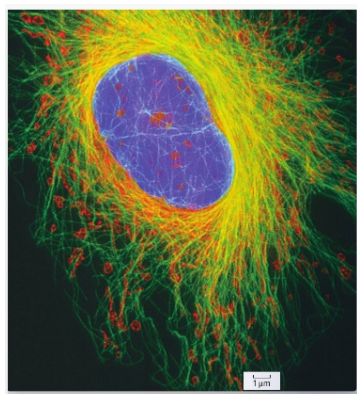


Reading is NOT a passive activity. By actively engaging with reading material, you can improve retention of information. Instead of sitting back and letting your brain and eyes do all the work, you can physically and consciously work with the material.

Preview the chapter



CHAPTER 4 Cell Structure

Chapter Contents

- 4.1 Cell Theory
- 4.2 Prokaryotic Cells
- 4.3 Eukaryotic Cells
- 4.4 The Endomembrane System
- 4.5 Mitochondria and Chloroplasts: Cellular Generators
- 4.6 The Cytoskeleton
- 4.7 Extracellular Structures and Cell Movement
- 4.8 Cell-to-Cell Interactions

Skim through the chapter taking note of headings and diagrams.

When you finish, verbally explain to yourself what the chapter is about and describe anything that stood out while you skimmed, for instance, "This chapter is about cell structure with some useful diagrams and tables".

***Why say these things aloud?**
Studies have found that verbalisation improves memory, attention, and focus.

Note down the headings

Textbook chapters are usually broken down into headings and subheadings. These provide an overview of the chapter's key ideas.

Capture this information in a table of headings/subheadings and write the key idea under each one.

In some textbooks, headings reveal the key ideas and words.

Example: Headings & key ideas

HEADING	KEY IDEAS/WORDS
Cell theory is the unifying foundation of cell biology	Three principles: life progresses, basic units of organisation, division from existing cell
Cell size is limited	Diffusion, metabolism, transport, surface area: volume ratio
Microscopes allow visualisation of cells and components	Cells < 50 µm

termed "animalcules," or little animals. After these early efforts, a century and a half passed before biologists fully recognized the importance of cells. In 1838, German botanist Matthias Schleiden stated that all plants "are aggregates of fully individualized, independent, separate beings, namely the cells themselves." In 1839, German physiologist Theodor Schwann reported that all animal tissues also consist of individual cells. Thus, the cell theory was born.

Cell theory is the unifying foundation of cell biology

The cell theory was proposed to explain the observation that all organisms are composed of cells. It sounds simple, but it is a far-reaching statement about the organization of life.

In its modern form, the *cell theory* includes the following three principles:

1. All organisms are composed of one or more cells, and the life processes of metabolism and heredity occur within these cells.
2. Cells are the smallest living things, the basic units of organization of all organisms.
3. Cells arise only by division of a previously existing cell.

Although life likely evolved spontaneously in the environment of early Earth, biologists have concluded that no additional cells are originating spontaneously at present. Rather, life on Earth represents a continuous line of descent from those early cells.

Cell size is limited

Most cells are relatively small for reasons related to the diffusion of substances into and out of them. The rate of diffusion is affected by a number of variables, including (1) surface area available for diffusion, (2) temperature, (3) concentration gradient of diffusing substance, and (4) the distance over which diffusion must occur. As the size of a cell increases, the length of time for diffusion from the outside membrane to the interior of the cell increases as well. Larger cells need to synthesize more macromolecules, have correspondingly higher energy requirements, and produce a greater quantity of waste. Molecules used for energy and biosynthesis must be transported through the membrane. Any metabolic waste produced must be removed, also passing through the membrane. The rate at which this transport occurs depends on both the distance to the membrane and the area of membrane available. For this reason, an organism made up of many relatively small cells has an advantage over one composed of fewer, larger cells.

The advantage of small cell size is readily apparent in terms of the *surface area-to-volume ratio*. As a cell's size increases, its volume increases much more rapidly than its surface area. For a spherical cell, the surface area is proportional to the square of the

Figure 4.1 Surface area-to-volume ratio. As a cell gets larger, its volume increases at a faster rate than its surface area. If the cell radius increases by 10 times, the surface area increases by 100 times, but the volume increases by 1000 times. A cell's surface area must be large enough to meet the metabolic needs of its volume.



