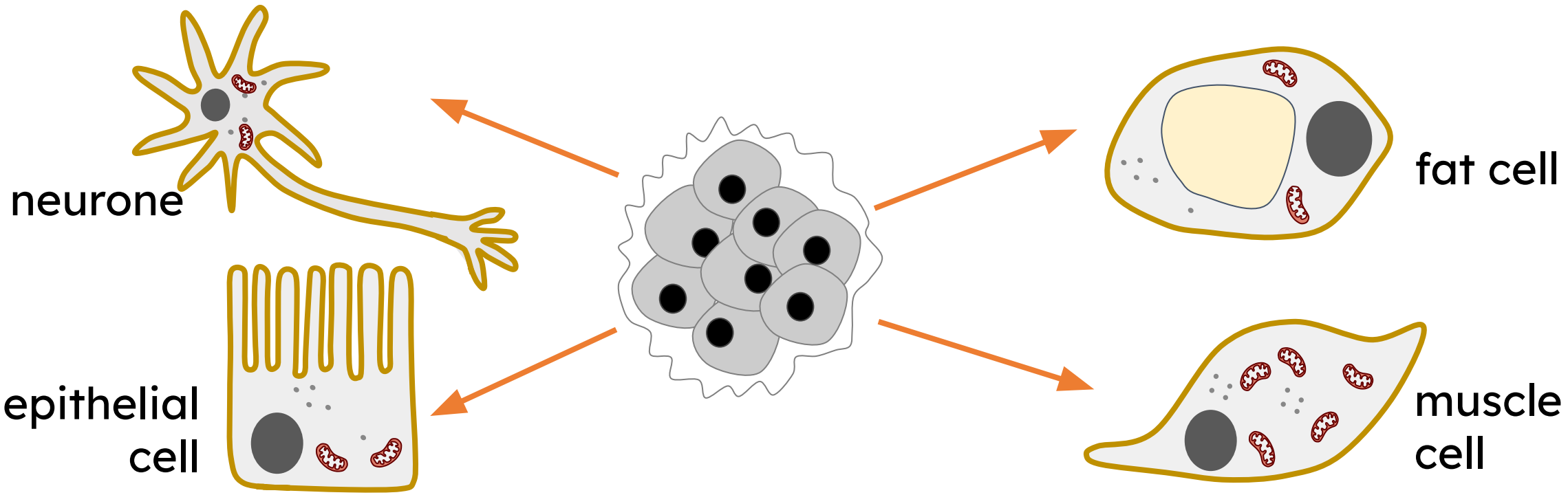
Differentiation and genes

Explanation

The zygote undergoes mitosis to form the embryo; which then undergoes differentiation to form **specialised cells.**

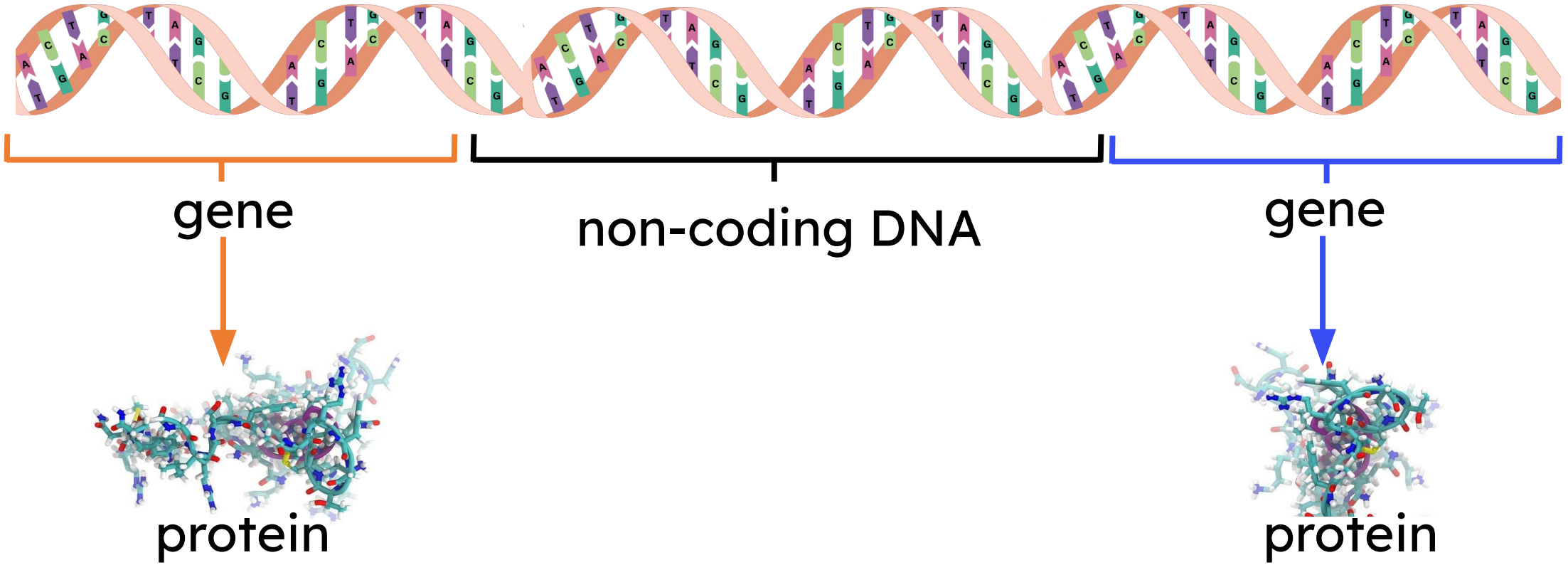


Differentiation and genes

Explanation

Genes are short sections of DNA that code for proteins, not all proteins are needed by all cells.

A **specialised cell** will make only the proteins it needs to survive and carry out its specific function.

