

Lecture 3

Cell size (why are most cells microscopic?)

- Cell is so small (**microscopic**) because it needs a large **surface area** in order to get **nutrients** (food) and to remove the **wastes** from itself.
- Small cells have **more** surface area than large cells.



One 4-cm cube



Eight 2-cm cubes



Sixty-four 1-cm cubes

Total surface area (height \times width \times number of sides \times number of cubes)

96 cm²

192 cm²

384 cm²

Total volume (height \times width \times length \times number of cubes)

64 cm³

64 cm³

64 cm³

Surface area: Volume per cube (surface area \div volume)

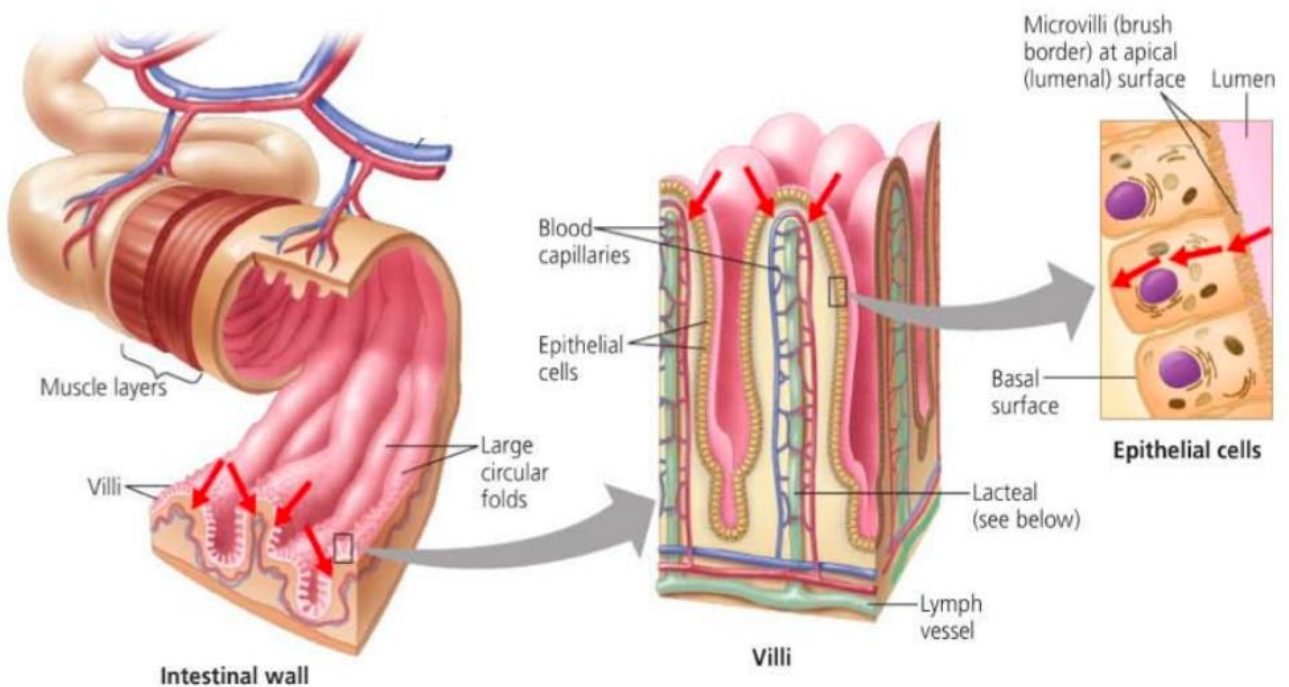
1.5:1

3:1

6:1

The calculations show that a 4-cm cube has a surface-area-to-volume ratio of only 1.5:1, whereas a 1-cm cube has a surface-area-to-volume ratio of 6:1.

- As a cell increases in **size**, its volume grows more than its **surface area**. Thus, a smaller object has a **greater ratio** of **surface area** to **volume**.
- Larger organisms **do not** generally have **larger** cells than smaller organisms - simply **more** cells.
- **High ratio** of **surface area** to volume is important in cells to **exchange** a lot of material with their surroundings, such as **intestinal cells**.
- **Intestinal cells** may have many long, thin **projections** from their surface called **microvilli**, which increase surface area without an appreciable increase in volume.





Villi in small intestine

What is the main advantage of small cell size?

- A small cell has a **larger** plasma membrane **surface area** than a large cell.
- Small cells can better **take up** sufficient **nutrients** and **oxygen** to service their cell volume.
- It takes **less energy** to make an organism **out** of small cells.
- Small cells require **less oxygen** than do large cells.

The importance of compartmental organisation

In addition to the **plasma membrane** at its outer surface, an eukaryotic cell has extensive and elaborately arranged **internal membranes**, which divide the cell into **compartments**-typically called **organelles** (**little organs**) to perform their specific functions **more efficiently**.

