TOPIC 4 Fluid Movement in Cells

The Cell Membrane - A cell membrane allows some substances to enter or leave the cell, while **stopping other substances.**

It is a **selectively permeable membrane.**

A permeable membrane allows all materials through, while an impermeable membrane does not **allow anything through**

At the border certain materials are not allowed into the country.

Figure 2.11A Plastic is impermeable to water.

Figure 2.11B Cheesecloth is permeable to water.

Figure 2.11A Plastic is impermeable to water.

Figure 2.12 In time, the ink particles will become evenly dispersed with the water particles, and the whole solution will appear ink-coloured.

Diffusion

The structure of the cell membrane controls what moves in or **out of a cell.**

According to the particle model particles are moving in all directions, **bumping into each other.**

Diffusion – movement of particles from an area of high concentration to and area of **low concentration until the concentrations are equal.**

Diffusion plays a part in moving substances into **and out of a cell.**

Diffusion in Cells

Diffusion also plays a part in moving substances **into and out of cells.**

For example, imagine an amoeba living in water. The concentration of dissolved carbon dioxide gas in the water is the same as the concentration of dissolved carbon dioxide gas in **the amoeba's cytoplasm.**

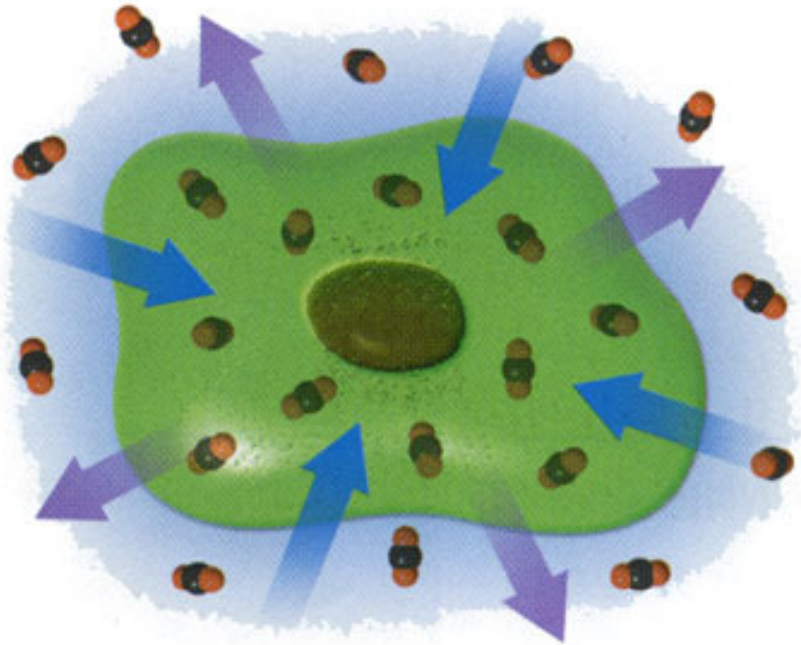
Carbon dioxide particles therefore move into and out of the cell at the same rate, passing through small openings in the amoeba's **selectively permeable membrane.**

Now imagine the amoeba has been producing carbon dioxide as a waste product **inside its single cell.**

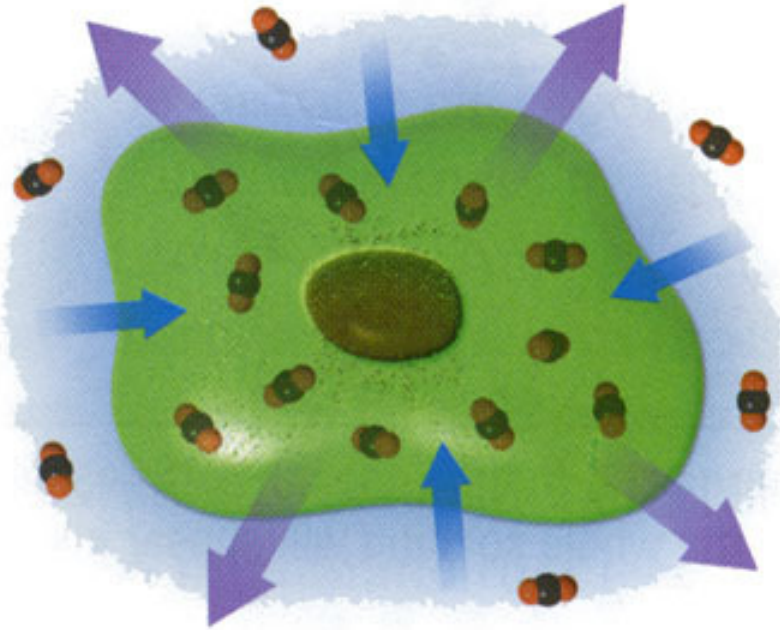
The concentration of dissolved carbon dioxide particles in the amoeba's cytoplasm is now greater than the concentration of carbon dioxide **in the surrounding water.**

As a result, more carbon dioxide particles move out of the cell by diffusion during a given time **than move into the cell.**

The diffusion process continues until the concentration of the dissolved carbon dioxide gas on both sides of the cell membrane **is once again equal.**



An equal concentration of carbon dioxide particles on both sides of the cell membrane. The particles move into and out of the cell at an equal rate.



A greater concentration of carbon dioxide particles inside the cell.
The particles move out of the cell at a greater rate than they move into the cell.

Osmosis

The most common substance found inside and **around cells is water.**

About 70 percent of a cell's content is water, and most cells die quickly without a **supply of this liquid.** Water particles are small and can easily move into and out of **cells by diffusion.**

The diffusion of water through a selectively permeable membrane **is called osmosis.**

You have probably already seen osmosis at work.
Have you ever cut carrot sticks from a fresh carrot?
You may have left some extra sticks in the refrigerator.
By the next day, they have lost some of their moisture and they **have gone limp**.
Suppose you place the sticks in a glass of water.

Several hours later they are **crisp again.**

What has happened?

Water particles have moved from the water in the glass into the **carrot cells by osmosis**

DidYouKnow?

Can your doctor give you medicine without using pills, syrups, or needles?

Yes, by using **diffusion.**

Drugs can be put into a patch similar to a BandAid that is **stuck onto the skin.**

There is a high concentration of drugs in the patch but a low **concentration in the body.**

Therefore, the drug particles diffuse through the skin **into the bloodstream.**

When you are very active, you lose moisture from your body in your breath and in sweat. Moisture is lost by the body through the skin's surface and the **surface of the lungs.**

Water is then drawn from other cells and structures of the body to replace the water lost from **these surfaces.**

This happens partly by osmosis and partly as a result of the **body's circulatory system.**

At some point, you need a new supply of water to restore the cell water content in your body **to its normal level.**

Water is important to living things because it dissolves many of the substances **involved in cell processes.**

For example, glucose (which cells use for energy) dissolves in water to form a **glucose solution**.

When water moves out of a cell, the dissolved substances inside the cell become **more concentrated**.

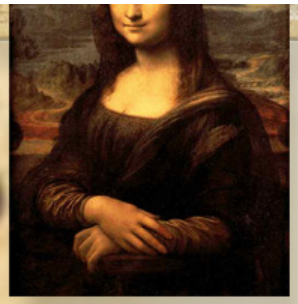
When water moves into a cell, the dissolved substances inside the cell become **more diluted.**

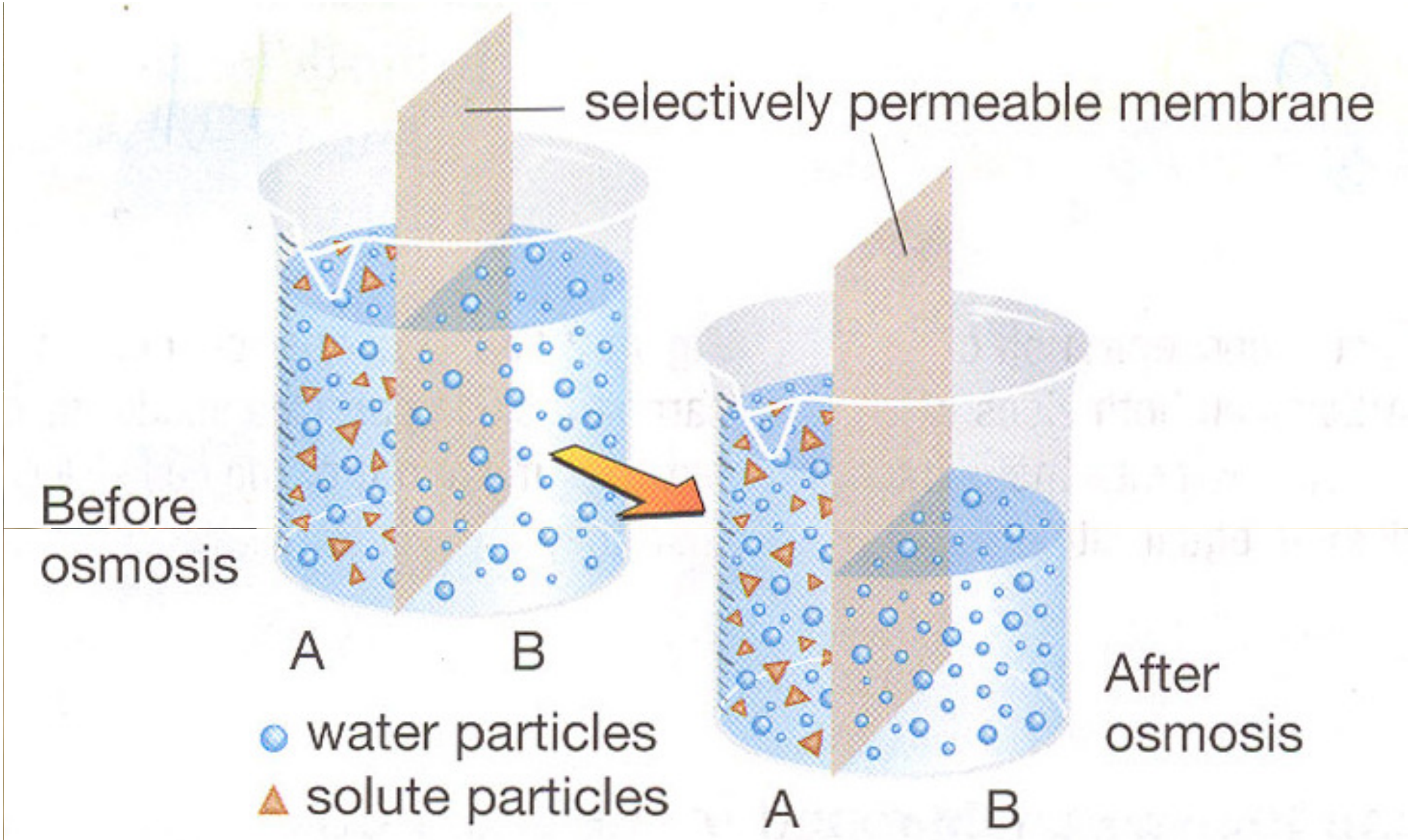
Water tends to move by osmosis from a diluted solution to a **more concentrated solution.**

In other words, water moves from a region where it is in high concentration to one where it is **in lower concentration.**

What do you think would happen if you put a fresh carrot stick into a glass containing a concentrated salt solution?

It would lose water through diffusion.





Side B – carrot stick Side A – glass of water

In this simplified diagram, which side represents a carrot stick and which side represents a glass of water?

Can cells break sidewalks?
With the help of osmosis, they can!
When cells take in water by osmosis, they tend to swell.
The increasing pressure from the added volume of water may burst **open animal cells.**
Plant cells, however, can withstand much greater pressure because they are **surrounded by rigid cell walls.**

This pressure is called osmotic pressure. Have you ever seen weeds breaking through a paved sidewalk?

They force their way through asphalt by osmotic pressure, generated by water in the **cells of the shoot tip**

Fluid Movement in Plants

Most plants need a large **supply of water.** Plants require water to make sugars in the process of photosynthesis.

Plants obtain water **from the soil.**

How does water get from the soil into the plants?

Roots need the sugars **made in the leaves.**

How do cells in the roots of plants obtain these sugars?

Tissues are groups of cells that **perform similar functions.**

The transport of nutrients is the role of the plant's tissues. Inside the plant, two types of tissues, called vascular tissues, connect the **roots to the leaves.**

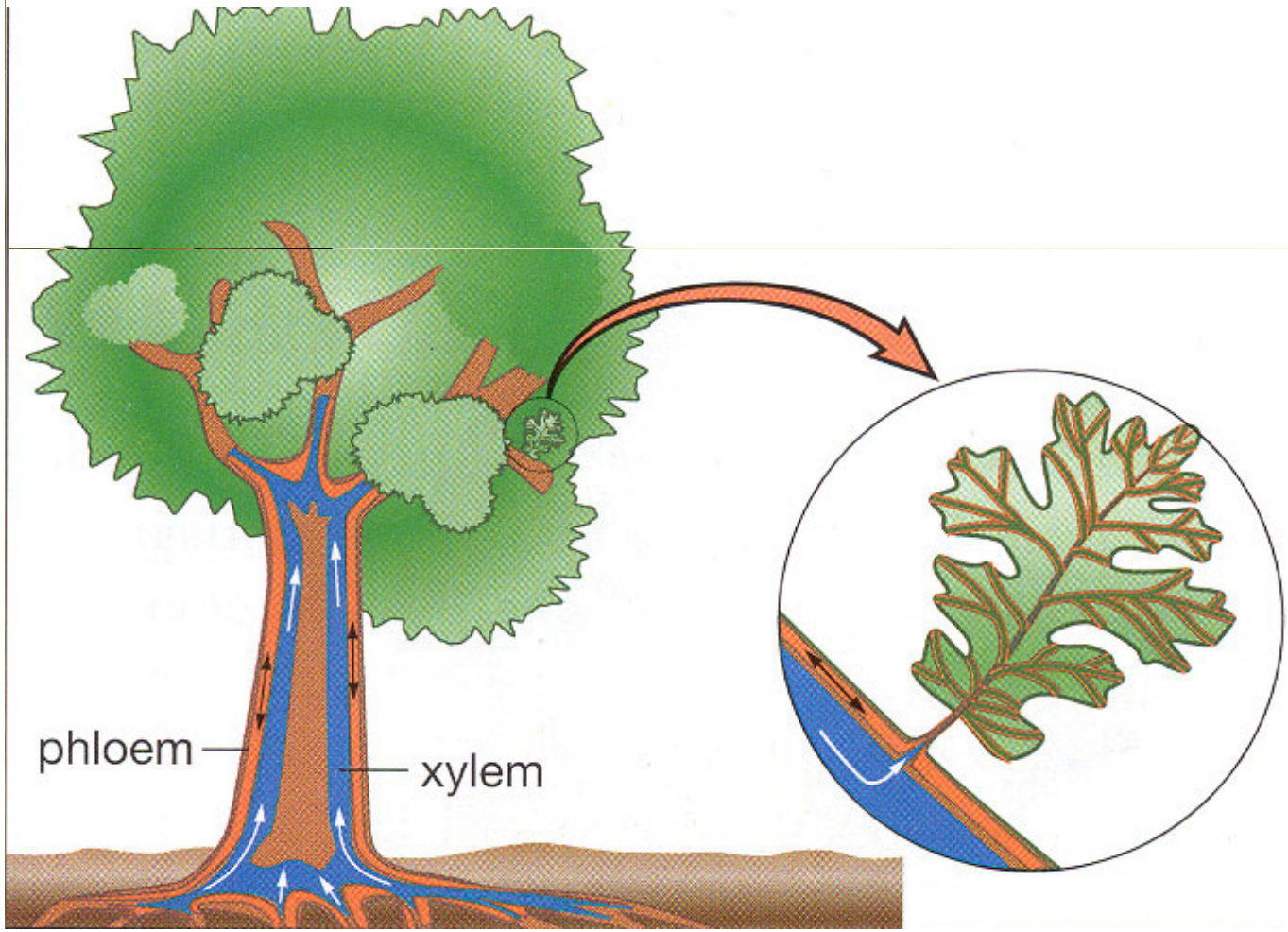
Phloem tissue transports sugars manufactured in the **leaves to the rest of the plant.**