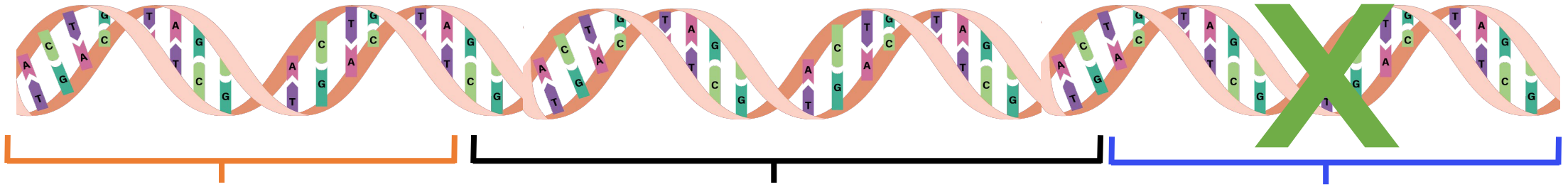


Differentiation and genes

Explanation

If a protein is not needed by a cell then the **gene** that codes for it can be turned off.

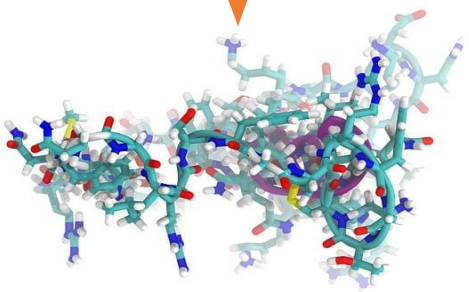
Therefore, different **specialised cells** can produce different proteins.



gene

non-coding DNA

gene



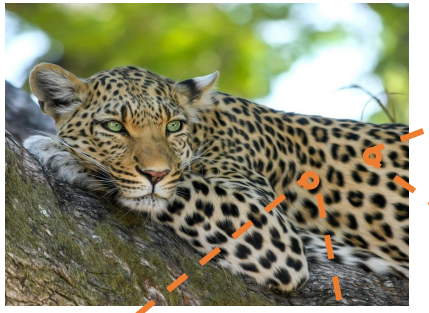
protein

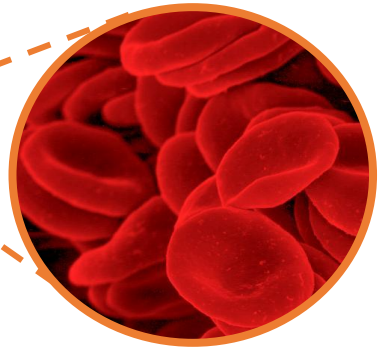
Differentiation and genes

Explanation

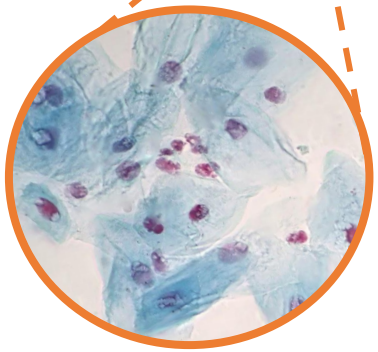
Which **genes** are turned on and off in each **specialised cell** controls its structures, shape and processes.

This allows many different tissues and organs to form, which aids the survival of a **multicellular** organism.

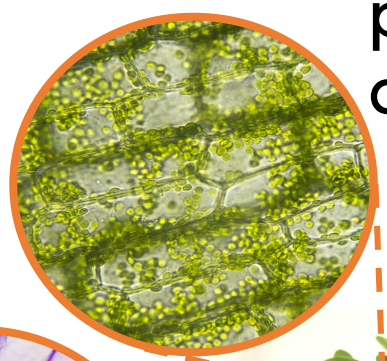




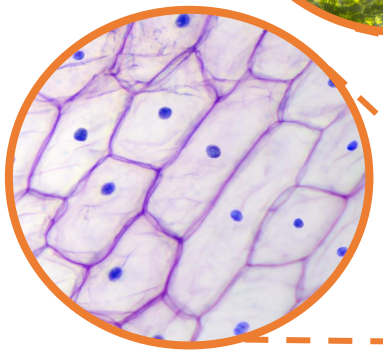
red blood cells



epithelial cells



palisade cells



root cells

guard cells

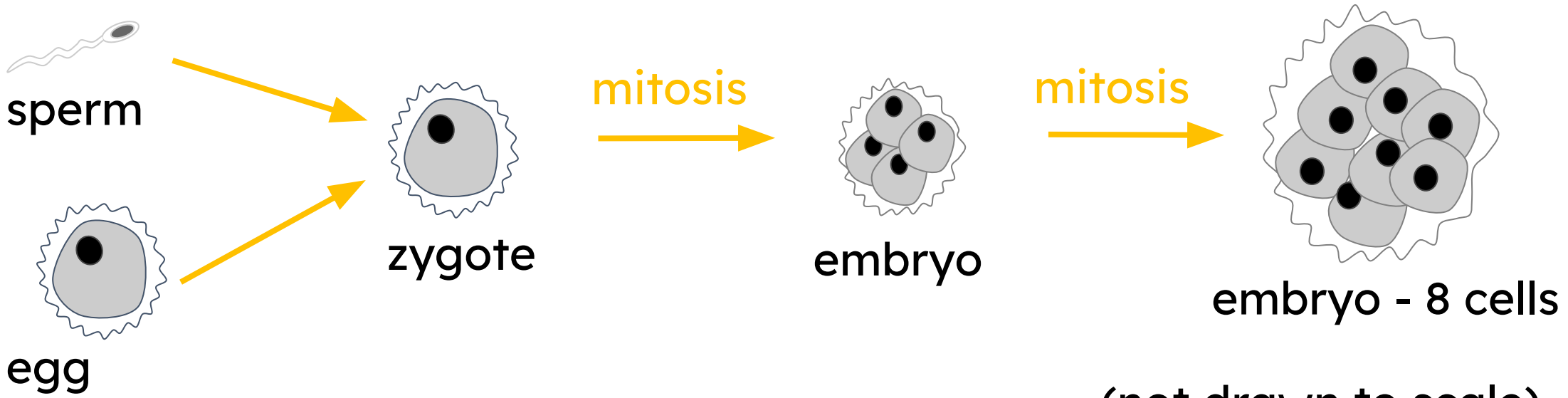
Stem cells in animals

Differentiation and embryos

Explanation

During sexual reproduction in humans, fertilisation produces a single cell (a zygote), this cell is **unspecialised.**