The benefits of cell compartment are:

1. Separation of various metabolic processes:

The establishment of physical **boundaries** around the organelles enables the cell to **carry out** different **metabolic activities** at the **same time**. This may include keeping certain **biomolecules** **within a region** or keeping other molecules **outside**. Example, the **nucleus** is a compartment that **houses** the genetic material (DNA) within eukaryotic chromosomes. The nucleus **communicates** with ribosomes in the cytoplasm to produce proteins.

2. Localizes enzymes and products:

- Each organelle in the cell has its own produced **enzymes** and **products**.
- These **products** are moved from one organelle to another by small **membranous sacs** called **vesicles**, which keep the products separated from the cytoplasm. Example: communication between **Endoplasmic reticulum** and **Golgi apparatus** through **transport** vesicles.

3. Allows cells to become specialized:

Cell becomes **specialised** by having abundances of **particular organelles** therefore, each **tissue** has a different **function** because it is composed of different **types of cells** with **special** organelles.

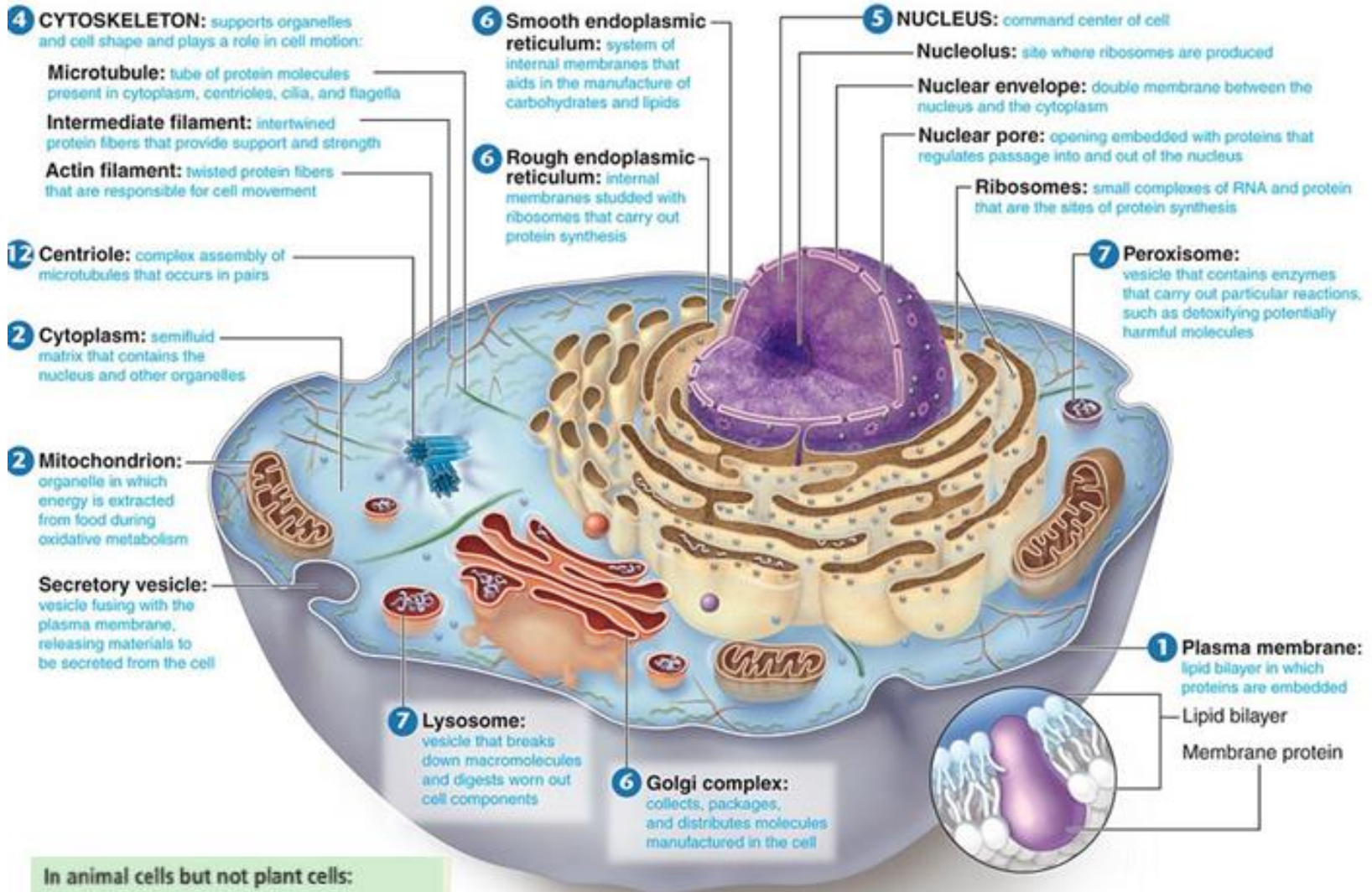
A panoramic view of the eukaryotic cell

Exploring animal cell

- Most common structure of animal cells contains various components, including **organelles** bounded by **membranes**.
- The most prominent organelle in an animal cell is usually the **nucleus**.
- Most of the cell's **metabolic activities** occur in the **cytoplasm**, the entire region between the nucleus and the plasma membrane.
- The cytoplasm contains many organelles and other cell components suspended in a semi-fluid medium, the **cytosol**.

