**Chapter: 2: Organisation of the organism**
**Book/PDF:** Chapter-2pdf.pdf
**Pages:** 1-40
**Exam level:** Cambridge IGCSE (0610)

# 1) Big-picture overview (100–150 words)

This chapter introduces the fundamental concept that all living things are made of cells. It begins by exploring the microscopic world, detailing the structures (organelles) inside animal, plant, and bacterial cells and explaining the specific job each part does. You'll learn the key differences between these cell types, such as the cell wall and chloroplasts found in plants. The chapter then zooms out to show how cells don't work in isolation. It explains the hierarchy of organisation: similar cells group to form tissues, different tissues combine to make organs, organs work together in organ systems, and all these systems make up a complete organism. Finally, it covers the practical skills of using a light microscope and performing essential calculations to determine the magnification and actual size of the specimens you observe.

# 2) Syllabus mapping

Syllabus outcome codes are not provided in the chapter. The learning outcomes are based on the "Focus Point" questions.

| Outcome description | Where covered (page) |
|---|---|
| Describe and compare the structure of animal, plant, and bacterial cells. | 5-14 |
| State the functions of the main organelles and cell structures. | 6-10, 13-14, Table 2.1 (p. 10), Table 2.2 (p. 15) |
| Identify cell structures in diagrams and images. | 6, 8, 11, 12, 13 |
| State the differences between plant and animal cells. | 8, 10, Table 2.1 (p. 10) |
| Understand how new cells are produced by cell division. | 7, 14 |

| Outcome description | Where covered (page) |
|---|---|
| Relate the structure to the function of specialised cells (ciliated, root hair, palisade, neurones, red blood, sperm, egg). | 21-25 |
| Define cell, tissue, organ, organ system, and organism. | 2, 26, 29, 31 |
| Calculate magnification and the actual size of biological specimens. | 32-35 |

## 3) Key terms and definitions

| Term | One-sentence definition | First appears (page) | Example/application |
|---|---|---|---|
| **Cell** | The basic structural and functional unit of all known organisms. | 2 | A liver cell, a palisade cell. |
| **Tissue** | A group of cells with similar structures, working together to perform a shared function. | 26 | Muscle tissue contracts to cause movement (p. 26, 28). |
| **Organ** | A structure made up of a group of tissues, working together to perform a specific function. | 29 | The stomach is an organ that digests food (p. 29). |
| **Organ system** | A group of organs with related functions, working together to perform a body function. | 29 | The digestive system breaks down and absorbs food (p. 29, 31). |
| **Organism** | A living thing made up of organ systems working together. | 31 | A human, a flowering plant. |
| **Cytoplasm** | The jelly-like substance enclosed by the cell membrane, where chemical reactions occur and organelles are found. | 5 | Site of protein synthesis and respiration (p. 6). |

| Term | One-sentence definition | First appears (page) | Example/application |
|---|---|---|---|
| **Nucleus** | A large organelle containing the genetic material (chromosomes) which controls the cell's activities. | 5 | Controls cell division and what type of cell it becomes (p. 7). |
| **Cell membrane** | A partially permeable layer forming a boundary around the cytoplasm that controls substances entering and leaving the cell. | 5 | Allows oxygen to enter and waste to leave (p. 7). |
| **Cell wall** | A tough, non-living layer made of cellulose (in plants) that surrounds the cell membrane and provides structural support. | 8 | Prevents plant cells from bursting when they take in water (p. 10). |
| **Mitochondria** | Organelles responsible for releasing energy from food through aerobic respiration. | 11 | Found in high numbers in active cells like sperm and muscle cells (p. 11, 25). |
| **Chloroplasts** | Organelles found in some plant cells that contain chlorophyll and are the site of photosynthesis. | 8 | Packed into palisade mesophyll cells to absorb light energy (p. 9, 23). |
| **Vacuole** | A fluid-filled space in a plant cell containing cell sap, which helps keep the cell firm. | 8 | The large central vacuole pushes cytoplasm against the cell wall (p. 9). |
| **Ribosomes** | Tiny organelles, found free in the cytoplasm or on membranes, that are responsible for protein synthesis. | 10 | Build proteins needed for cell structures and enzymes (p. 10). |

| Term | One-sentence definition | First appears (page) | Example/application |
|---|---|---|---|
| **Magnification** | The ratio of an image's size to the actual size of the object. | 33 | Magnification = image size / actual size (p. 33). |