The zygote undergoes mitosis to form the **embryo**; up to the eight cell stage they are all unspecialised, this type of cell is called a **embryonic stem cell.**



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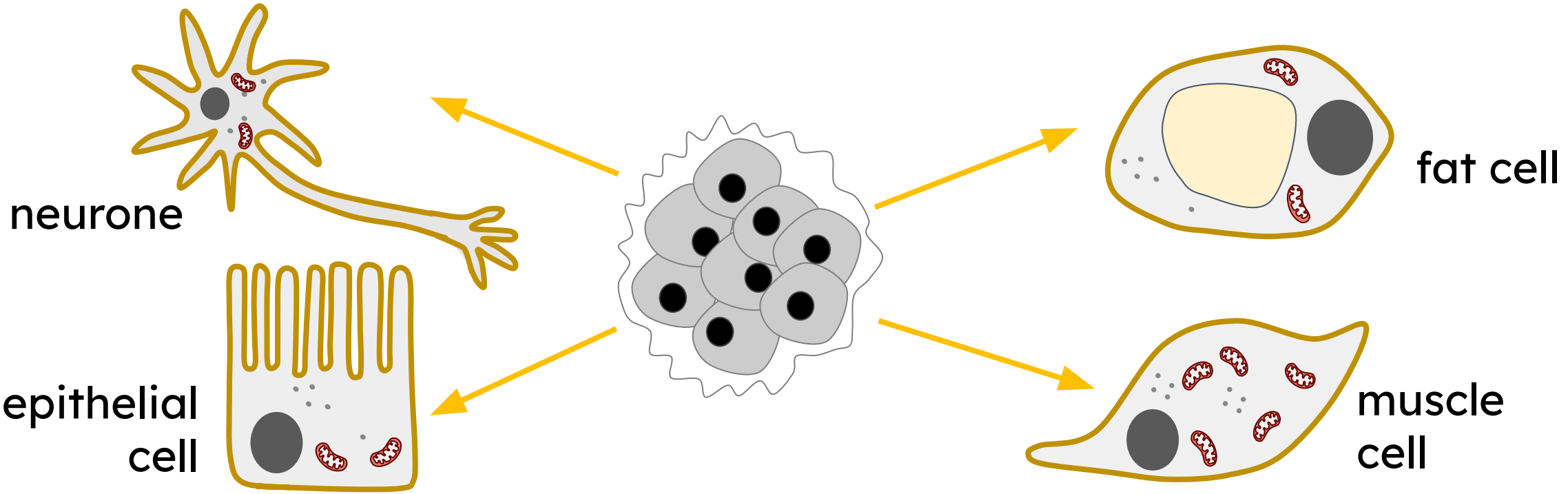
Differentiation and embryos

Explanation

These **embryonic stem cells** undergo **differentiation** to form all the different types of specialised cells needed for a developing foetus.

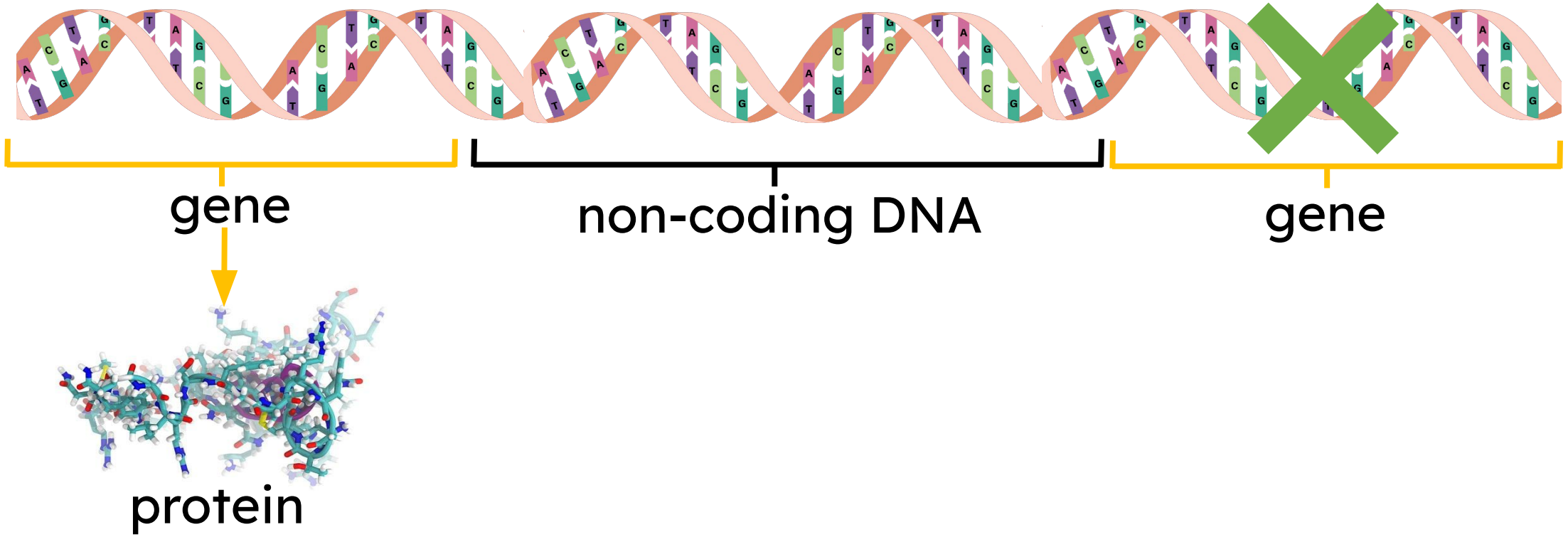
Examples of specialised cells:



Differentiation and embryos

Explanation

During development, chemical changes in the **embryo** control whether genes are turned on or off; if a protein is not needed by a cell then the gene that codes for it can be turned off.