Cell radius (r)	1 unit	10 units
Surface area (4πr ²)	12.57 unit ²	1257 unit ²
Volume (4/3πr ³)	4.189 unit ³	4189 unit ³
Surface Area / Volume	3	0.3

role in controlling cell function. Because small cells have more surface area per unit of volume than large ones, control over cell contents is more effective when cells are relatively small.

Although most cells are small, some quite large cells do exist. These cells have apparently overcome the surface area-to-volume problem by one or more adaptive mechanisms. For example, some cells, such as skeletal muscle cells, have more than one nucleus, allowing genetic information to be spread around a large cell. Some other large cells, such as neurons, are long and skinny, so that any given point within the cell is close to the plasma membrane. This permits diffusion between the inside and outside of the cell to still be rapid.

Microscopes allow visualization of cells and components

Other than egg cells, not many cells are visible to the naked eye (figure 4.2). Most are less than 50 µm in diameter, far smaller than the period at the end of this sentence. So, to visualize cells we need the aid of technology. The development of microscopes and their refinement over the centuries has allowed us to continually explore cells in greater detail.

The resolution problem

How do we study cells if they are too small to see? The key is to understand why we can't see them. The reason we can't see such small objects is the limited resolution of the human eye. *Resolution*



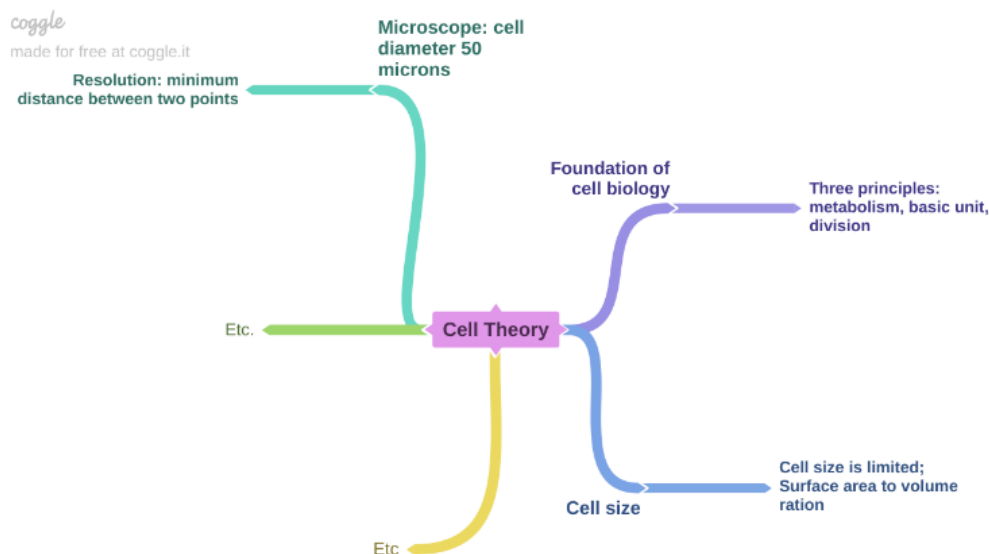
Find this helpsheet online
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Active reading

Engage with the texts and actively create your own questions and visual prompts to help you learn and remember. The more you 'get involved' with text by trying to illustrate it, or summarise it, the more meaning you will build from it and be able to recall later. If you feel yourself glazing over, take a break and come back to it later. Like any skill, active reading takes a little practise. At university, it is a skill that can help you go a long way.

Example: Mind map

An alternative to tables is a mind map of the headings. Make a mind map by hand or use one of the many free apps such as [Coggle](#).



Creating visual prompts of the course material will assist memory and give you a method of easy revision. Download the map, print it out, put it up on the wall next to your desk, or collate a bunch of maps and place them in folders as chapter summaries.

Make question prompts

Turn the learning outcomes into questions, for example:

- What is cell theory?
- What factors limit cell size?
- How are cells categorised based on structural and functional similarities?

Next, read the sections strategically so that you can answer the questions.

4.1 Cell Theory

Learning Outcomes

1. Discuss the cell theory.
2. Describe the factors that limit cell size.
3. Categorize structural and functional similarities in cells.

Related helpsheets

- Reading Journal Articles
- Reading Strategies: Questioning
- Reading & Writing Critically



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