# 4) Core concepts explained

## Cell Structure (p. 2-14)

- All living organisms are made of fundamental units called **cells** (p. 2).
- Cells are studied using microscopes, often by observing thin slices called **sections**. A slice along the length is a **longitudinal section**, and a slice across is a **transverse section** (p. 3).
- All cells contain **cytoplasm**, a **cell membrane**, and most have a **nucleus**. Many cellular processes occur in the cytoplasm, which also contains specialised structures called **organelles** (p. 5-6).
- **Mitochondria** are organelles where aerobic respiration occurs to release energy (p. 11). **Ribosomes** are responsible for making proteins (p. 10).

**Comparison of Animal and Plant Cells (p. 5-10)**

| Feature | Animal Cell (e.g., Liver cell) | Plant Cell (e.g., Palisade cell) | Exam Note |
|---|---|---|---|
| **Cell Wall** | Absent | Present (made of cellulose) | Provides rigid support to the plant cell. Freely permeable. |
| **Cell Membrane** | Present | Present | Partially permeable; controls entry/exit of substances. |
| **Cytoplasm** | Present | Present | Site of most chemical reactions. |
| **Nucleus** | Present | Present | Controls cell activities and division. |
| **Chloroplasts** | Absent | Present (in photosynthetic parts) | Site of photosynthesis. |

| Feature | Animal Cell (e.g., Liver cell) | Plant Cell (e.g., Palisade cell) | Exam Note |
|---|---|---|---|
| **Vacuole** | Small, temporary (if present) | Large, central, permanent | Contains cell sap; helps maintain turgor pressure. |
| **Shape** | Irregular / rounded | Fixed / regular shape | The cell wall gives a fixed shape. |

**Bacterial Cell Structure (p. 13-14)**

- Bacteria are single-celled organisms, much smaller and simpler than plant or animal cells.
- They have a **cell wall**, but it is **not made of cellulose** (p. 13).
- They **do not have a true nucleus**. Instead, their genetic material is a single circular chromosome of DNA located in the cytoplasm (p. 14).
- They may also have small, circular rings of DNA called **plasmids** (p. 14).
- They lack mitochondria but have ribosomes for protein synthesis (p. 13).

## Specialisation of Cells (p. 21-25)

- Most cells in multicellular organisms become **specialised**, meaning they develop a distinct shape and structure to perform a specific function. This is known as the **division of labour** (p. 22).
- **Ciliated cells:** Line the windpipe; have tiny hairs (cilia) that move mucus away from the lungs (p. 23).
- **Root hair cells:** Have a long extension to increase surface area for absorbing water and minerals from the soil (p. 23).
- **Palisade mesophyll cells:** Packed with chloroplasts to maximise light absorption for photosynthesis (p. 23).
- **Nerve cells (neurones):** Are long to transmit electrical impulses over large distances in the body (p. 24).
- **Red blood cells:** Have no nucleus when mature to maximise space for haemoglobin, which transports oxygen (p. 24).
- **Sperm cells:** Have a tail for swimming and mitochondria for energy to reach the egg (p. 25).
- **Egg cells (ova):** Are large and contain a food store (yolk) for the developing embryo (p. 25).