Differentiation and embryos

Explanation

The pattern of which genes are turned on and off in each specialised cell controls **differentiation**.

This leads to the presence of different proteins in different cells, therefore they are no longer stem cells but specialised cells.

embryonic stem cells

differentiation → expression of certain genes

epithelial cell in trachea

mitosis → identical cells form tissues

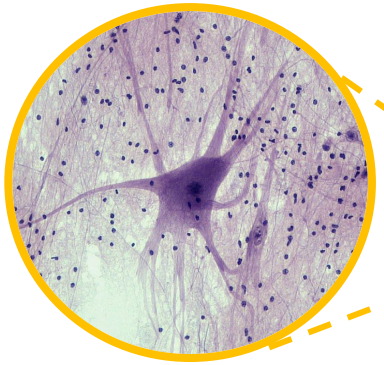
epithelium tissue in trachea

Differentiation and embryos

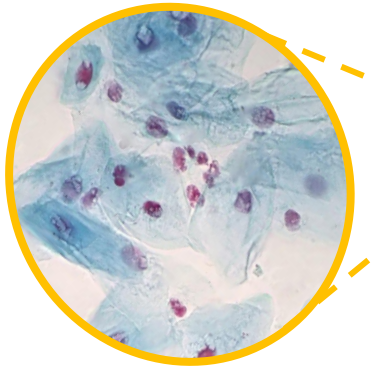
Explanation

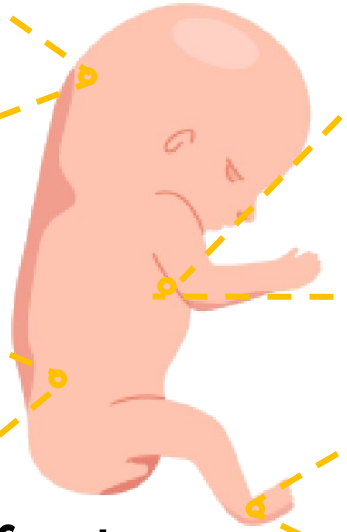
Embryonic stem cells can differentiate into any type of cell, but once they become specialised and formed tissues they can no longer form other types of cell.

Nervous tissue in spinal cord



epithelial tissue in the skin





foetus

cardiac muscle tissue in the heart

red blood cells in the blood

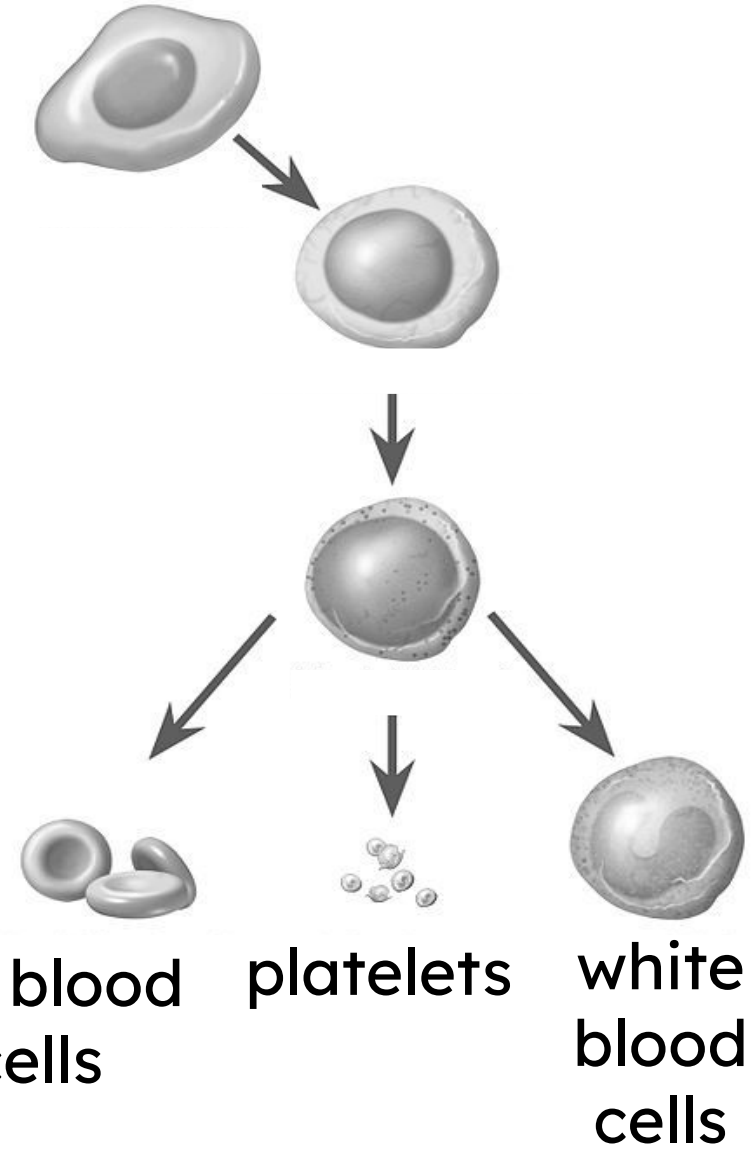
Adult stem cells

Explanation

Most embryonic stem cells will **differentiate** and become specialised, however some become **adult stem cells.**

Unlike **embryonic stem cells**, adult stem cells differentiate into a limited number of specialised cells.