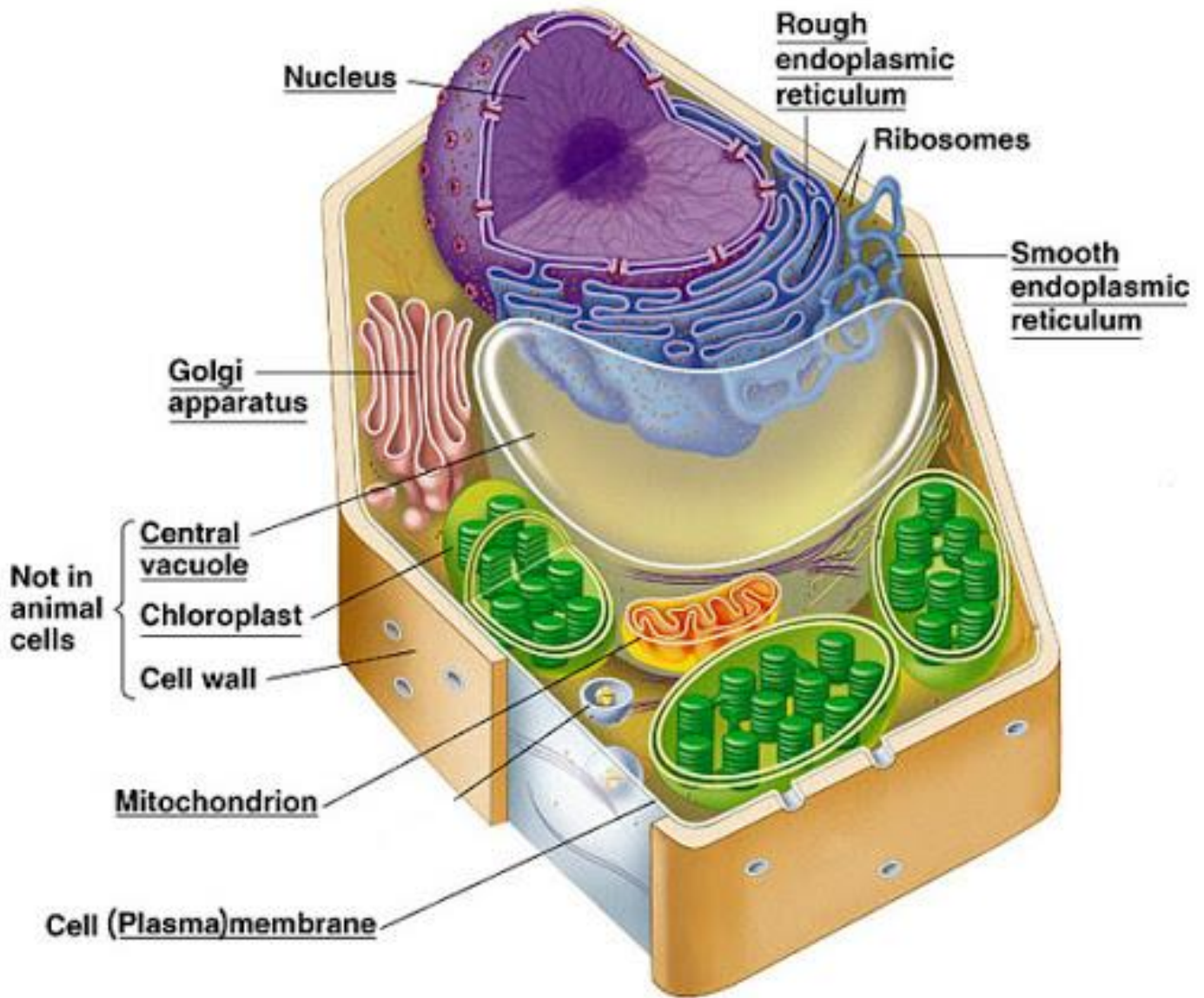
Exploring plant cell

- The drawing of plant cells reveals the similarities and differences between an animal cell and a plant cell.
- In addition to most of the features seen in an animal cell, a plant cell has organelles called **plastids**, and the most important type of plastid is the **chloroplast**, which carries out **photosynthesis**.
- Many plant cells have a large central vacuole; some may have one or more smaller vacuoles.
- Outside a plant cell's plasma membrane is a thick cell wall.