Xylem tissue conducts water and minerals absorbed by the root cells **to every cell in the plant.**

Xylem and phloem tissue usually occur together, along the length of the plant **stems and roots.**

Both types of tissue are surrounded and supported by other tissue that **gives the plant strength.**

This other tissue has large vacuoles for **storing food and water.**



Xylem tissue conducts water from the roots to the rest of the plant. Phloem tissue carries sugars from the leaves to the rest of the plant.

http://www.youtube.com/watch?v=w6f2BiEiYiM

From Root to Leaf

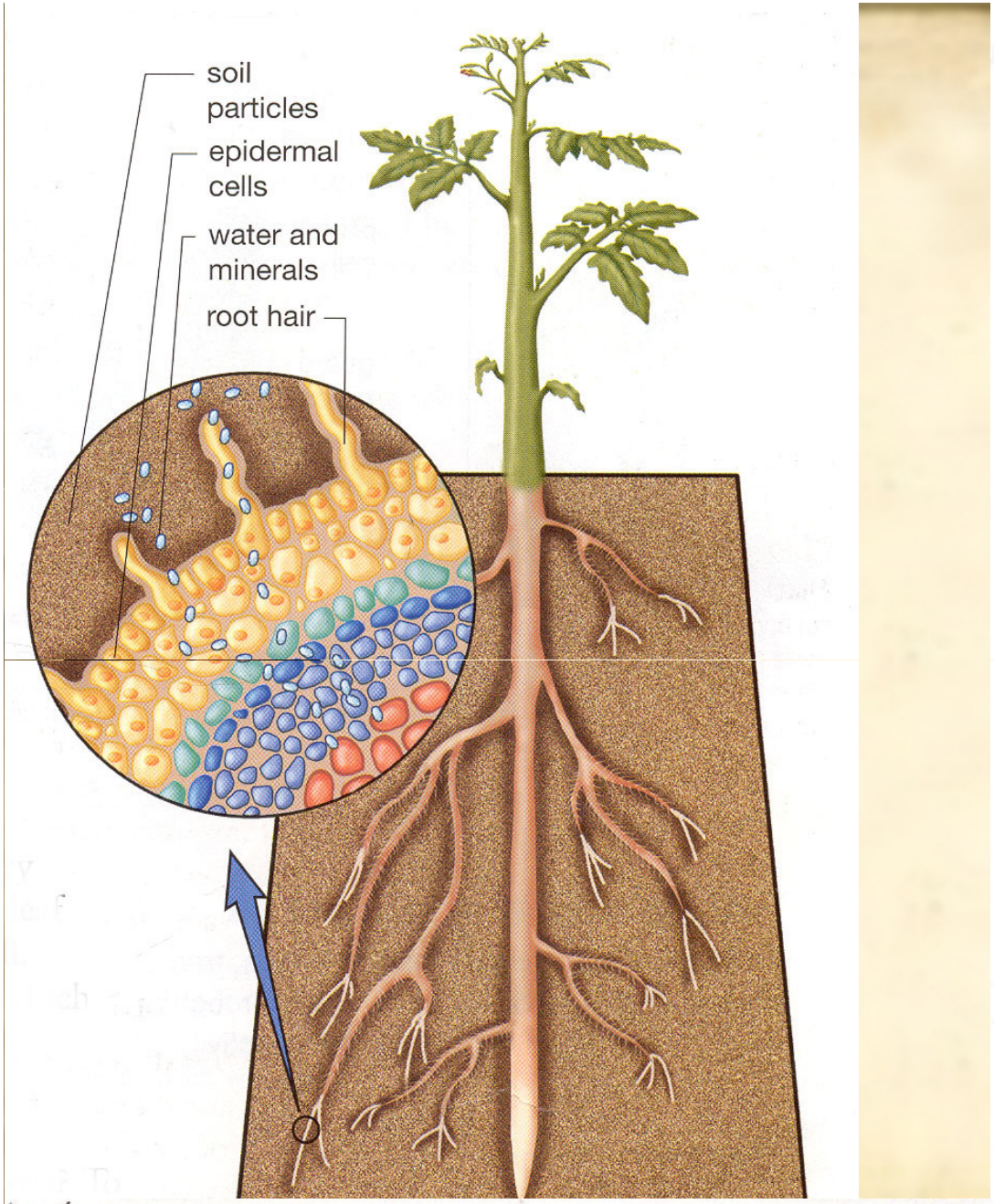
If you examine the structure of a root system, you will see that its growing tips are covered **with fine root hairs.**

These "hairs" are, in fact, extensions of **single epidermal cells.** Epidermal cells form epidermal tissue, which protects **the outside of a plant.**

When the concentration of water in the soil is greater than the concentration of water in the root cells, water enters these root hairs **by osmosis.**

From the root hairs, water passes from cell to cell by osmosis until it reaches the **xylem tissue.** The tube-shaped cells making up xylem tissue have thick walls with holes in their ends. Stacked end to end, they form bundles of hollow vessels similar **to drinking straws.**

Water can flow easily through these vessels. As more water enters the root hairs, it creates pressure that pushes water up the plant through **the xylem tissue.**



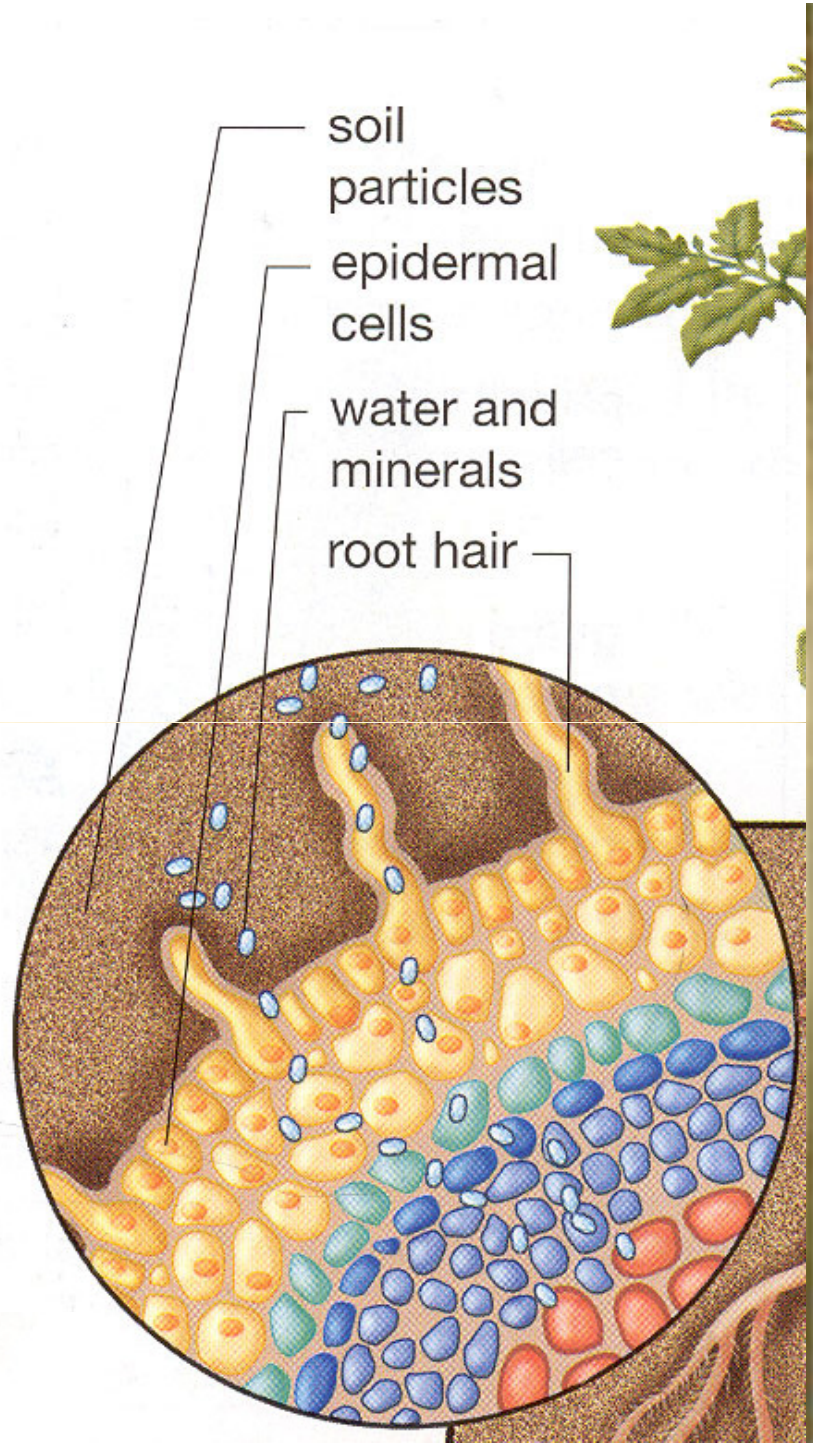
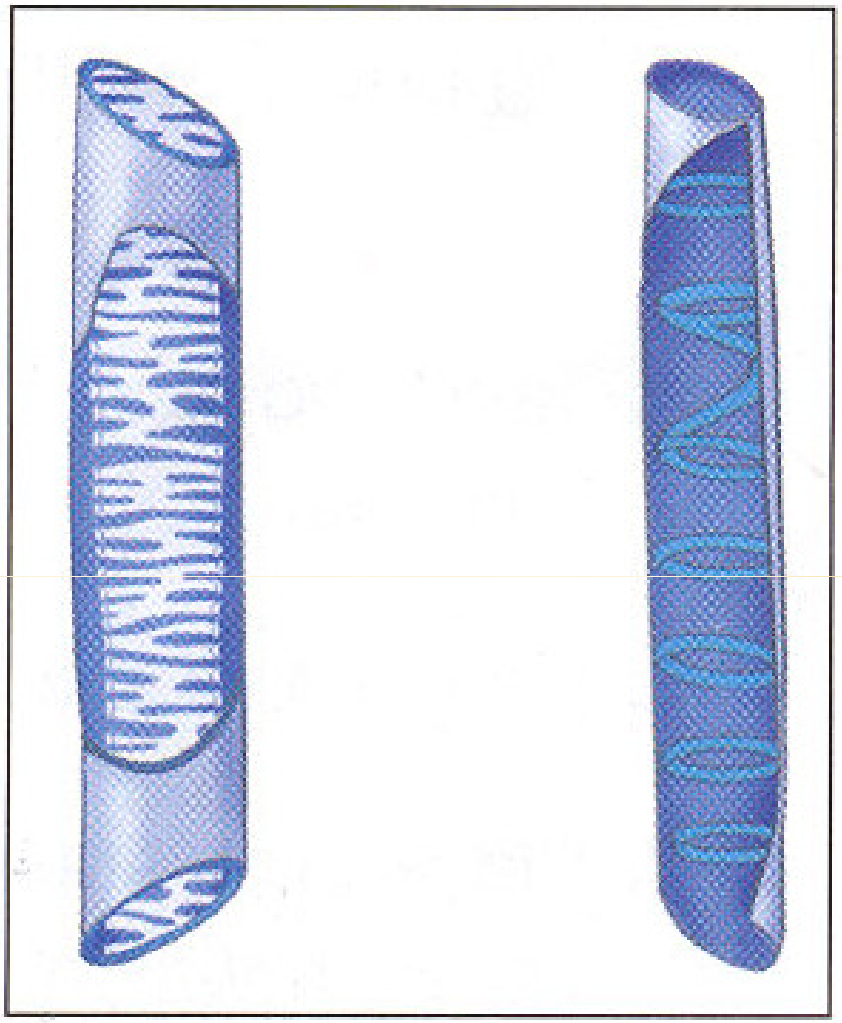


Figure 2.17 Water and dissolved minerals enter the plant by osmosis through the root hairs.

Figure 2.18 Xylem cells have thick walls for strength. Their open ends allow water to pass through freely.



DidYouKnow?

The phloem of a tree lies close to the outer surface of the trunk, **just below the bark.**

Because of this, sugar tappers can easily draw sugar solution from the **trunks of maple trees.**

This is done by boring a small hole through the bark and pushing small tubes into **the phloem tissue.**

The best time to tap maple trees is early in the spring, when large amounts of sap are flowing to provide **energy for new growth.**

Water is transported by xylem tissue into the **stems and the leaves.** Leaves are the plant's **food-producing organs**. Recall that photosynthesis manufactures sugars from **water, carbon dioxide, and sunlight.** Most photosynthesis takes place in a layer of cells in the leaf that are filled **with chloroplasts**. These cells are called **palisade cells.**

Why are many leaves typically flat and thin?