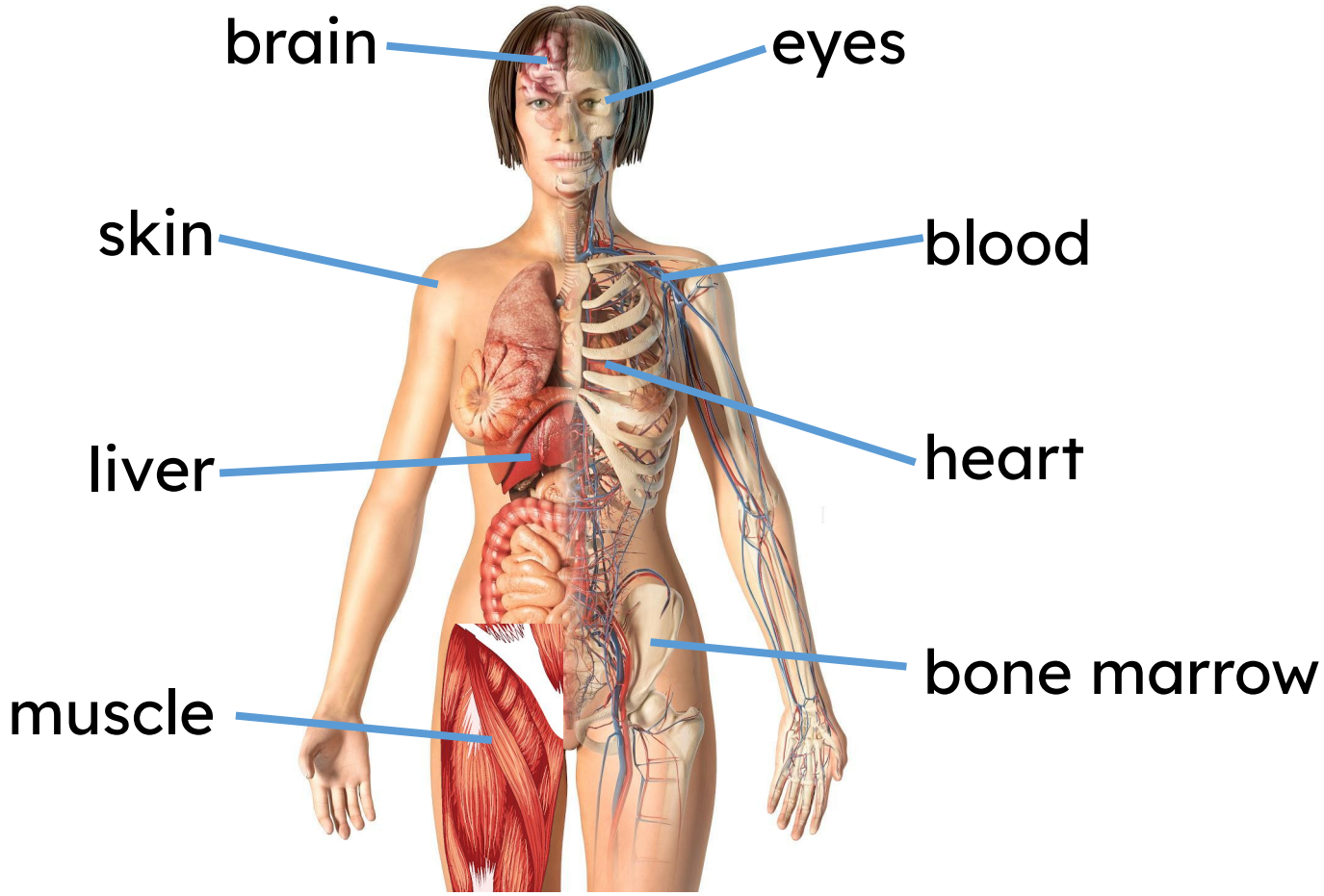
Example: adult blood stem cells can differentiate into specialised red blood cells, platelets and different types of white blood cells.



Adult stem cells

Explanation

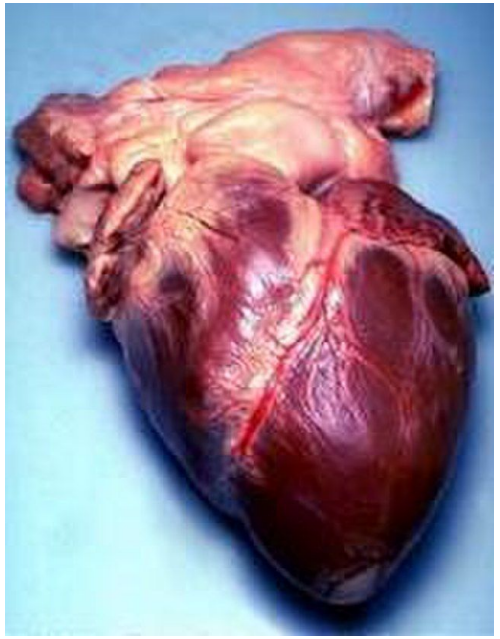
Adult stem cells are few in number compared to specialised cells, but they are found in the following regions:



Adult stem cells

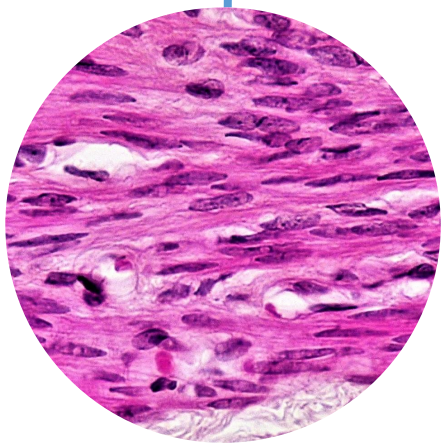
Explanation

Adult stem cells can **differentiate** into cells that are related to each other.