### Levels of Organisation (p. 26-31)

- In complex organisms, cells are organised into a hierarchy.
- **Tissue:** A group of similar cells working together (e.g., muscle tissue) (p. 26).
- **Organ:** A structure made of different tissues working together for a specific purpose (e.g., the stomach, which contains muscle tissue, epithelial tissue, and glandular tissue) (p. 29).
- **Organ System:** A group of organs working together to perform a major function (e.g., the digestive system, including the stomach, intestines, and oesophagus) (p. 29).
- **Organism:** The complete living being, formed by all the organ systems working together (p. 31).

## 5) Diagrams and micrographs (figures)

- **Figure 2.4 A group of liver cells (p. 6)**
  - **What it shows:** A simple diagram of typical animal cells.
  - **Labels:** `cell membrane`, `cytoplasm`, `nucleus`, `mitochondria`. Functions are to control passage of substances, be the site of reactions, control the cell, and release energy, respectively.
- **Figure 2.6 Palisade cells from a leaf (p. 8)**
  - **What it shows:** A diagram of typical plant cells, showing the additional features.
  - **Labels:** `cell wall` (support), `cell membrane` (control), `cytoplasm`, `nucleus`, `chloroplast` (photosynthesis), `vacuole` (stores sap, maintains pressure).
- **Figure 2.9 Generalised diagram of a bacterium (p. 13)**
  - **What it shows:** The simple structure of a prokaryotic cell.
  - **Labels:** `cell wall` (protection, not cellulose), `cytoplasm`, `ribosome` (protein synthesis), `chromosome (circular DNA)` (genetic control), `plasmid` (extra genes), `flagellum` (movement).
- **Figure 2.16 Specialised cells (p. 23-25)**
  - **What it shows:** Diagrams of various animal and plant cells adapted for specific functions.
  - **Includes:** Ciliated cells, root hair cell, palisade mesophyll cells, nerve cell, red blood cells, sperm cell, egg cell. Each diagram highlights the key structural adaptations.
- **Figure 2.20 A light microscope (p. 33)**
  - **What it shows:** The main parts of a standard laboratory microscope.
  - **Labels:** `eyepiece lens` (look through, magnifies image), `objective lens` (magnifies specimen, different powers), `stage` (holds slide), `light source` (illuminates specimen), `focusing dial` (moves stage/lens to focus image).

# 6) Processes and cycles

### Cell Division (p. 7, 14)

This is the process by which new cells are produced from existing cells.

- **Animal Cell Division (as shown in Figure 2.5, p. 7):**
  i. An animal cell prepares to divide.
  ii. The **nucleus divides first**, ensuring each new cell gets a full copy of the genetic material.
  iii. The two new 'daughter' nuclei separate to opposite ends of the cell.
  iv. The **cytoplasm divides** by pinching inwards in the middle.
  v. Two separate, smaller cells are formed.
- **Bacterial Cell Division (as shown in Figure 2.11, p. 14):**
  i. The single circular chromosome replicates (makes a copy of itself).
  ii. The cell elongates and the cytoplasm begins to divide.
  iii. A new cell wall forms, separating the cell into two genetically identical daughter cells. This process is called binary fission.

# 7) Formulae and calculations

| Quantity | Formula | Units | Typical values | Worked example (with sig. figs.) |
|---|---|---|---|---|
| **Total Magnification (microscope)** | Eyepiece lens mag. $\times$ Objective lens mag. | None ($\times$) | Eyepiece: $\times 10$; Objective: $\times 4$, $\times 10$, $\times 40$. Total: $\times 40$ to $\times 400$. | Eyepiece = $\times 10$, Objective = $\times 40$. Total Mag. = $10 \times 40 = \times 400$ (p. 33). |
| **Magnification (of a drawing)** | $Magnification = \frac{Image\ size}{Actual\ size}$ | None ($\times$) | $\times 50$ to $\times 5000$ in exam questions. | A cell drawing is 6 cm (60 mm) wide. Its actual size is 0.1 mm. Magnification = 60 mm / 0.1 mm = $\times 600$ (p. 35). |

| Quantity | Formula | Units | Typical values | Worked example (with sig. figs.) |
|---|---|---|---|---|
| **Actual Size (from a drawing)** | $Actual\ size = \frac{Image\ size}{Magnification}$ | mm or $\mu$m | Cells are typically 10–100 $\mu$m. | An image of a cell is 2.5 cm (25 mm) wide. Magnification is $\times 500$. Actual size = 25 mm / 500 = 0.05 mm (p. 35). |