This shape provides a large surface area to **absorb sunlight.** This shape also makes it easy for gases to diffuse **into the leaf cells.**

Notice the tiny openings on the **underside of the leaf**. These openings are called **stomata (singular: stoma).** They allow air to enter the leaf, supplying the oxygen the cells need for respiration and the carbon dioxide they **need for photosynthesis**. Spaces between leaf cells allow the air to flow around each cell. Surrounding each stoma are guard cells, which can expand to **close off the stoma.**

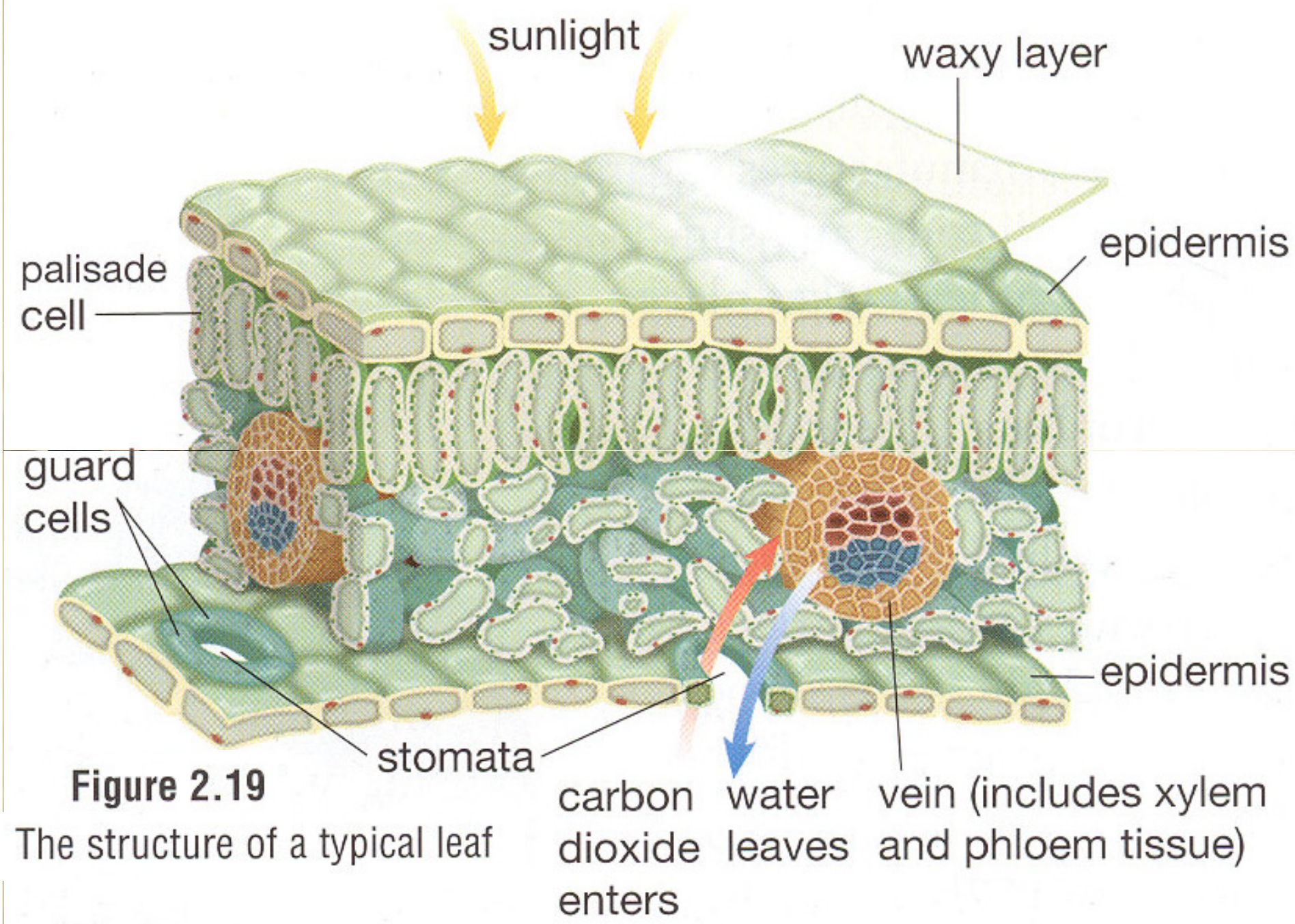


Figure 2.19
The structure of a typical leaf

Transpiration

Why do the stomata in a leaf open and close?
To answer this question, recall that water first enters a plant through **its root system.** Then it moves into **its shoot system**.
What happens next?
The water does not continually circulate like the blood in our bodies. It does not go back into **the root system.**

Instead, it exits the plant through the **open stomata in the leaves.**

This loss of water from a plant through evaporation is **called transpiration.** The loss of water is not a problem as long as it is replaced by more water that enters the plant **through the roots.** In periods of drought and in deserts, however, water loss from a plant can **be a serious problem.**

Pulling and Pushing

If all the tissues of a plant were to magically disappear, leaving only the water in them behind, you would see a ghostly outline of the plant in a **web-like network of water.** There is no break in this water system. Fine columns of water connect every cell, from the **leaves to the roots.** The network extends even beyond the root hairs it connects root hairs to **channels of water in the soil.**

According to the particle model, individual water particles are held together by bonds of attraction, which make the plant's water network behave **as a single unit**. Water drawn into the root hairs by osmosis pushes slender **water columns up the plant**. At the same time, water lost from the leaves by transpiration pulls water up the xylem tissues all the way **from the roots.** Both these actions - pushing and pulling - are necessary to raise the water up to **the top of very tall trees.** In this way, trees can transport water without having a pumping **organ similar to the human heart.**

TOPIC 4 Review

1. What process causes water to enter or leave a cell?

Osmosis

2. How are osmosis and diffusion alike? How are they different?

They both have substances moving from an area of high concentration to an area of low concentration

Osmosis – water through a selectively permeable membrane

Diffusion is any substance

3. If your teacher opens a bottle of ammonia at the front of the classroom, you will smell ammonia at the back of the room a short while later. Explain what has occurred.

Diffusion

4. Which tissues conduct water in plants?

Water is transported by xylem tissue into the **stems and the leaves**

5. Which tissues conduct sugars in plants? Phloem.

6. 'What is the function of guard cells?

Open and close the stoma to allow gases in and out of the cell

7. Why do grocery stores spray their fresh vegetables with water?

So they don’t wilt or go limp

8. Is it better to water plants in the evening or during the day?

TOPIC 5

Cell Specialization and Organization

Imagine an orchestra made up of only a hundred trumpet players or a **hundred violins.** Such an orchestra would be very limited. To play every kind of music, an orchestra needs a variety of musical instruments, each with its **own special sound**. In an orchestra, the same instruments and those that are similar are grouped together so they can work together more easily to make their particular, **unique sound**. In the same way, a multicellular organism has different kinds of cells, which are organized in ways that help them **to do their jobs.**

Specialized Cells

Although multicellular organisms grow from single cells that repeatedly divide, their cells are **not all the same**.

Like the instruments in an orchestra, different cells have different appearances and **perform different jobs.** They are said to be specialized for **particular tasks**.

For example, your muscle cells are shaped to move parts of your body, and your skin cells are built to protect your body from the **drying rays of the Sun**.

Humans have about a hundred different types of cells, each with its own particular **structure and functions.**

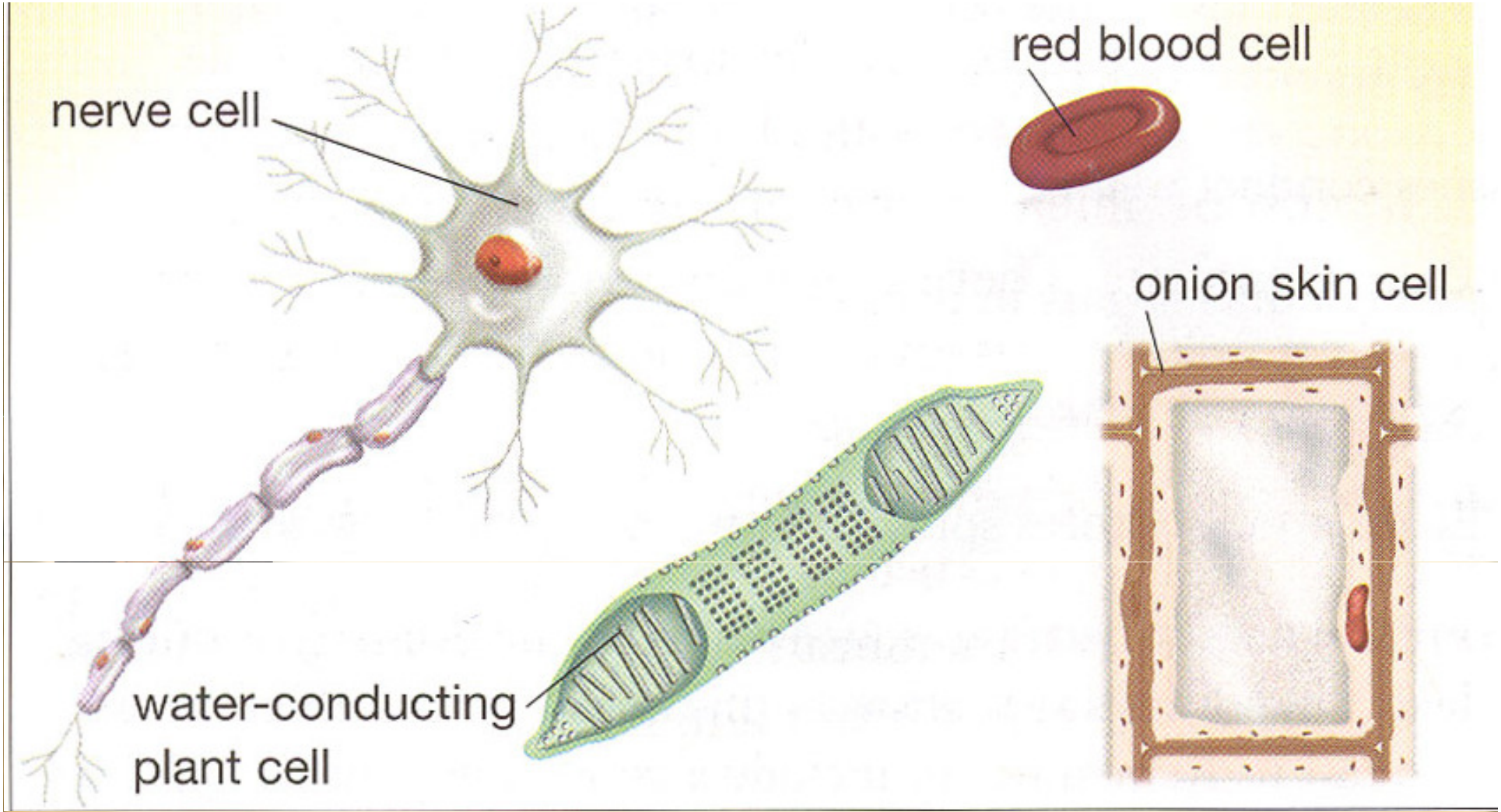
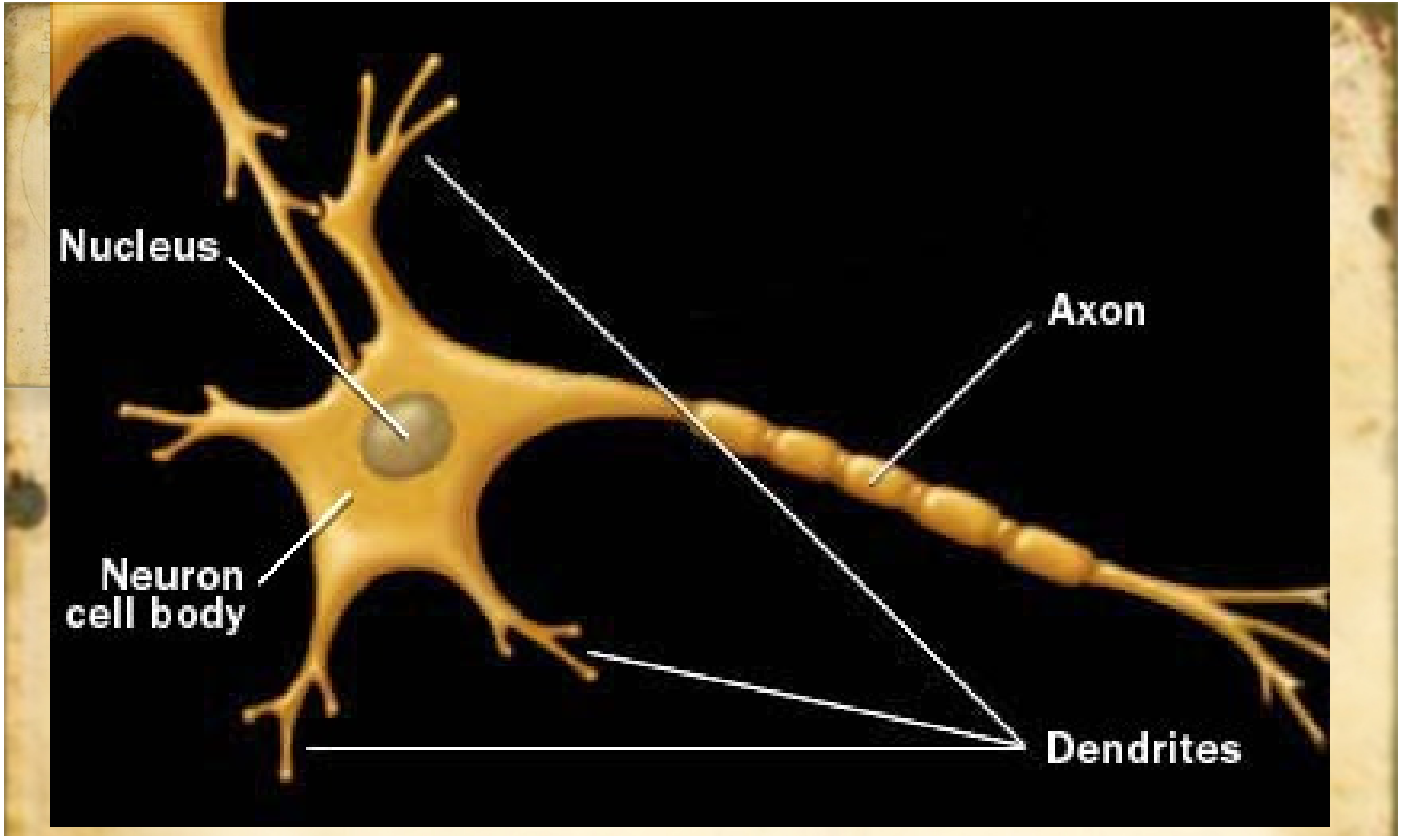
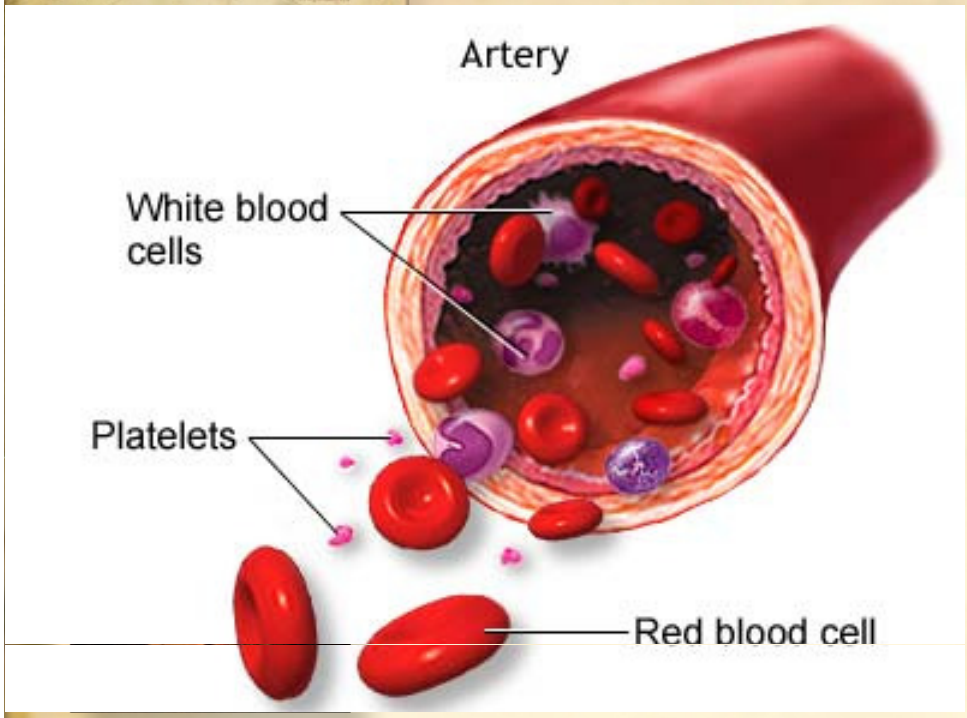


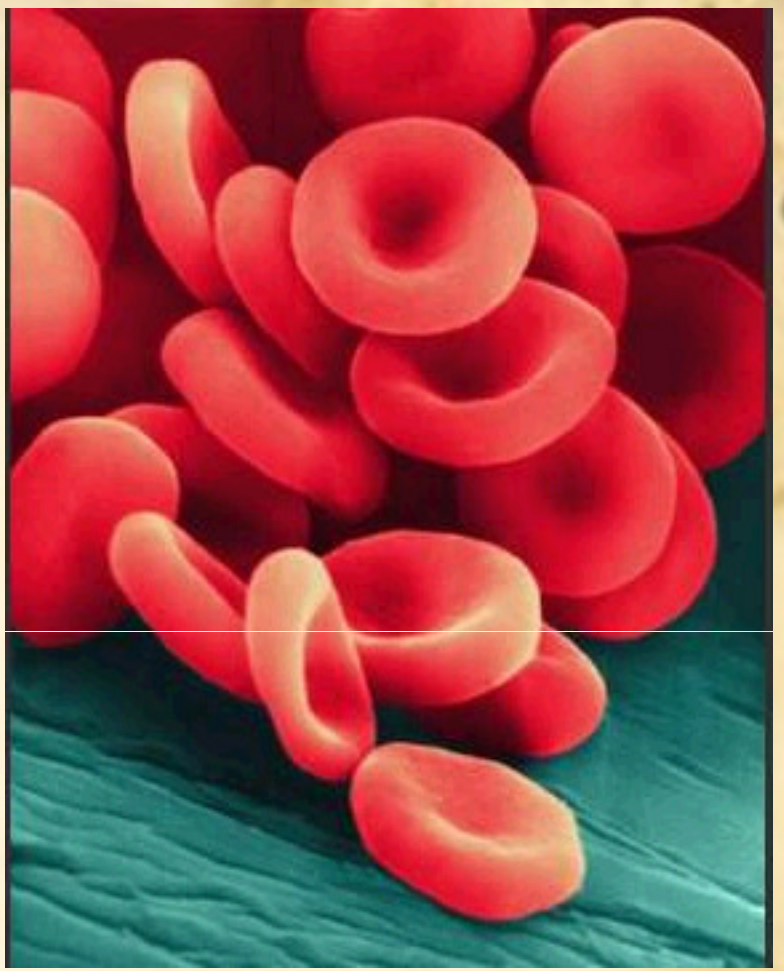
Figure 2.20 Different cells have different shapes and functions.