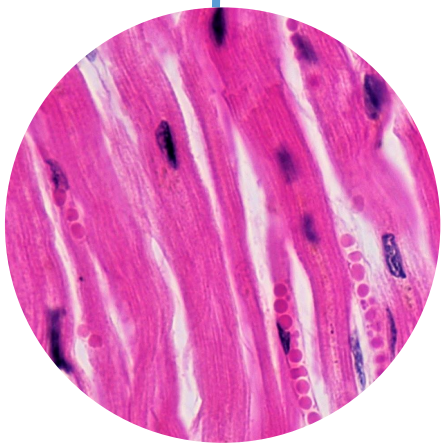


heart contains stem cells

differentiation from heart stem cells



smooth muscle tissue



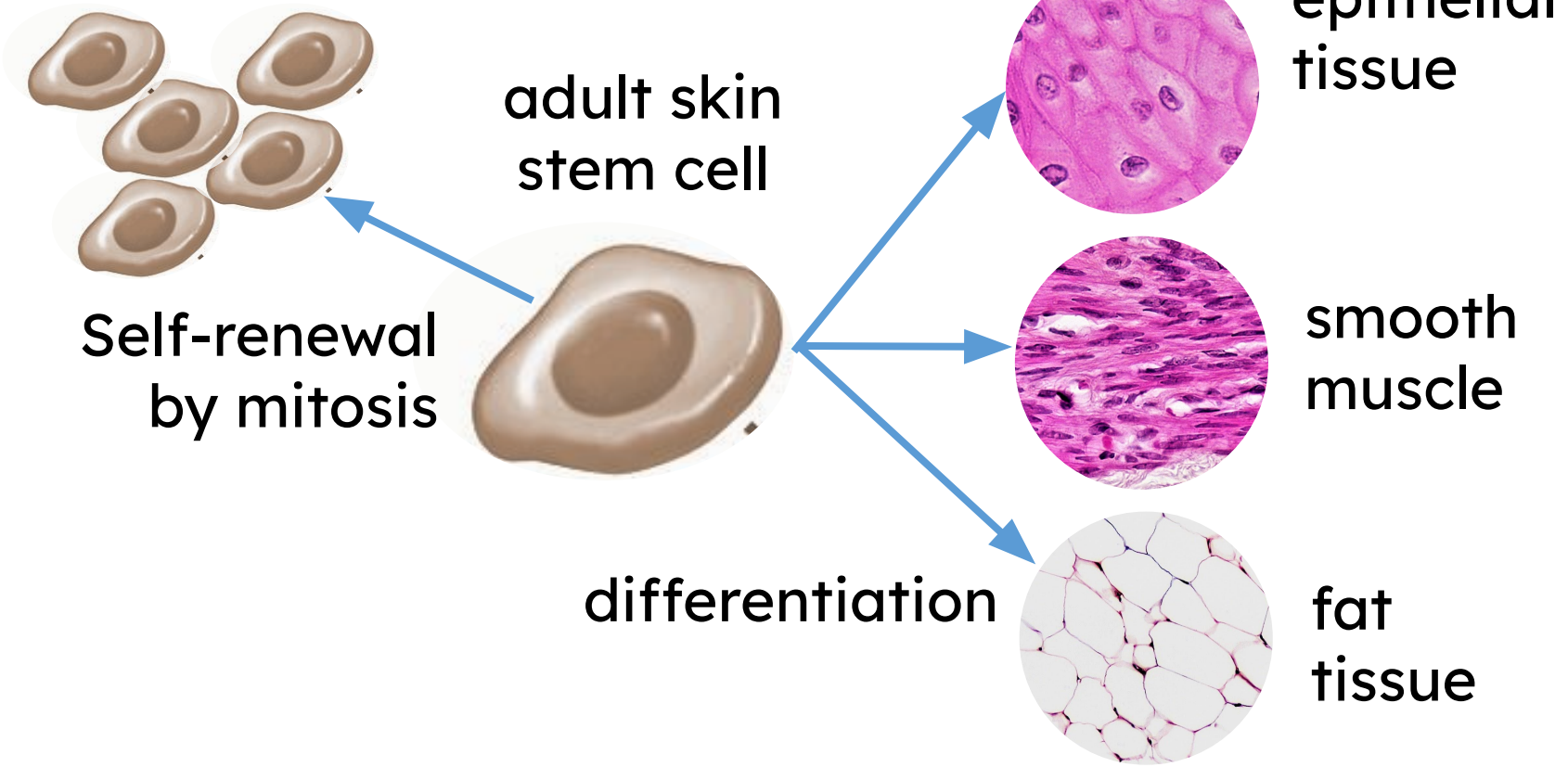
cardiac muscle tissue

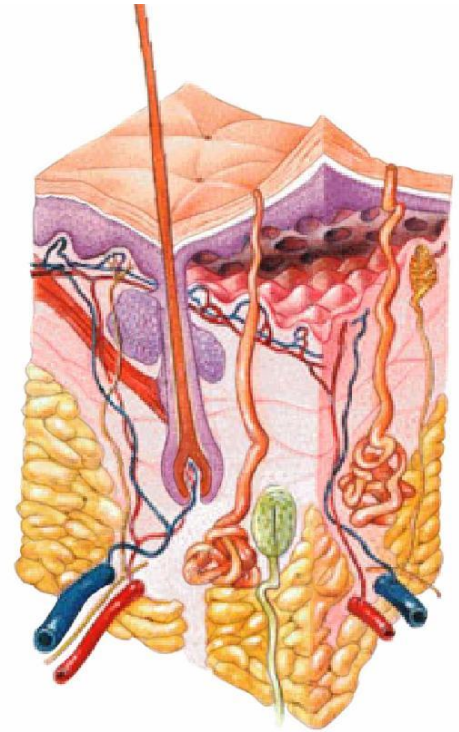
epithelial tissue

Adult stem cells

Explanation

Adult stem cells can divide by mitosis, as well as **differentiate**, so that there is a continuous supply.