**Unit Conversions (p. 36):**

- 1 millimetre (mm) = 1000 micrometres ($\mu$m)
- To convert mm to $\mu$m, multiply by 1000.
- To convert $\mu$m to mm, divide by 1000.

# 8) Required practicals / experiments

## 1. Preparing a slide of onion epidermis cells (p. 15-16)

- **Aim:** To prepare and observe plant cells using a light microscope.
- **Apparatus:** Onion, microscope slide, coverslip, forceps, scalpel, mounted needle, iodine solution, light microscope.
- **Method:**
  i. Use forceps to peel a thin, transparent layer of epidermis from the inside of an onion leaf.
  ii. Place the tissue flat on a microscope slide.
  iii. Add a few drops of **iodine solution** (a stain to make the nucleus more visible).
  iv. Lower a coverslip carefully at an angle to avoid trapping air bubbles.
  v. Observe under the microscope, starting with the lowest power objective lens.
- **Safety:** Wear eye protection. Take care with the scalpel and with iodine, which can stain skin and clothes (p. 15).
- **Sources of error:** Trapping air bubbles which obscure the view; tissue folded over on itself.
- **Expected results:** A single layer of rectangular, closely-packed cells. The cell wall, cytoplasm, and a yellowish-brown nucleus should be visible (see Figure 2.13, p. 18).

### 2. Preparing human cheek cells (p. 19-20)

- **Aim:** To prepare and observe animal cells using a light microscope.
- **Apparatus:** Fresh cotton bud, microscope slide, coverslip, methylene blue dye, disinfectant, light microscope.
- **Method:**
    i. Gently rub a cotton bud on the inside of your cheek.
    ii. Smear the cotton bud onto the centre of a clean slide.
    iii. Add a few drops of **methylene blue dye** (a stain to make the nucleus visible).
    iv. Carefully lower a coverslip.
    v. Observe under the microscope, starting at low power.
- **Safety:** Treat all contaminated items (cotton bud, slide) with disinfectant afterwards (p. 19).
- **Sources of error:** Sample too thick; air bubbles trapped under the coverslip.
- **Expected results:** Irregularly shaped cells, scattered on the slide. A cell membrane, cytoplasm, and a dark blue nucleus should be visible in each cell (see Figure 2.15, p. 20).

## 9) Data handling and graphing

This chapter focuses on calculation rather than graphing.

- **Calculations from images:** The primary data skill is using the magnification formula. You will often be given a photomicrograph with a scale bar or a magnification value.
- **Typical exam prompts:**
    i. "Measure the diameter of the cell shown in the image." (Requires using a ruler).
    ii. "The magnification of the image is $\times 800$. Calculate the actual diameter of the cell. Show your working and give your answer in micrometres ($\mu$m)." (Requires measurement, formula rearrangement, and unit conversion).
    iii. "The scale bar represents 10 $\mu$m. Calculate the magnification of the image." (Requires measuring the image size of the scale bar and using the magnification formula).
- **Tables:** You may be asked to complete tables comparing the features of different cell types (see Exam-style questions, p. 37-38).

## 10) Common misconceptions and exam tips

- **Misconception:** Plant cells only have a cell wall.