How do their shapes relate to their functions?

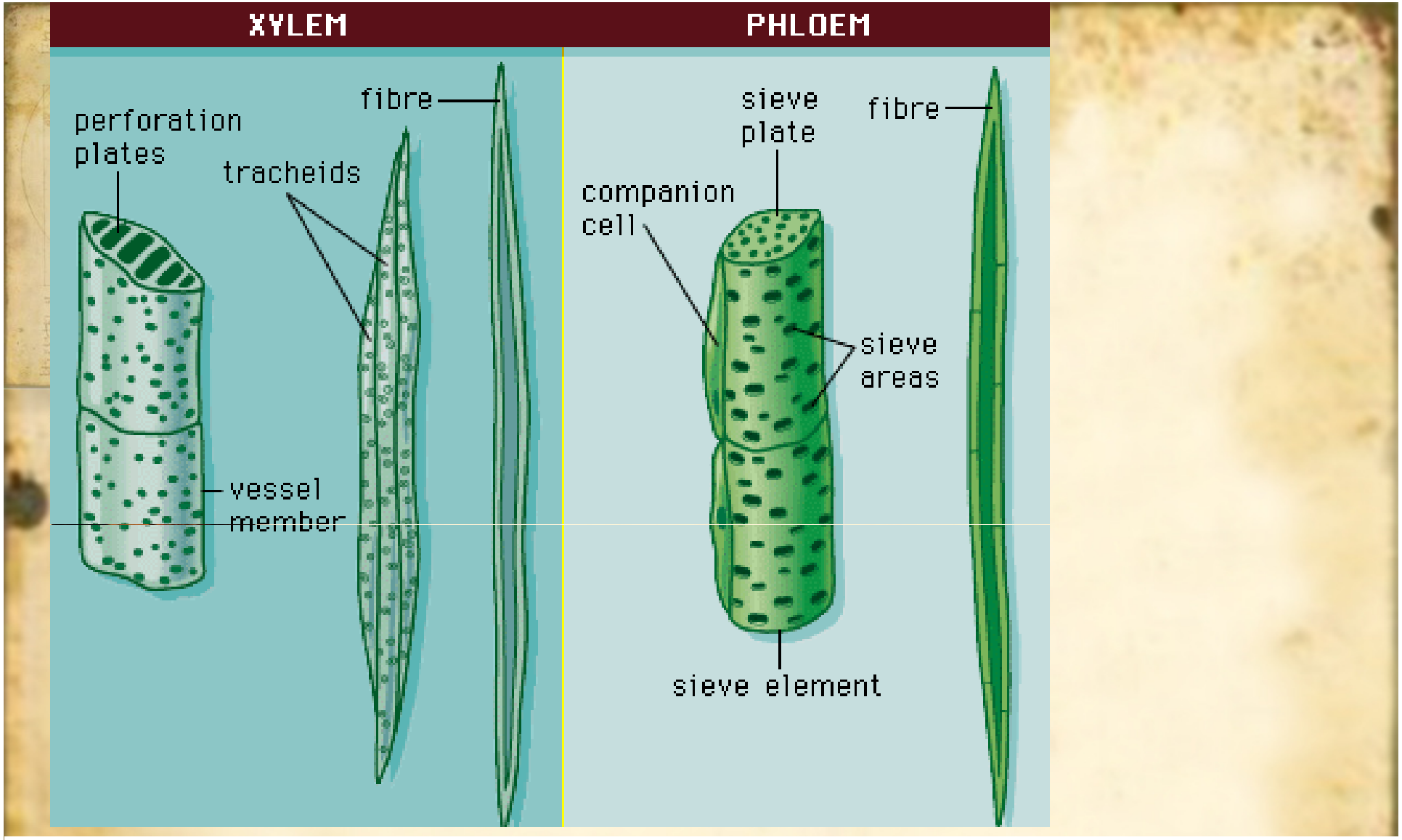


Nerve cells have long, branched fibres running from the main part of the cell, shaped to carry nerve signals from one part of the **body to another.**

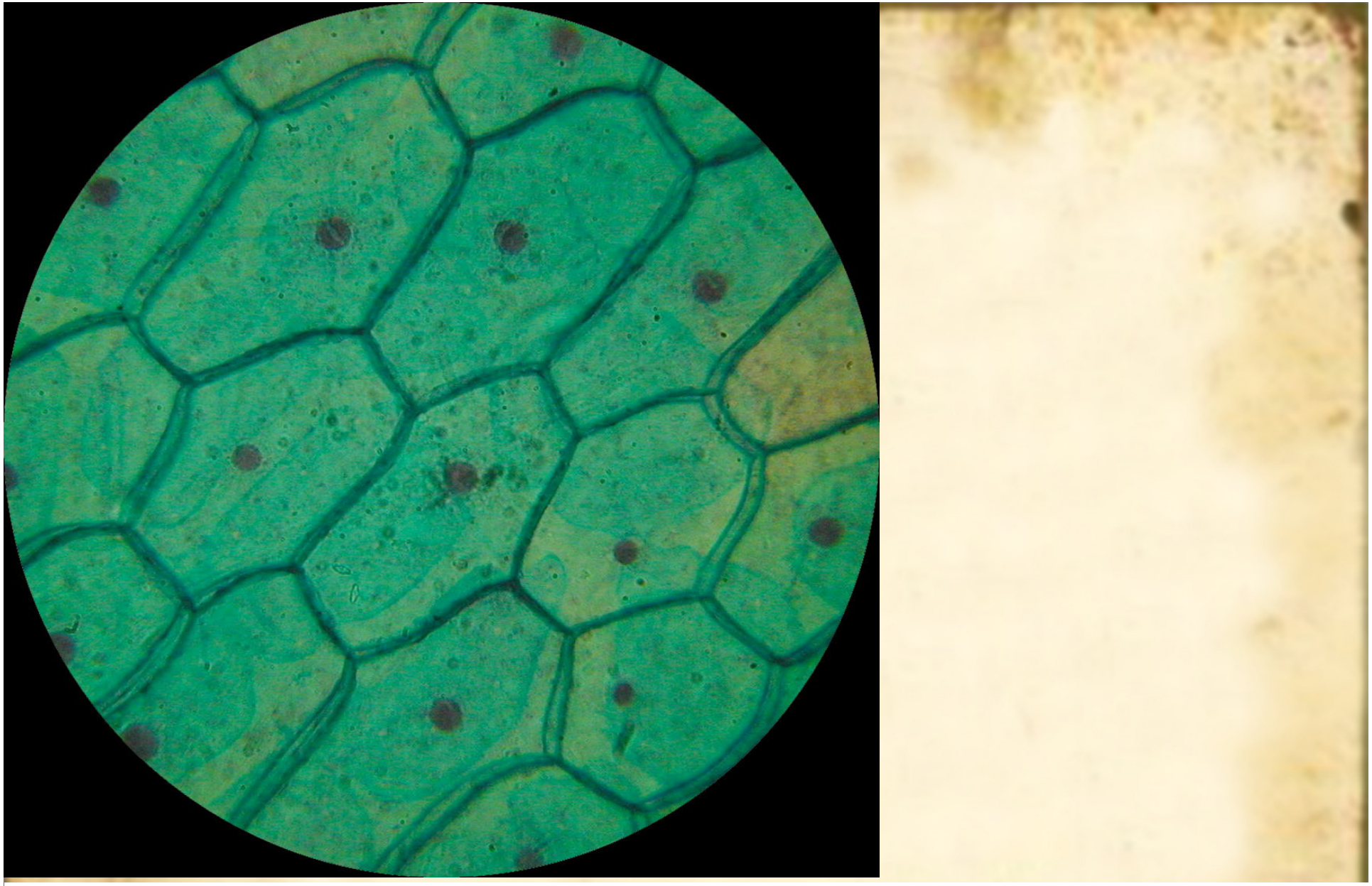




Red blood cells, which carry oxygen in the bloodstream, have a thin, **dislike shape.** This gives them a large surface area to pick up large **amounts of oxygen**.



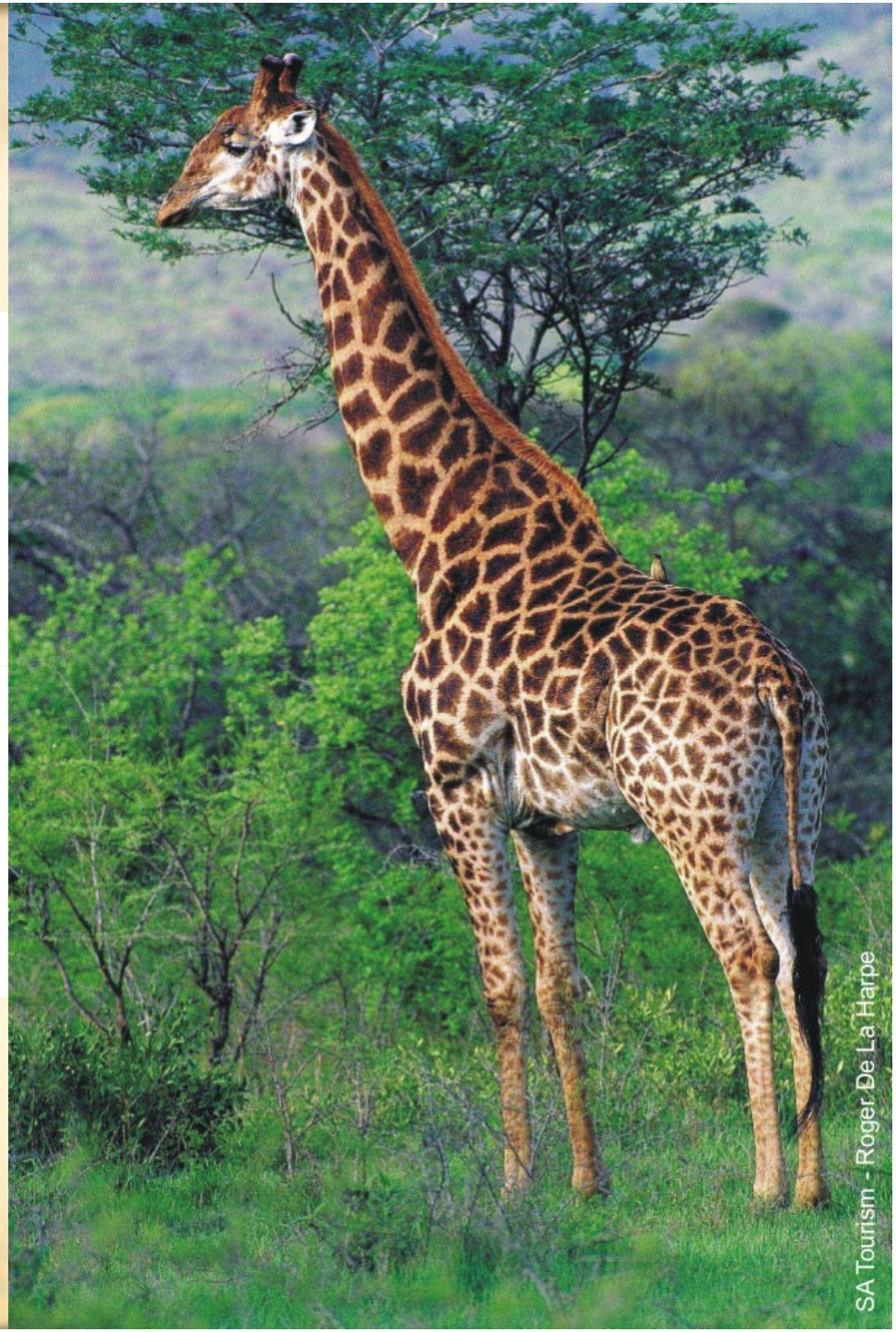
The water-conducting cells of a plant are tube-like, with thick walls and a network of holes that lets water pass easily **through them.**



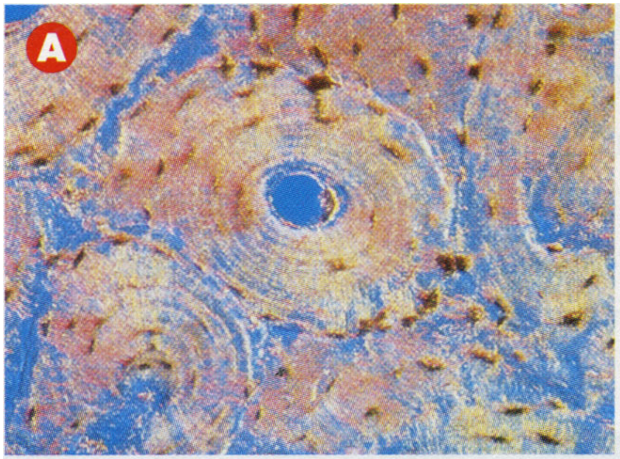
Onion skin cells are flat and brick-shaped, so they can fit closely together to form a continuous **protective layer.**