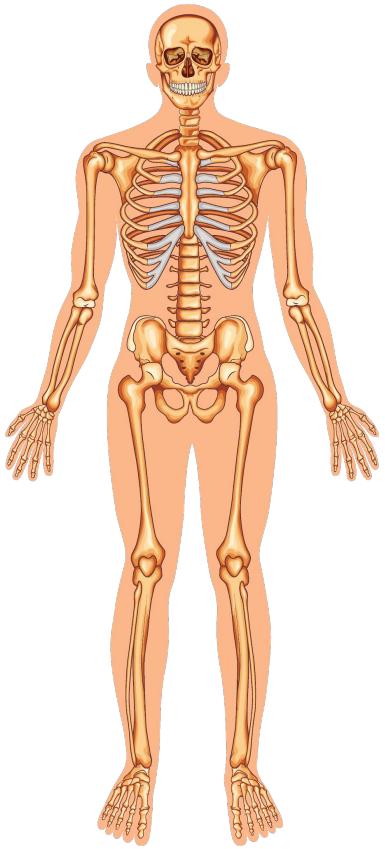
layers of skin tissue

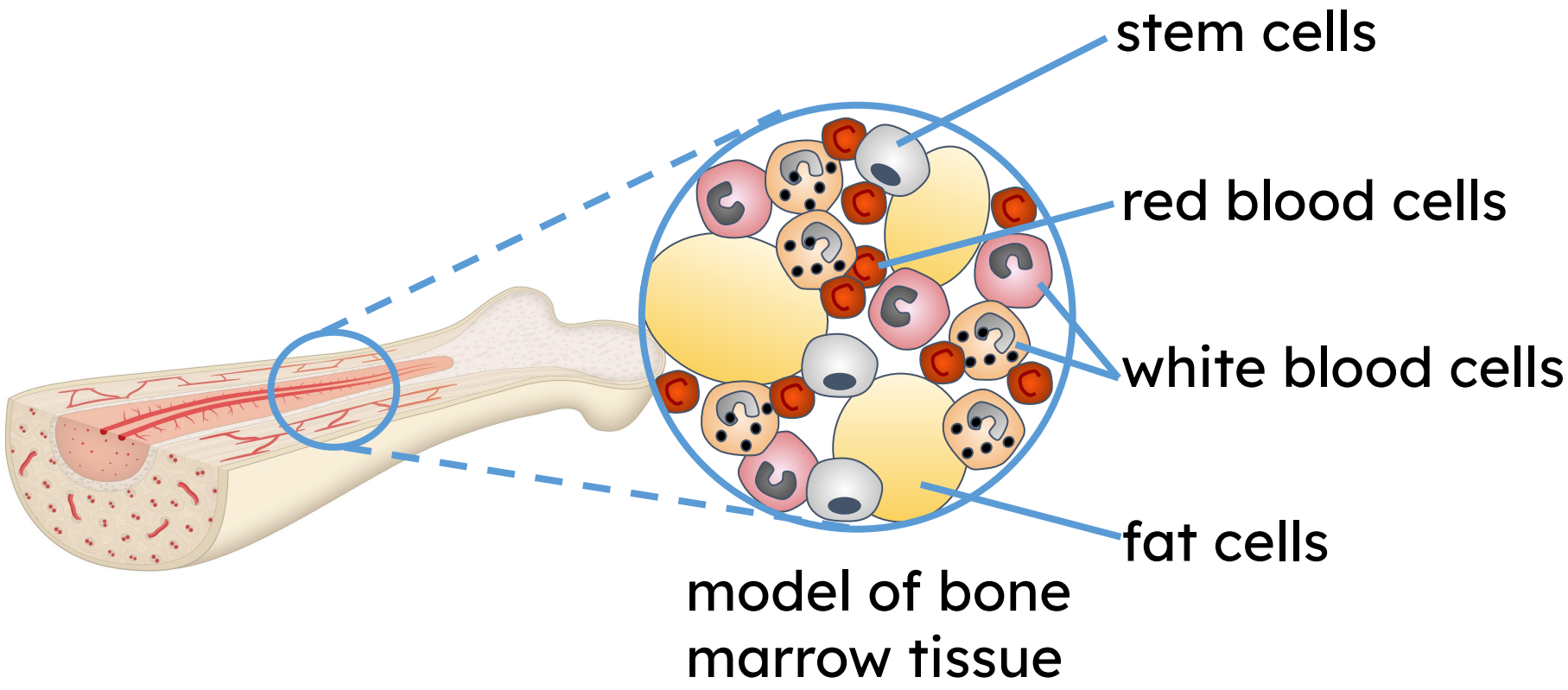
Adult stem cells

Explanation

Bone marrow **adult stem cells** are located in the bones.

Bone marrow contains stem cells that can **differentiate** into many types of cells, including blood cells.