    - **Correct understanding:** Plant cells have **both** a cell wall on the outside and a cell membrane just inside it (p. 8). The cell membrane still controls what enters and leaves the cytoplasm.
    - **Quick tip:** The wall is like a strong box (support), the membrane is like a security guard (control).
- **Misconception:** All plant cells can photosynthesise.
    - **Correct understanding:** Only plant cells with chloroplasts can photosynthesise. Cells not exposed to light, like root hair cells or onion epidermal cells, do not have chloroplasts.
    - **Quick tip:** No light = No need for chloroplasts.
- **Misconception:** Magnification has units.
    - **Correct understanding:** Magnification is a ratio (e.g., image size in mm / actual size in mm). The units cancel out, so it is written as, for example, '$\times 500$'.
    - **Quick tip:** Always convert both measurements to the *same unit* before you divide. This is the most common source of error.
- **Exam Tip:** When asked to compare two cell types (e.g., plant vs. animal), always make a direct point of comparison. Use words like "whereas" or "but". For example, "Plant cells have a cell wall, whereas animal cells do not."

# 11) Exam-style practice

#### Multiple Choice Questions (MCQs)

1. Which structure controls the passage of substances into and out of the cell cytoplasm?
   A. Nucleus
   B. Cell wall
   C. Cell membrane
   D. Vacuole
   ***Answer: C.*** *The cell membrane is partially permeable (p. 7).*
2. A student observes a cell with a microscope. The eyepiece lens is $\times 10$ and the objective lens is $\times 40$. What is the total magnification?
   A. $\times 4$
   B. $\times 50$
   C. $\times 400$
   D. $\times 4000$
   ***Answer: C.*** *Total magnification* = $10 \times 40 = 400$ *(p. 33).*

3. Which of these is a tissue?
   A. Stomach
   B. Xylem
   C. Red blood cell
   D. Circulatory system
   ***Answer: B.*** *Xylem is a plant tissue made of similar cells for water transport (p. 26).*
4. Which feature is found in a bacterial cell but not in a plant cell?
   A. Cytoplasm
   B. Plasmid
   C. Ribosomes
   D. Cell wall
   ***Answer: B.*** *Plasmids are small rings of DNA found in bacteria (p. 14).*
5. The diagram of a red blood cell is 14 mm wide. Its actual size is 7 $\mu$m. What is the magnification?
   A. $\times 2$
   B. $\times 200$
   C. $\times 2000$
   D. $\times 20000$
   ***Answer: C.*** *Image = 14 mm = 14000 $\mu$m. Magnification = 14000 / 7 = $\times 2000$ (p. 35).*
6. What is the main function of a root hair cell?
   A. Photosynthesis
   B. Transport of oxygen
   C. Absorption of water and minerals
   D. Conduction of nerve impulses
   ***Answer: C.*** *The root hair provides a large surface area for absorption from the soil (p. 23).*
7. Which row correctly matches an organelle with its function?
   A. Mitochondria – Protein synthesis
   B. Ribosomes – Respiration
   C. Nucleus – Controls cell activities
   D. Chloroplast – Controls entry of water
   ***Answer: C.*** *The nucleus contains chromosomes and controls the cell (p. 7).*
8. Which structures are found in a liver cell?
   A. Nucleus, cell membrane, cell wall
   B. Cell membrane, cytoplasm, chloroplasts
   C. Cytoplasm, nucleus, mitochondria
   D. Mitochondria, cell wall, vacuole
   ***Answer: C.*** *A liver cell is a typical animal cell (p. 6).*

9. A group of organs working together is called:
   A. A tissue
   B. An organism
   C. An organ system
   D. A cell
   ***Answer: C.*** *E.g., the heart and blood vessels form the circulatory system (p. 29).*
10. What is the cell wall of a plant cell made of?
    A. Protein
    B. Cellulose
    C. Starch
    D. Glycogen
    ***Answer: B.*** *Plant cell walls contain cellulose for strength (p. 8).*