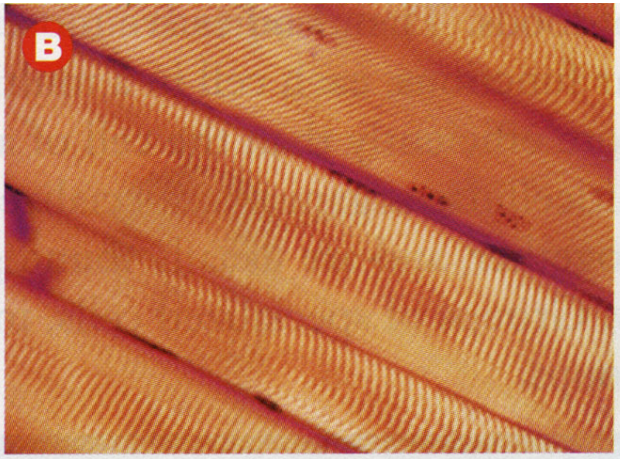
Off the Wall

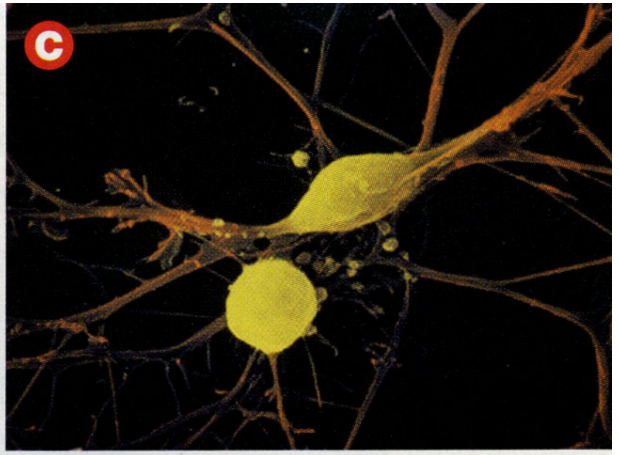
A nerve fibre in the neck of a giraffe can be up to 1 m in length.
However, the main part of the cell from which it comes is about the same size as **a human nerve cell.**

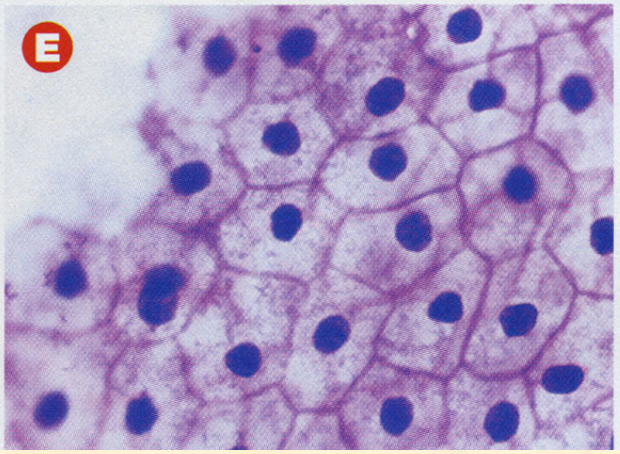


Type of Cell	Shape (Structure)	Function
Muscle	Elongated and tapered on **either end**	Move parts of **the body**
Skin	Flat and thin, brick-shaped **or honeycomb**	Cells close together to form a continuous **protective layer**
Nerve	Long branched fibres running from **the main part of the cell**	To carry nerve signals from one part of the **body to another**
Blood	Thin, **disc-like**	**Large surface area to collect oxygen**
Bone	Thick, **mineral matrix**	To provide **support**





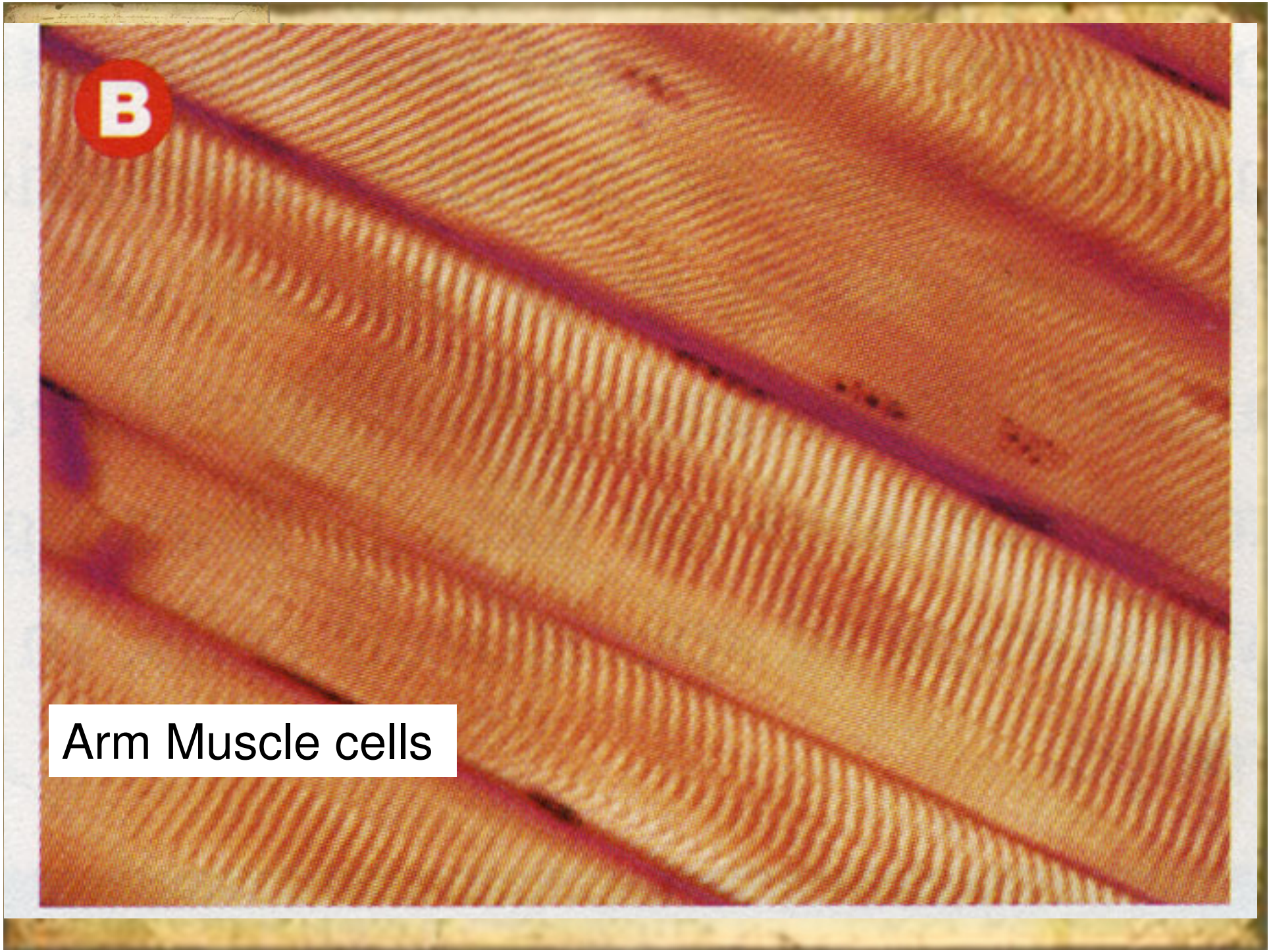


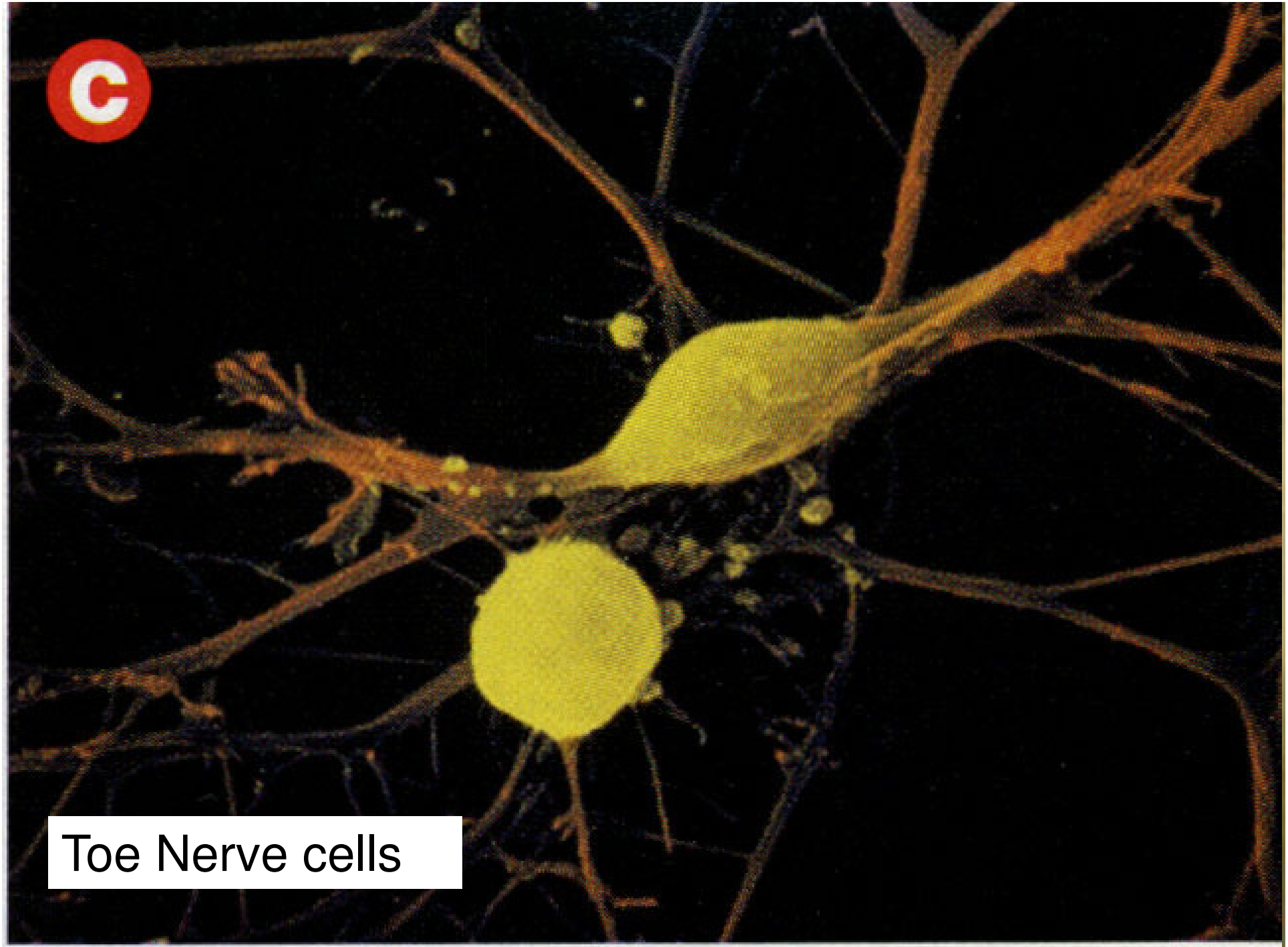


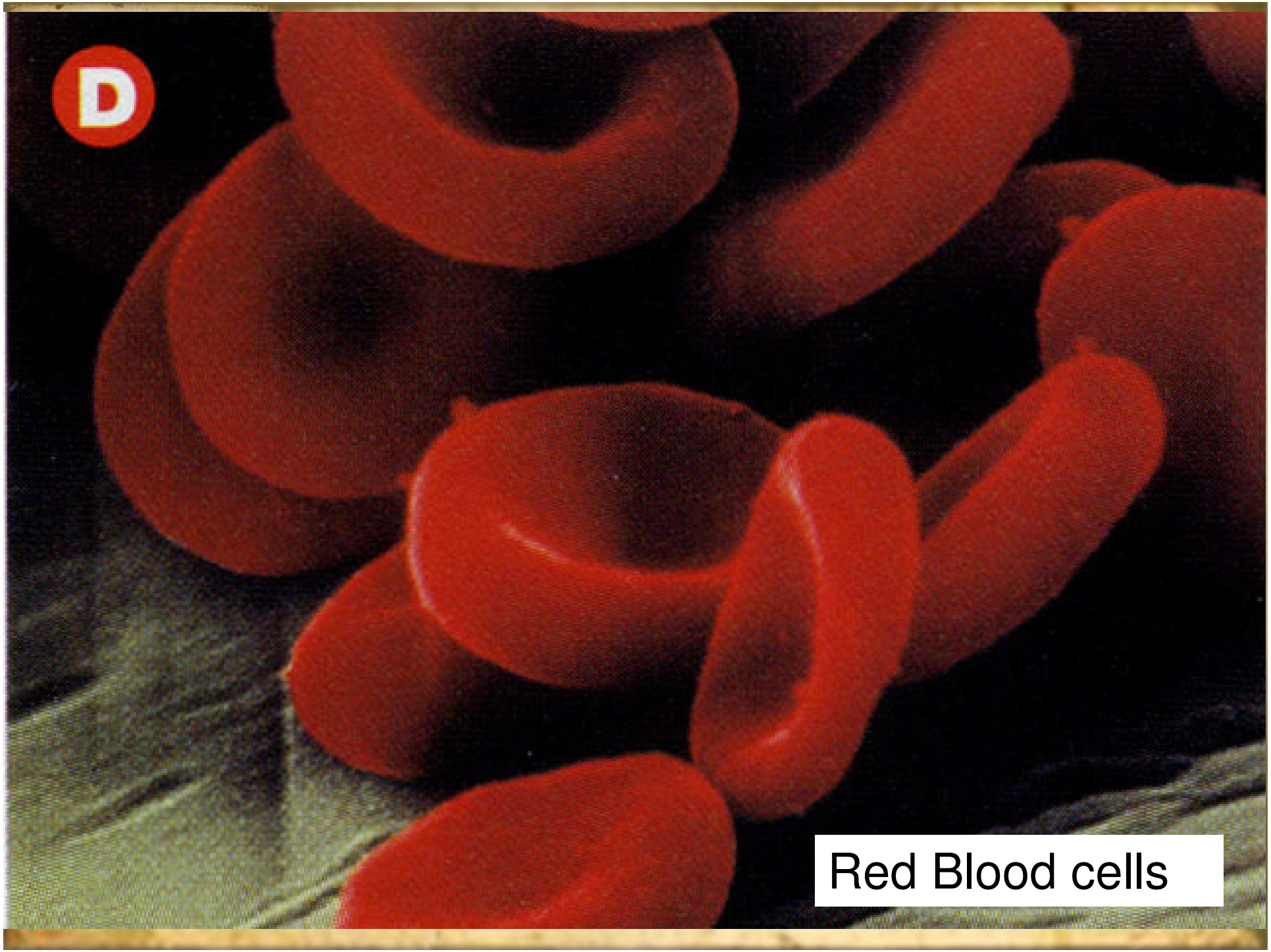
Look at the structures of these cells and think about the function – Can you identify them?