In animal cells but not plant cells:
 Lysosomes
 Centrosomes, with centrioles
 Flagella (but present in some plant sperm)

Animal cell



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Plant cell

Protoplasm

- **Protoplasm:** a living part of the cell which surrounds the **cell membrane** and includes **cytoplasm** and **nucleoplasm**.
- **Cytoplasm** (between cell membrane and the nucleus).
- **Nucleoplasm** (inside the nucleus and surrounded by nuclear envelope).
- Most cell activities occur in cytoplasm, such as metabolic pathways and processes such as cell division.

Cytoplasm

Cytoplasm consists of:

1. **Cytosol** (= **soluble fraction**) is a gel-like material that is 80% water and usually clear in colour.
2. Cytoplasmic **organelles**.
3. **Non-living materials**.

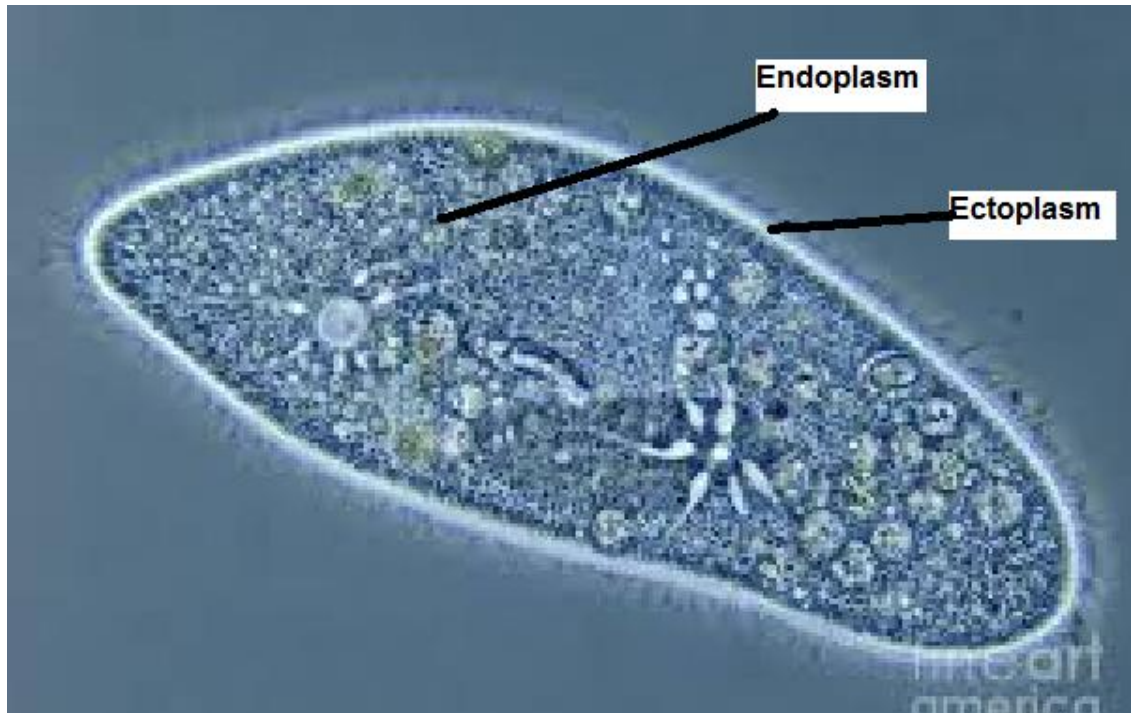
Non-living materials include:

- **Macromolecules:** protein (enzymes), carbohydrate, lipid, and some types of RNA.
- **Minerals:** (C, H, O, N, P, K, ...).
- **Trace elements:** (Cu, Mg, S, Ca, Cl, Na ...).

Cytosol

The **cytosol** of eukaryotic cell consists of **two** layers:

1. **Ectoplasm** (outer, thin, clear, non-granulate layer).
2. **Endoplasm** (inner mass granulated layer of cytoplasm).



Paramecium cell shows ectoplasm and endoplasm

Definitions

Microvilli: are long and thin projections located on the surface of intestinal cells that increase surface area without increasing cell volume.

Protoplasm: is a living part of the cell that surrounds the cell membrane and includes cytoplasm and nucleoplasm.

Cytosol (or **soluble fraction**) is a gel-like material in the cytoplasm that is 80% water and usually clear in colour; it also contains soluble proteins and enzymes.

Ectoplasm: is an outer, thin, clear, non-granulate layer of cytosol in eukaryotic cells.

Endoplasm: is inner mass granulated layer of cytosol in eukaryotic cell.