**Short-answer questions**

1. State two structural differences between a palisade mesophyll cell and a liver cell.
   - **Marking points:**
     - Palisade cell has a cell wall, liver cell does not. [1]
     - Palisade cell has chloroplasts, liver cell does not. [1]
     - Palisade cell has a large central vacuole, liver cell does not. [1] (Any two)
2. Define the term 'tissue'.
   - **Marking points:**
     - A group of cells [1] with similar structures/function working together [1]. (p. 26)
3. Explain why a red blood cell has a different structure from other animal cells.
   - **Marking points:**
     - It has no nucleus when mature. [1]
     - This provides more space for haemoglobin to carry oxygen. [1] (p. 24)
4. A student is told to use iodine solution when preparing an onion slide. What is the purpose of the iodine?
   - **Marking points:**
     - It is a stain. [1]
     - It makes certain structures, like the nucleus, more visible/distinct. [1] (p. 16)
5. Describe the function of mitochondria. In which type of specialised cell would you expect to find many mitochondria?
   - **Marking points:**
     - Function: Site of aerobic respiration to release energy. [1] (p. 11)
     - Cell type: Sperm cell / muscle cell / nerve cell (any cell that requires a lot of energy). [1] (p. 25)

**Structured questions**

**Question 1**
The diagram shows a root hair cell.

a. **Identify** two structures visible in this cell that would also be found in an animal cell. [2]
b. **Identify** one structure visible in this cell that would not be found in an animal cell. [1]
c. **Explain** how the shape of this cell is adapted for its function. [2]

- **Model Answers & Marking Points:**
  - a. Cytoplasm [1] and cell membrane [1]. (Also accept nucleus, mitochondria).
  - b. Cell wall OR vacuole. [1]
  - c. It has a long, hair-like projection/extension [1]. This increases the surface area for efficient absorption of water and mineral salts from the soil [1]. (p. 23)

**Question 2**
A photomicrograph shows a plant cell. The length of the cell in the photograph is 40 mm. The actual length of the cell is 80 µm.

a. **Calculate** the magnification of the photomicrograph. Show your working. [3]
b. The cell is a palisade mesophyll cell. **State** the function of this cell and **describe** one adaptation for this function. [2]

- **Model Answers & Marking Points:**
  - a.
    - **Convert units:** Image size = 40 mm = 40,000 µm. [1]
    - **State formula:** Magnification = Image size / Actual size. [1]
    - **Calculate:** 40,000 µm / 80 µm = $\times 500$. [1]
  - b.
    - **Function:** To carry out photosynthesis / make food for the plant. [1] (p. 23)
    - **Adaptation:** It is packed with many chloroplasts to trap maximum light energy. OR It has a columnar shape to fit many cells at the top of the leaf. [1] (p. 23)

# 12) Quick revision checklist

- ☐ I can state the function of the cell membrane, cytoplasm, nucleus, mitochondria, and ribosomes.
- ☐ I can list the three additional structures found in plant cells but not animal cells.
- ☐ I can describe the function of the cell wall, chloroplasts, and large central vacuole.

- [ ] I can describe how a bacterial cell differs from a plant cell (nucleus, plasmids, cellulose).
- [ ] I can define tissue, organ, and organ system, and give one example of each in a plant and an animal.
- [ ] I can relate the structure of a ciliated cell, root hair cell, and palisade cell to their functions.
- [ ] I can relate the structure of a red blood cell, nerve cell, and sperm cell to their functions.
- [ ] I can calculate total microscope magnification from the eyepiece and objective lenses.
- [ ] I can use the formula triangle for Image Size, Actual Size, and Magnification.
- [ ] I can convert between millimetres (mm) and micrometres ($\mu$m).
- [ ] I know that iodine is used to stain plant cells and methylene blue is used for animal cells.