Leg Bone cells

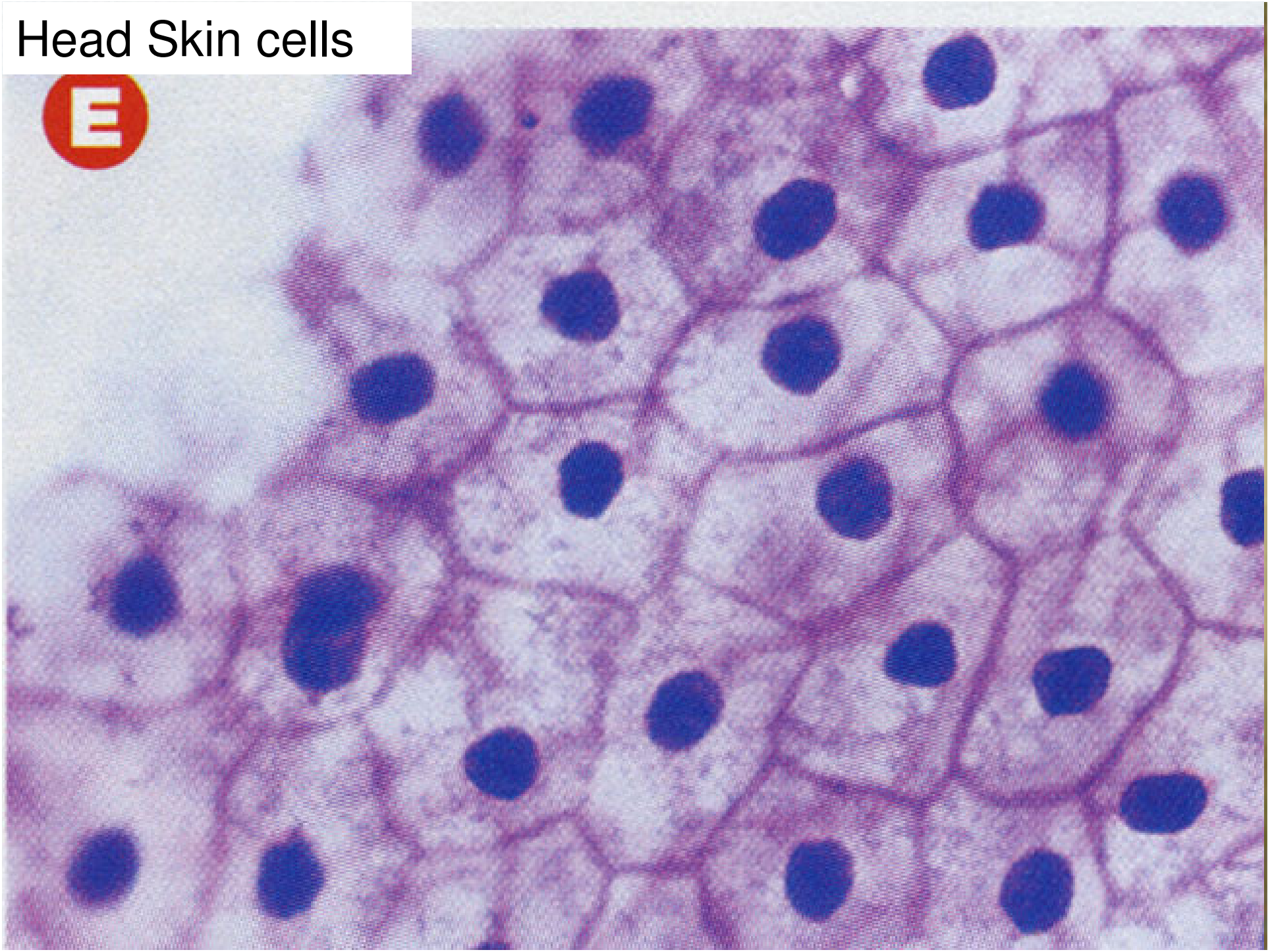
- cells secrete a hard mineral when they are alive


B
Arm Muscle cells


C
Toe Nerve cells


D
Red Blood cells

Head Skin cells



DidYouKnow?

Most household dust is made up of dead **human skin cells.**

You and everyone around you are continually shedding parts of the thin **outer layer of skin.**

Your entire outer layer of skin is completely replaced by the growth of new cells approximately **every 28 days.**

The Advantages of Being Multicellular

Imagine you are a microscopic, unicellular organism. Your whole body is **one cell.**

This one cell must carry out all the functions needed to **keep you alive.** It must be able to move, obtain food, reproduce, and respond **to the environment**. There are many living organisms that consist of only one cell.

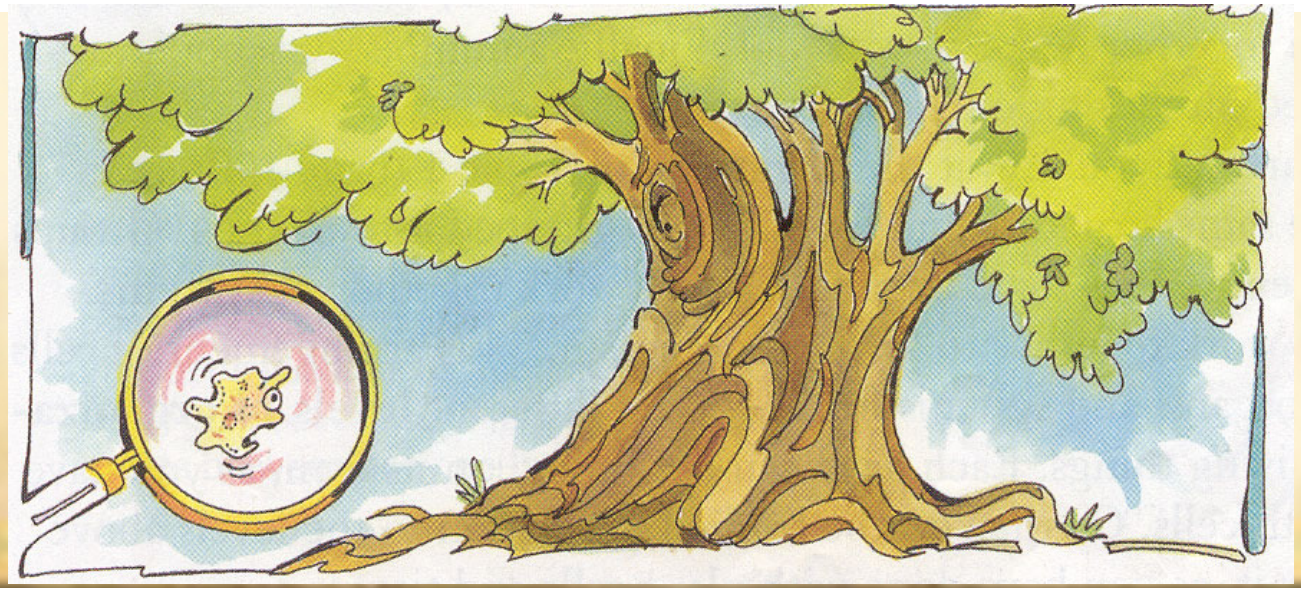
What disadvantages do you think they have, compared with multicellular organisms?

Unicellular organisms cannot **grow very large**.
Also, because they must take in all the materials they need through their cell membranes, most unicellular organisms can only live in watery, **food-rich surroundings.**

The Advantages of Being Multi-cellular

Multi-cellular organisms can:

- live in a wide **variety of environments**
- grow **very large**
- obtain their energy from a **wide variety of foods**
- have **complex bodies**
- specialize functions and work in **harmony with other cells**



Cell Organization

Multicellular organisms have several advantages compared to **unicellular living things**. They can live in a wide **variety of environments.** They are able to grow very large - as large as **a whale or a Douglas fir**. Multicellular animals can obtain their energy from a wide **variety of foods.** Their bodies are **more complex.** By specializing in particular functions, each cell in a multicellular organism can work much more efficiently than the cell of **a unicellular organism.**

In multicellular organisms, specialized cells of a similar kind work closely together, and are usually found grouped closely together in the body. Groups of specialized cells, in turn, work in harmony **with other groups.**

- **Cells** with the same structure and **function form tissue**
- **Tissues** form **organs**
- **Organs** work together in **organ systems**
- **Systems** work together to **form an organism**

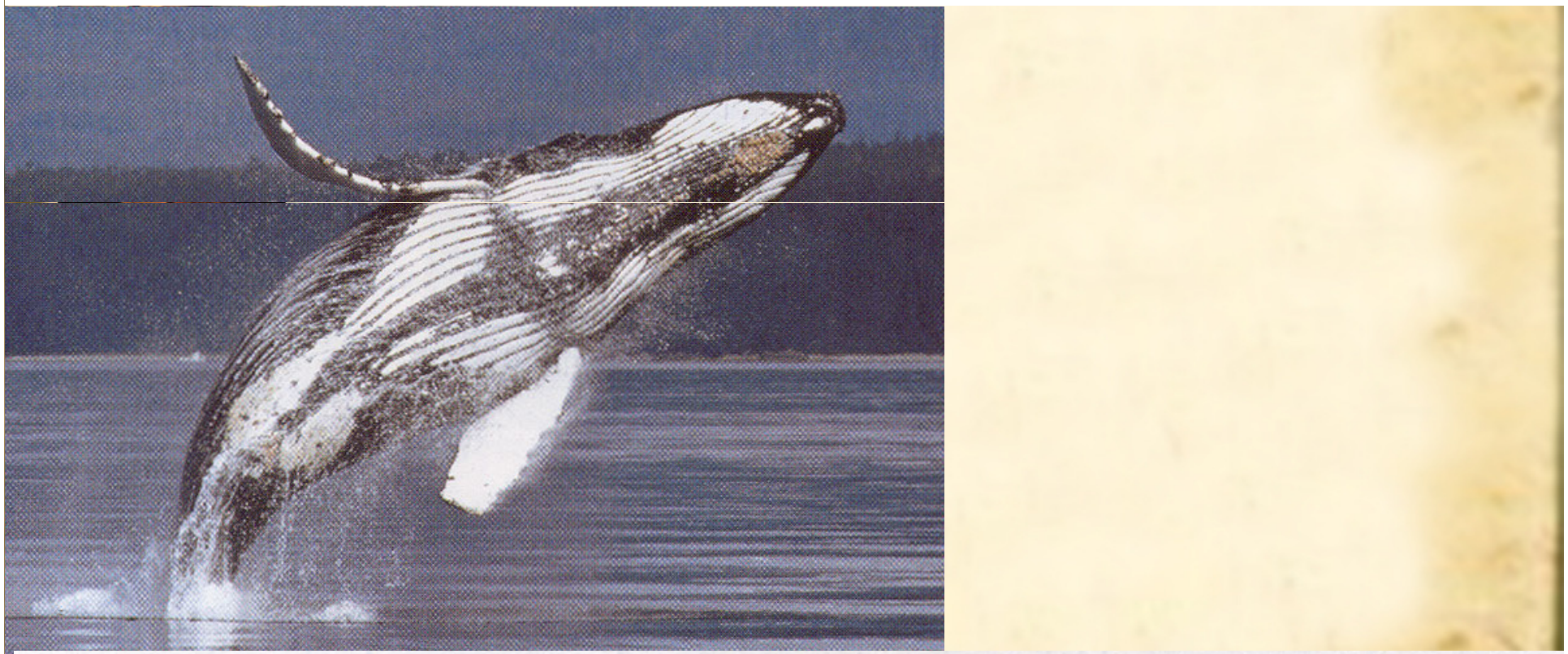


Figure 2.21 The body of this whale contains trillions of cells that are grouped into tissues, organs, and systems.

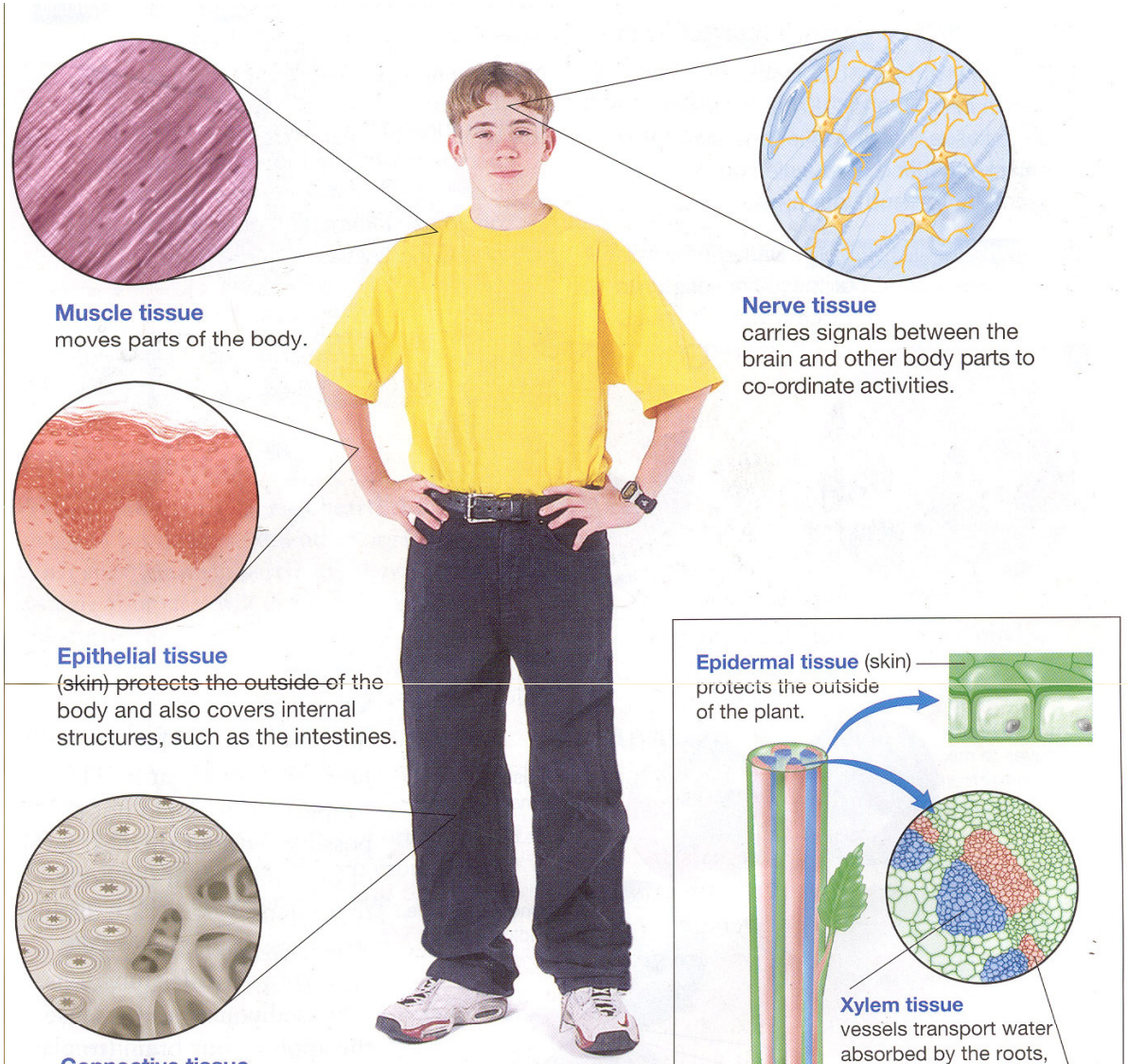
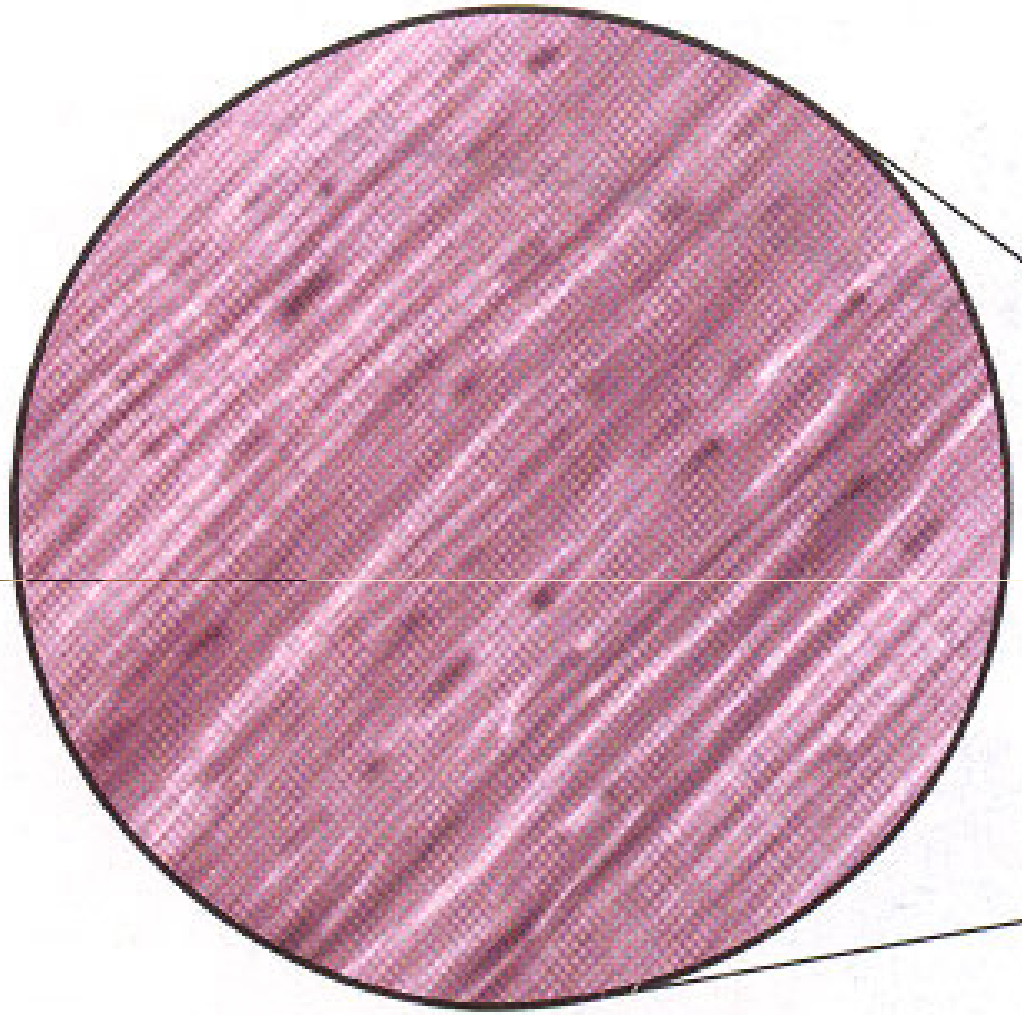