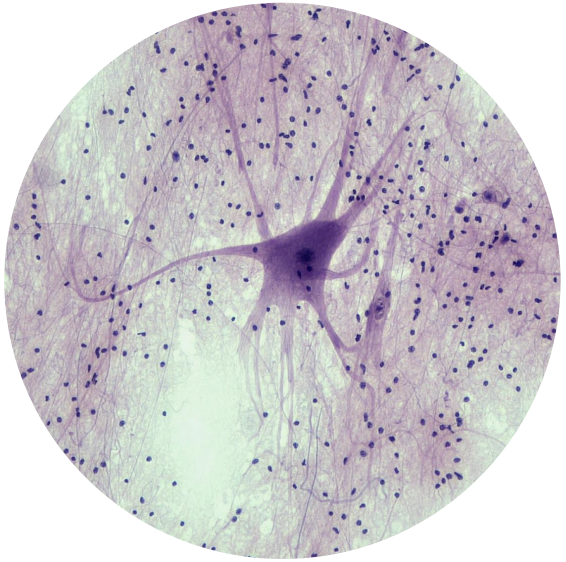




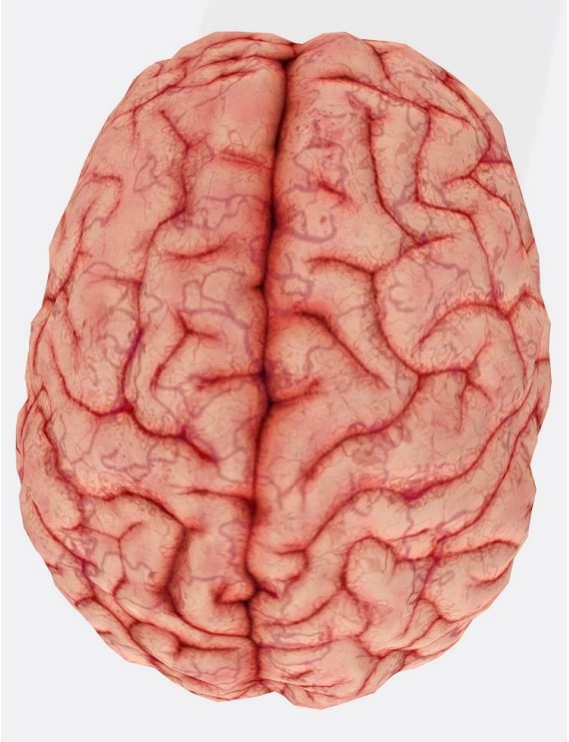
Adult stem cells

Explanation

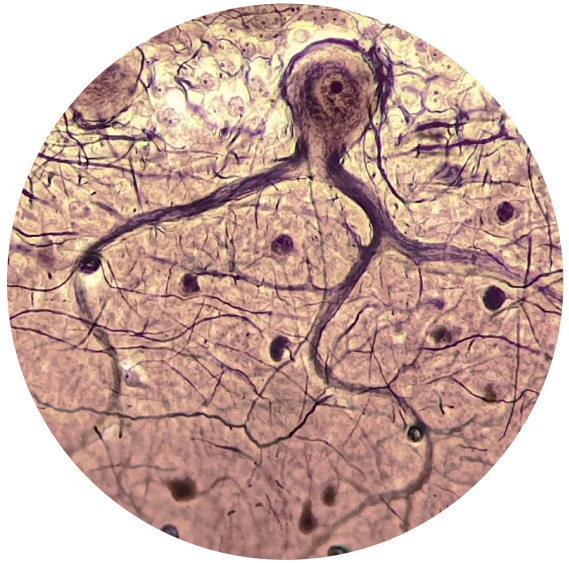
Adult stem cells are located in the brain, they can **differentiate** into different types of neurons.



motor neuron



brain



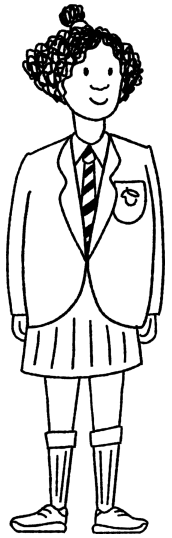
Purkinje cells in cortex of brain

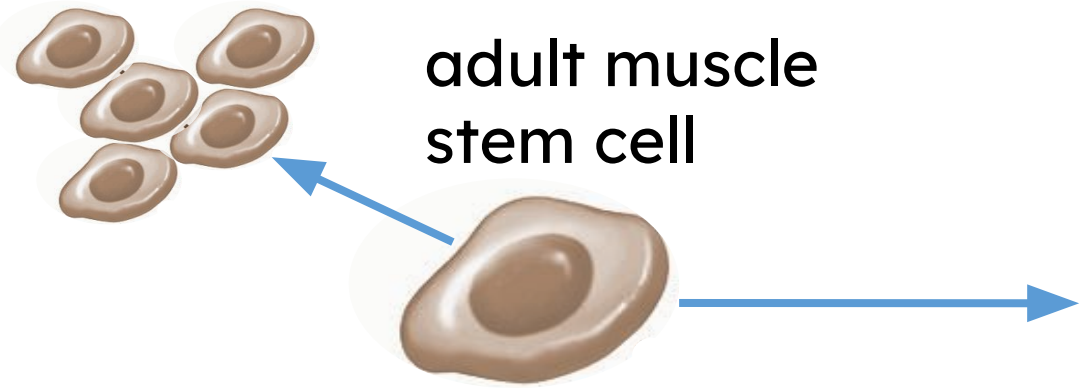
Task B Adult stem cells

Practice

Izzy has carried out some research into muscle stem cells, she has found out where they are located and what they differentiate into.

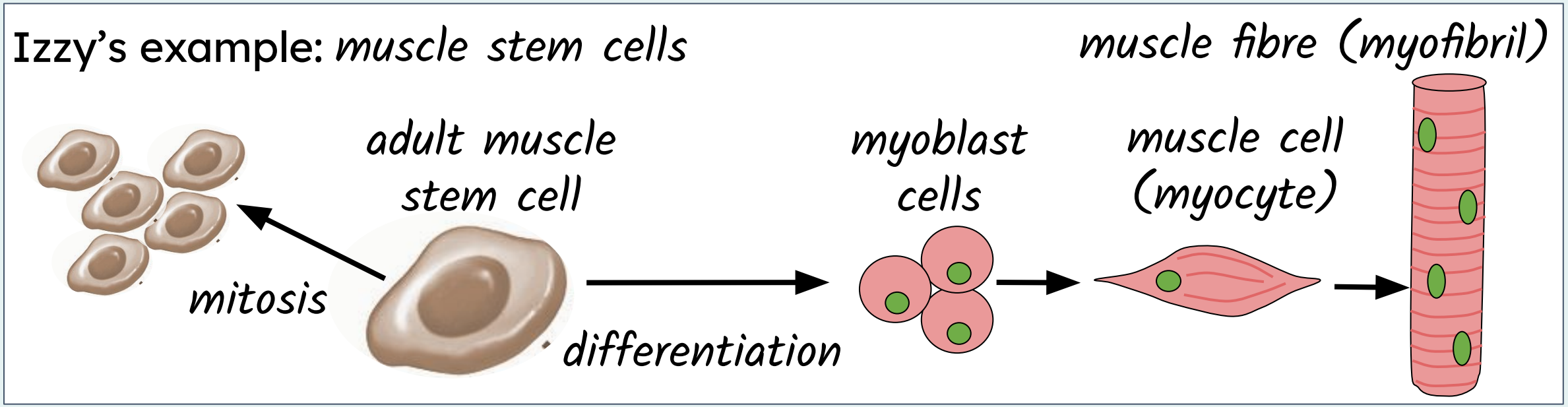
She will complete this diagram with the information from her research, and use it to help explain what adult stem cells are.





1. Carry out research into a type of human adult stem cell and complete the task in the same way as Izzy.

Complete the diagram with the information from your research, and use it to help explain what adult stem cells are.



Adult stem cells are in some regions in the body, such as the muscles. They can renew themselves by dividing by mitosis. The adult stem cells can differentiate into a limited number of related cells.