## 13) Flashcards (ready-to-use)

| Question | Answer |
|---|---|
| **Q1:** What is the function of the cell membrane? | **A:** To control which substances can enter and leave the cell. (p. 7) |
| **Q2:** What is the function of mitochondria? | **A:** To release energy from food via aerobic respiration. (p. 11) |
| **Q3:** What is the function of the nucleus? | **A:** To control the cell's activities and cell division. (p. 7) |
| **Q4:** Name 3 structures in plant cells not in animal cells. | **A:** Cell wall, chloroplasts, large central vacuole. (p. 8) |
| **Q5:** What is the plant cell wall made of? | **A:** Cellulose. (p. 8) |
| **Q6:** What is the function of chloroplasts? | **A:** To absorb light energy for photosynthesis. (p. 9) |
| **Q7:** How is a bacterial cell's DNA different from a plant's? | **A:** It is a single circular chromosome and plasmids, not in a nucleus. (p. 14) |
| **Q8:** Define a 'tissue'. | **A:** A group of similar cells working together to perform a function. (p. 26) |
| **Q9:** Define an 'organ'. | **A:** A group of different tissues working together to perform a function. (p. 29) |

| Question | Answer |
| --- | --- |
| **Q10:** What is an organ system? | **A:** A group of organs working together. E.g., the digestive system. (p. 29) |
| **Q11:** How is a root hair cell adapted for its function? | **A:** Has a long extension to increase surface area for water absorption. (p. 23) |
| **Q12:** How is a sperm cell adapted for its function? | **A:** Has a tail for swimming and many mitochondria for energy. (p. 25) |
| **Q13:** Why does a mature red blood cell lack a nucleus? | **A:** To maximise space for haemoglobin, which carries oxygen. (p. 24) |
| **Q14:** Write the formula for magnification. | **A:** Magnification = Image Size / Actual Size. (p. 33) |
| **Q15:** How many micrometres ($\mu$m) are in 1 millimetre (mm)? | **A:** 1000. (p. 36) |
| **Q16:** What stain is used for preparing onion cells? | **A:** Iodine solution. (p. 16) |
| **Q17:** What stain is used for preparing cheek cells? | **A:** Methylene blue. (p. 19) |
| **Q18:** What is the function of ribosomes? | **A:** Protein synthesis. (p. 10) |
| **Q19:** What does the large vacuole in a plant cell contain? | **A:** Cell sap (a solution of sugars and salts). (p. 9) |
| **Q20:** How do ciliated cells protect the lungs? | **A:** Their cilia sweep mucus, dust, and bacteria away from the lungs. (p. 23) |

## 14) 60-second recap

This chapter builds biology from the ground up. It starts with the cell, the basic unit of life, and details the key organelles like the nucleus for control, mitochondria for energy, and the cell membrane as a gatekeeper. We learn that plant cells have three extra parts: a supportive cellulose cell wall, chloroplasts for photosynthesis, and a large central vacuole. Bacterial cells are simpler, with no true nucleus. These cells then specialise for specific jobs—like long root hairs for absorption or red blood cells without a nucleus to carry more oxygen. Cells group into tissues, tissues form organs, organs

create systems, and systems make up the whole organism. To see any of this, we use a microscope, and you must be able to calculate magnification by dividing the image size by the actual size, remembering to keep the units consistent.

## 15) References to pages

- **Cell definition:** 2
- **Cell Structures (Animal & Plant):** 5-12
- **Bacterial Cell Structure:** 13-15
- **Cell Division:** 7, 14
- **Definitions (Tissue, Organ, System):** 26, 29, 31
- **Experiments (Onion, Cheek cells):** 15-20
- **Hierarchy of Organisation:** 26-31
- **Magnification Calculation:** 32-35
- **Microscope Diagram:** 33
- **Specialised Cells:** 21-25
- **Unit Conversion (mm to µm):** 36

## 16) Excluded "Going further" sections (not summarized)

| Section title | Pages |
| --- | --- |
| Not applicable. | No sections titled "Going further" were found in this chapter. |
| **Total excluded:** | **0** |