Figure 2.22 Main types of tissues found in animals

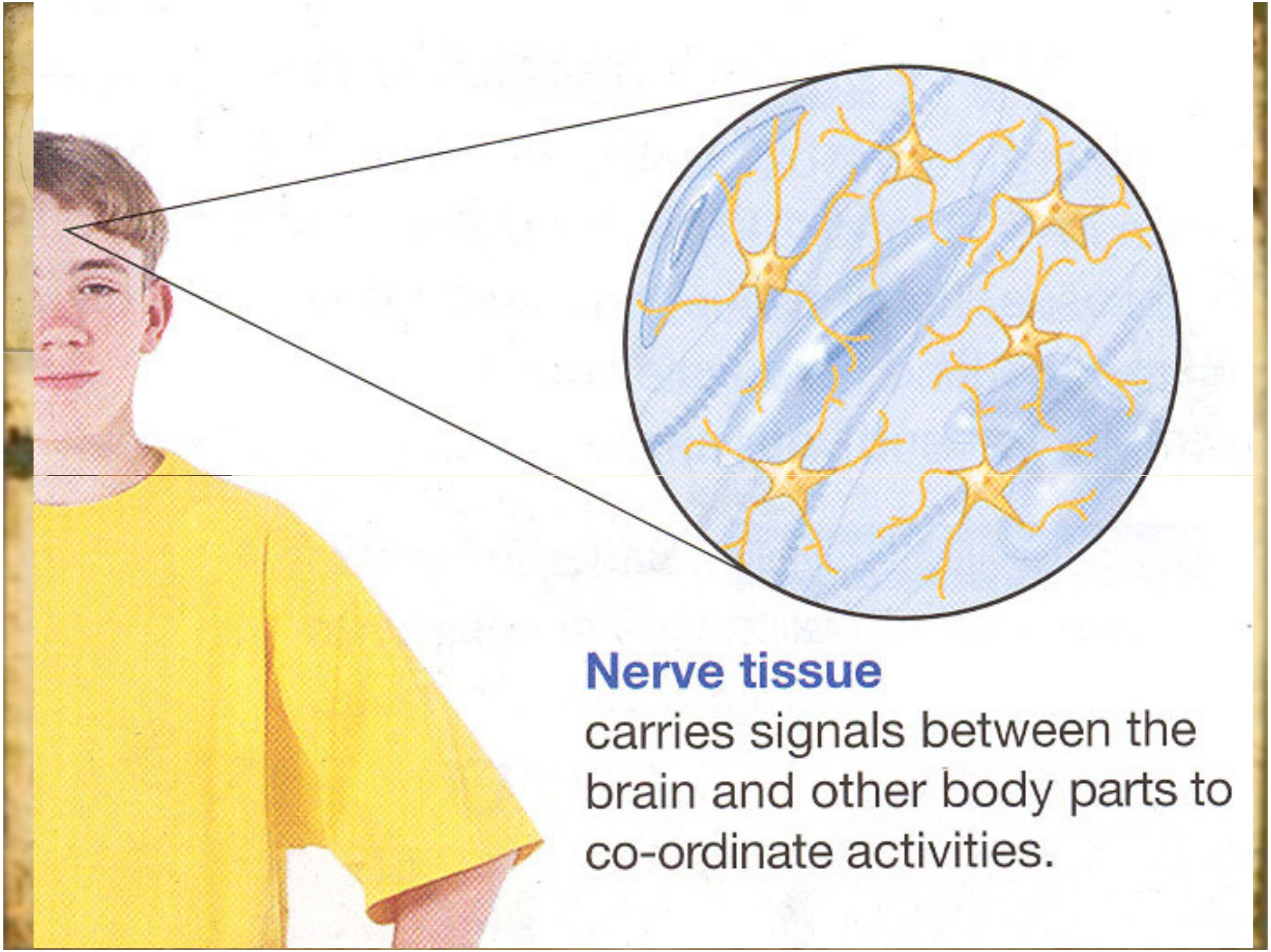
Figure 2.23 Main types of tissues found in plants

Tissues

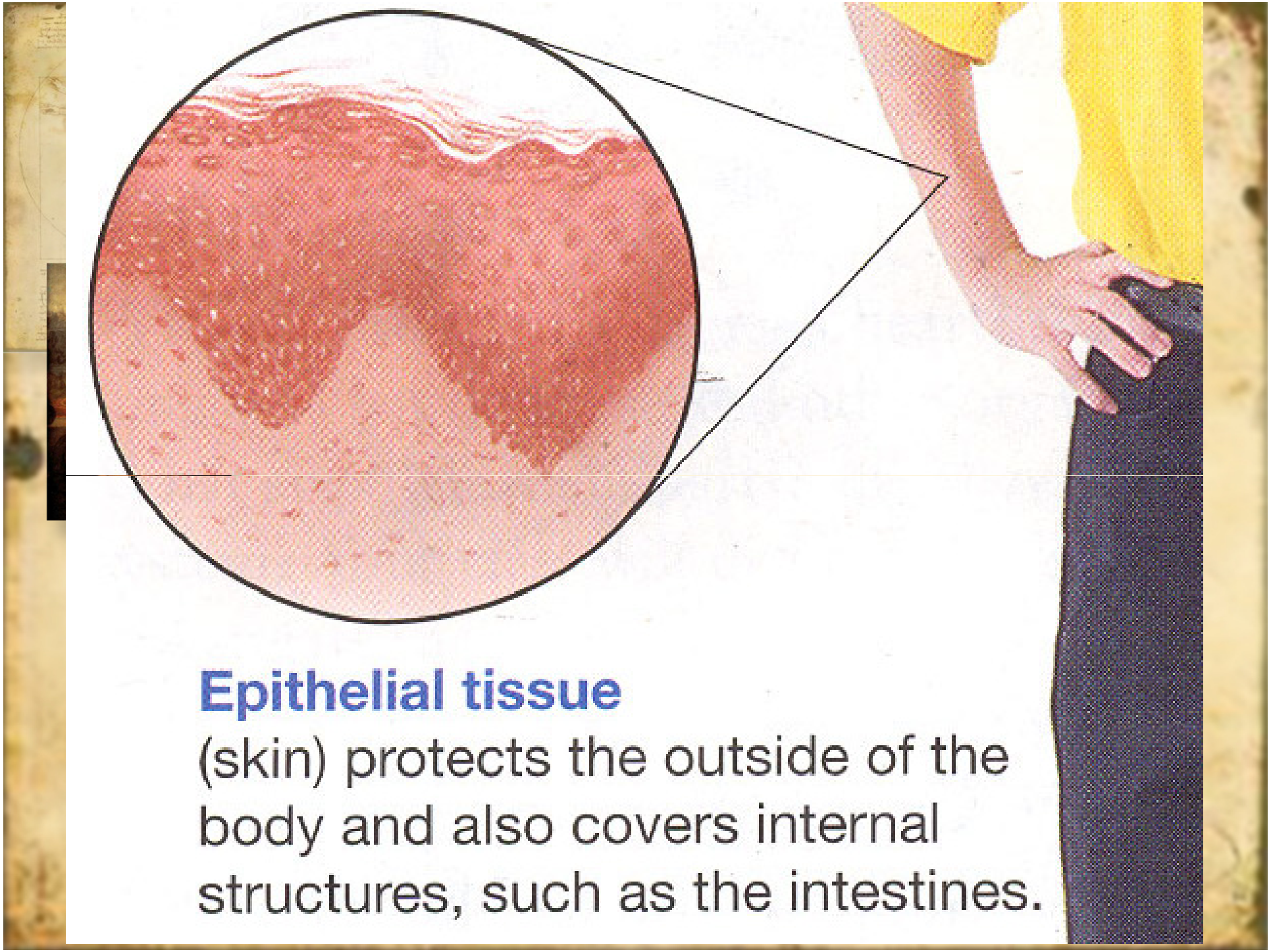
Tissues are groups of similar cells that work together, having **similar structure and function.**



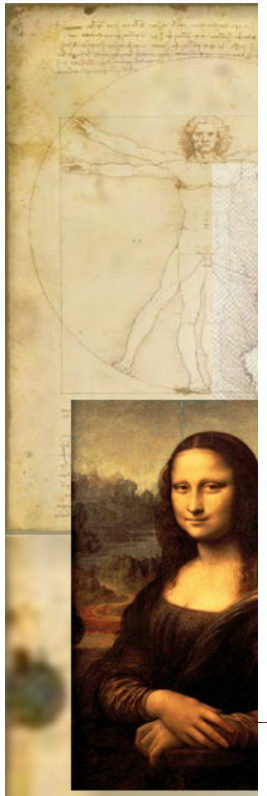
Muscle tissue
moves parts of the body.

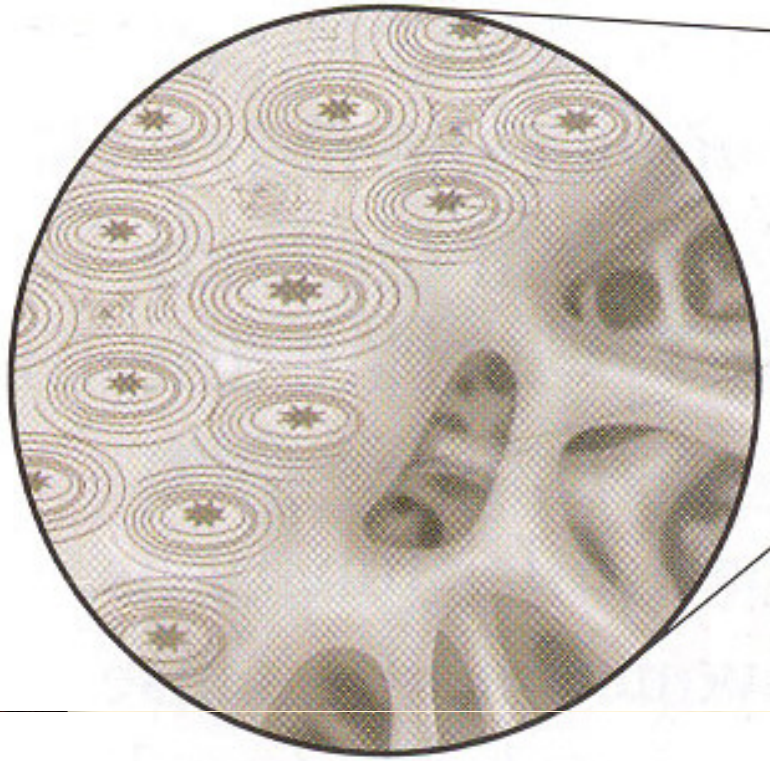


Nerve tissue
carries signals between the brain and other body parts to co-ordinate activities.



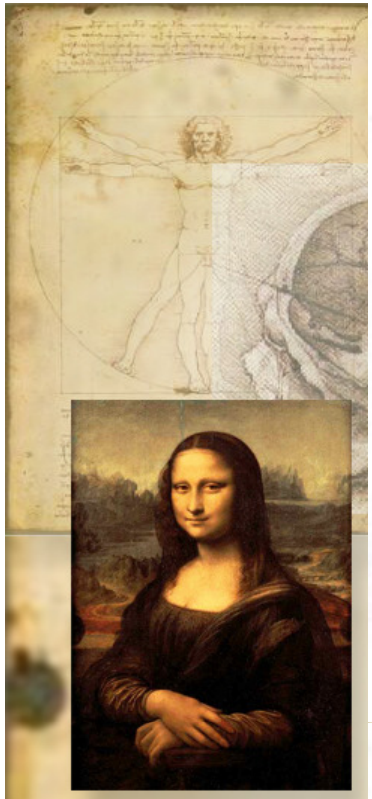
Epithelial tissue
(skin) protects the outside of the body and also covers internal structures, such as the intestines.



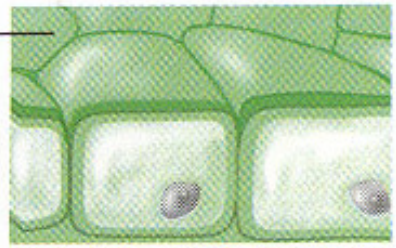


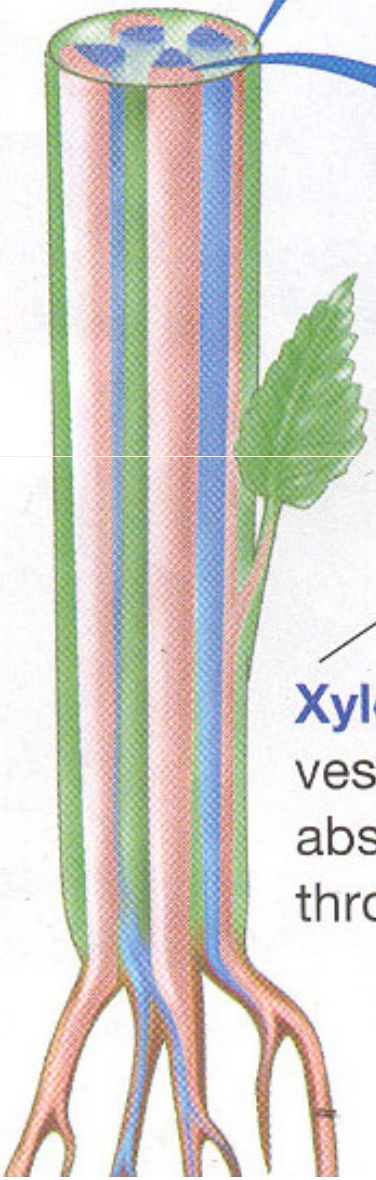
Connective tissue

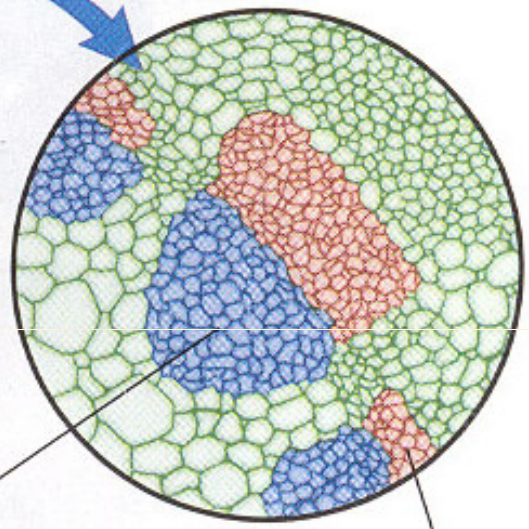
(bone) connects and supports different parts of the body. May be solid, like this bone tissue, or fluid like blood. Blood transports substances throughout the body. Other connective tissue forms loose, fibrous sheets between body parts.



Epidermal tissue (skin) protects the outside of the plant.







Xylem tissue
vessels transport water absorbed by the roots, throughout the plant.

Phloem tissue
vessels transport the glucose — sugar —

Organs

Each organ is made up of **several tissues all working together.**

They are distinct structures in the body **that perform particular functions.**

(Plants have organs as well – **roots, stem and leaves**)

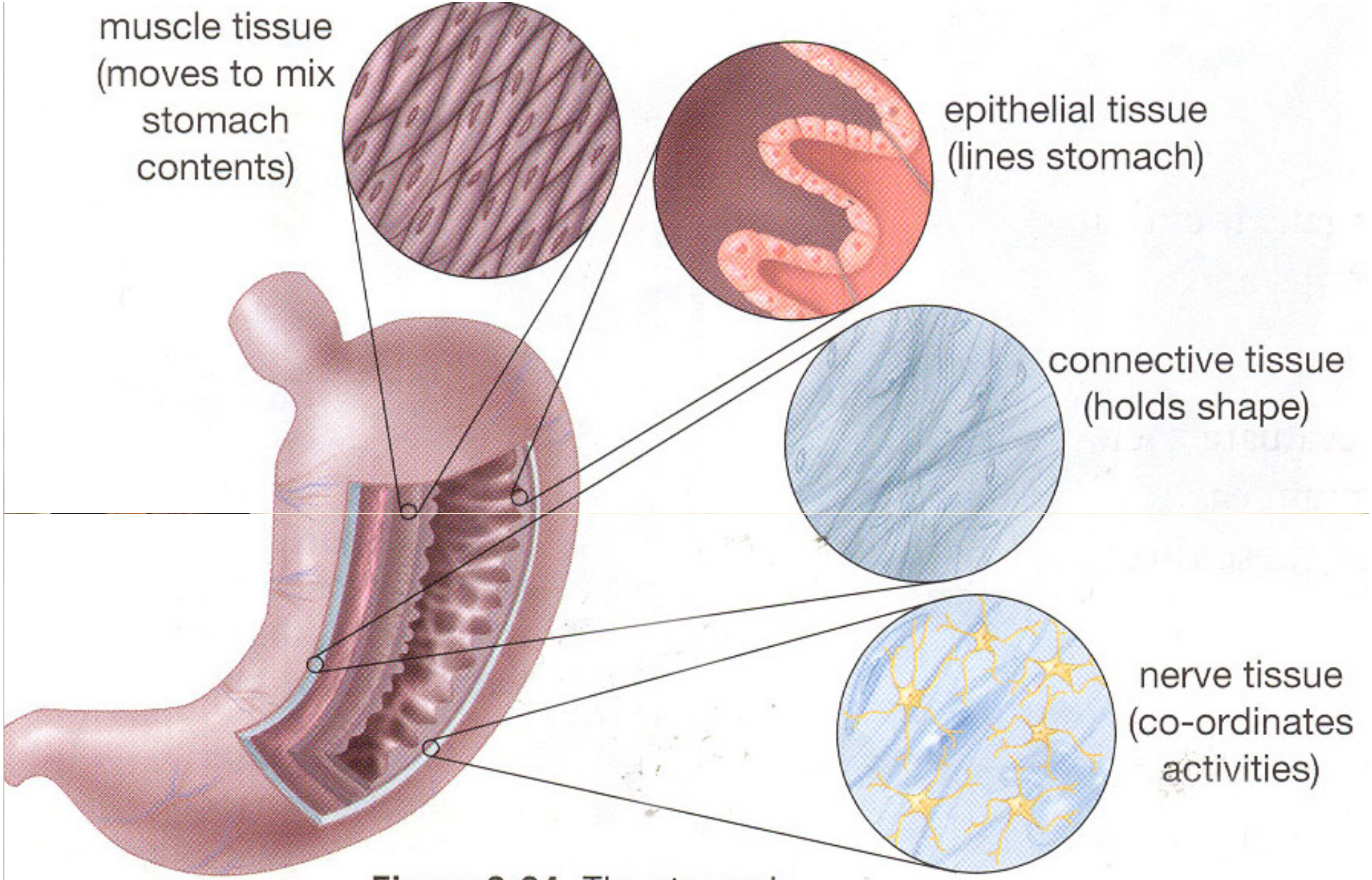


Figure 2.24 The stomach is an organ made of different tissues.

Systems

Organs work together to perform activities that help the **organism function as a whole.**

Plants typically have two systems

Root system below the ground

Function – to obtain **water and minerals**

Shoot system (stems and leaves) above the ground

Function – **to make food for the plant.**

At certain times there is a third system.

Reproductive system (flowers, fruits and seeds) is often produced at certain times as well.

Function – **to produce new plants**

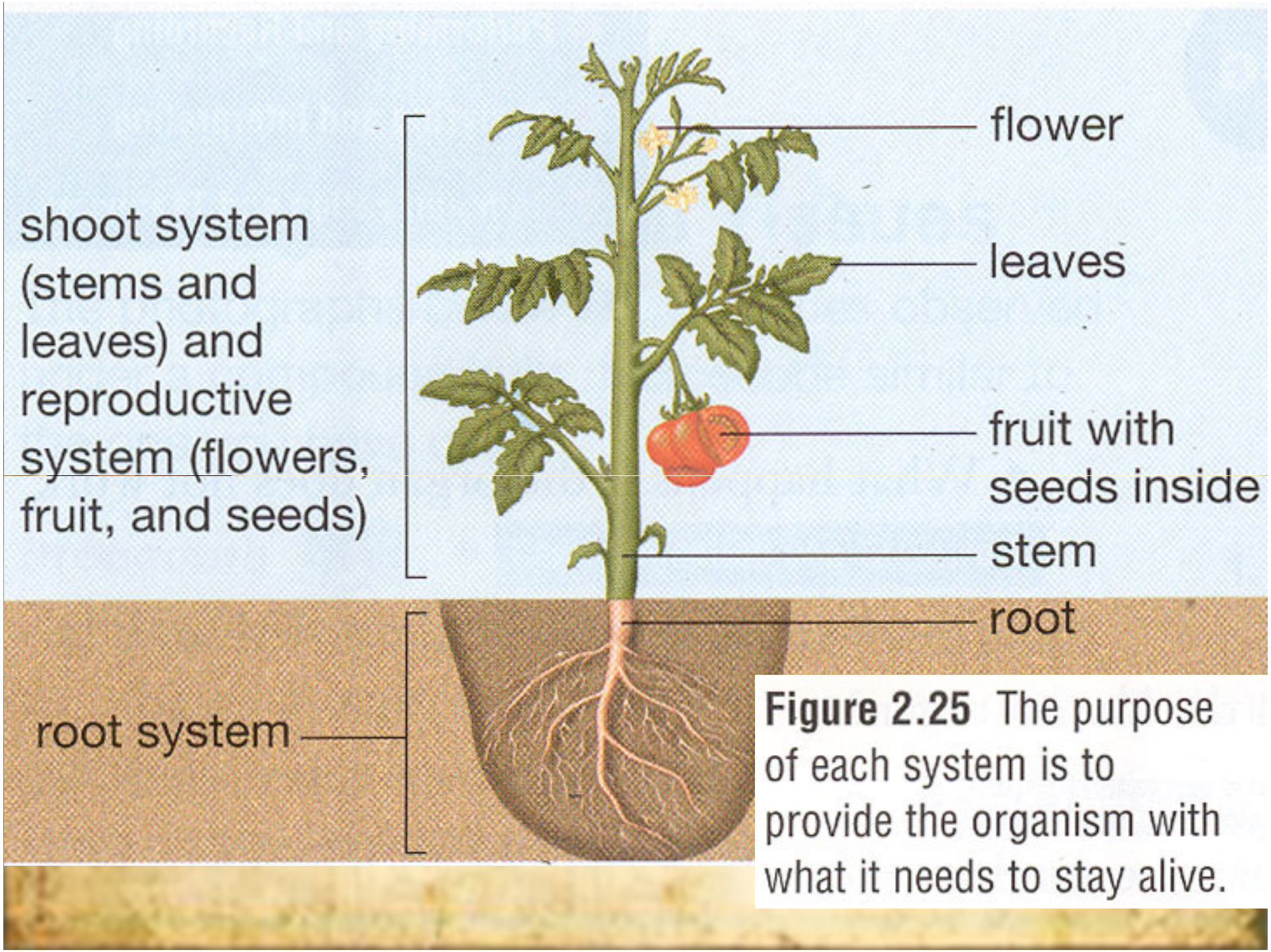


Figure 2.25 The purpose of each system is to provide the organism with what it needs to stay alive.

TOPIC 5 Review

1. Why do cells in your body need to be specialized?

By specializing in particular functions, each cell in a multicellular organism can work much more efficiently than the cell of **a unicellular organism.**

2. Why do nerve cells have long fibres, whereas red blood cells are thin and dislike?

Their structures are related to their function. Nerve cells pass on signals from one cell to another while red blood cells transport oxygen.

3. Why do unicellular organisms live mainly in a watery environment?

They need to be able to access food easily.

4. Choose the correct answer.

(a) A tissue is made from groups of
(i) organs, (ii) cells, (iii) organelles. **(ii) cells**

(b) Muscle is an example of
(i) a system, (ii) an organ, (iii) a tissue. **(iii) a tissue**

(c) The heart is an example of
(i) an organ, (ii) a system, (iii) epithelial tissue. **(i) an organ**

(d) One example of connective tissue is **(ii) Bone tissue**
(i) nerve tissue, (ii) bone tissue, (iii) epithelial tissue.

(e) An example of a system in plants is **(ii) The shoot system**
(i) seeds, (ii) the shoot system, (iii) xylem.

(f) The type of tissue that protects the outside of a plant is called
(i) epithelial tissue, **(ii) Epidermal tissue** connective tissue.

5. Apply Most people think of the skin as just a body covering. How do you think skin cells are important to other body cells?

It acts as a channel of communication with the outside world
protects the body from water loss
protects the body from ultraviolet radiation
and helps regulate body temperature and metabolism.

Wrap-up TOPICS 4-5

Key Terms

selectively permeable

Only allows certain substance to pass through the membrane.

permeable

Allows all substance to pass through the membrane.

impermeable

Allows no substance to pass through the membrane.

diffusion

Movement of particles from an area of high concentration to an area of low concentration.

osmosis

Diffusion of water through a selectively permeable membrane

vascular tissues

Tubular vessels that transport fluids

phloem tissue

Vessels that transport glucose to other parts of the plant

xylem tissue

Vessels that transport water to other parts of the plant

root hairs

Selectively permeable membranes that allow water and minerals into the plant

transpiration

The loss of water from a plant through evaporation

specialized tissues

Tissue that perform a specialized function like muscle tissue

organs

Distinct structures that perform particular functions – like your heart

systems

Organs working together that help plants and animals function as a whole

levels of organization

Cells, tissues, organs, and systems form levels of organization

Reviewing Key Terms

1. Complete each sentence with the correct ending from column B.

- A cell membrane is selectively permeable
- Water enters or leaves cells by osmosis
- Oxygen enters or leaves cells by diffusion
- Water evaporates from a plant by transpiration

Column B

- osmosis (4)
- diffusion (4)
- transpiration (4)
- selectively permeable (4)
- permeable (4)

2. Draw a flowchart illustrating the following terms in the correct order: organs, cells, tissues, organism, systems. (5)

Cells ➔ tissues ➔ organs ➔ systems ➔ organism

Understanding Key Concepts

3. Compare cell membranes with the screen doors used on houses in summer. Explain why neither can be completely impermeable or permeable. (4)

Cell membranes like screen doors keep some thing out and let other things in. No insects can make it in but cool air can pass through.

4. How are osmosis and diffusion different? (4)

Osmosis is the diffusion of water through a selectively permeable membrane. Diffusion is the movement of particles from an area of high concentration to an area of low concentration.

5. If a cell is placed in a concentrated solution of glucose, would you expect water to move into or out of the cell? Explain. (4)

Move out – Water will move from an area of high concentration to an area of low concentration.

6. Explain why cells need (a) water, and (b) food. (4)

Water - transport and make solutions
Food - energy

7. Why might a plant with a huge stem system and a tiny root system have difficulty surviving? (4)

Would not be able to get enough water.

8. Why are cells specialized in multicellular organisms? (5)

By specializing in particular functions, each cell in a multicellular organism can work much more efficiently than the cell of **a unicellular organism.**

9. Name the main types of specialized cells in animals. (5)

Nerve – Muscle – Bone - Skin - blood

10. Explain how the structure of a specialized cell is related to its function in the body of a multicellular organism. (5)

The structure is directly related to the function. Muscle cells have a structure that allows them to contract and move body parts. Nerve cells have structure that allows them to send signals. Blood cells have structure that allows them to carry oxygen.

11. List some advantages that multicellular organisms have over some unicellular organisms. (5)

Multi-cellular organisms can:

- live in a wide **variety of environments**
- grow **very large**
- obtain their energy from a **wide variety of foods**
- have **complex bodies**
- specialize functions and work in **harmony with other cells**

12. Name the five levels of organization in a multicellular organism and give an example of each. (5)

Cells – muscle cells **tissue** – muscle tissue **organs** – heart
Systems – cardiovascular **organism -** humans

13. Give two examples of systems in plants and explain their functions. (5)

Root systems – transport water
Shoot system – make food

14. Study the two photographs of red blood cells. One cell was part of a group of cells placed in distilled water, while the other was placed in a strong salt solution. Make an inference about which one was in which solution, giving your reasons for your inference. (4)

Cell B was placed in a strong salt solution. It has experienced water loss due to diffusion