CHAPTER 4

A Tour of the Cell

YOU MUST KNOW

- Three differences between prokaryotic and eukaryotic cells.
- The structure and function of organelles common to plant and animal cells.
- The structure and function of organelles found only in plant cells or only in animal cells.
- How different cell types show differences in subcellular components.
- How internal membranes and organelles contribute to cell functions.
- How cell size and shape affect the overall rate of nutrient intake and waste elimination.

2 TYPES OF CELLS:

Before kernel or nut

1. **Prokaryotes**: Domain Bacteria & Archaea without a nucleus

2. **Eukaryotes** (Domain Eukarya): Protists, Fungi, Plants, Animals have a nucleus

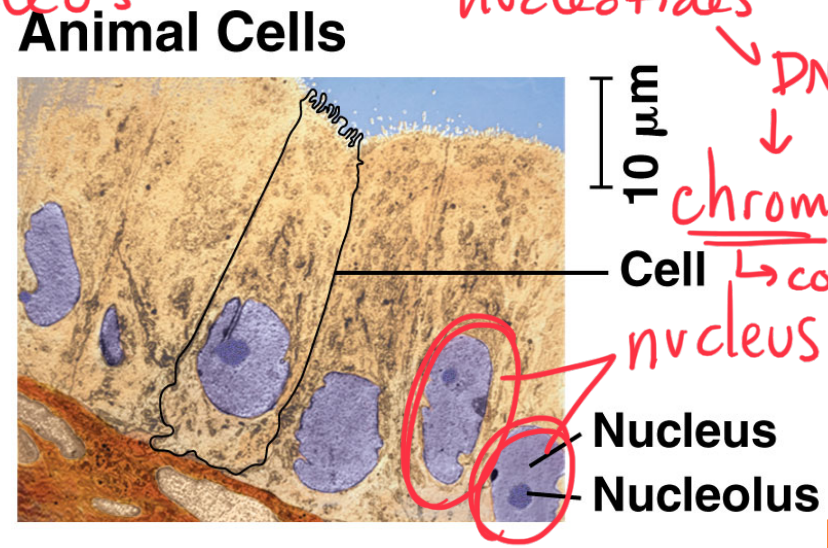
true

inside of nucleus are nucleotides → DNA → chromosome → color body

(b) A thin section through the bacterium *Bacillus coagulans* (TEM)

No nucleus

prokaryotic



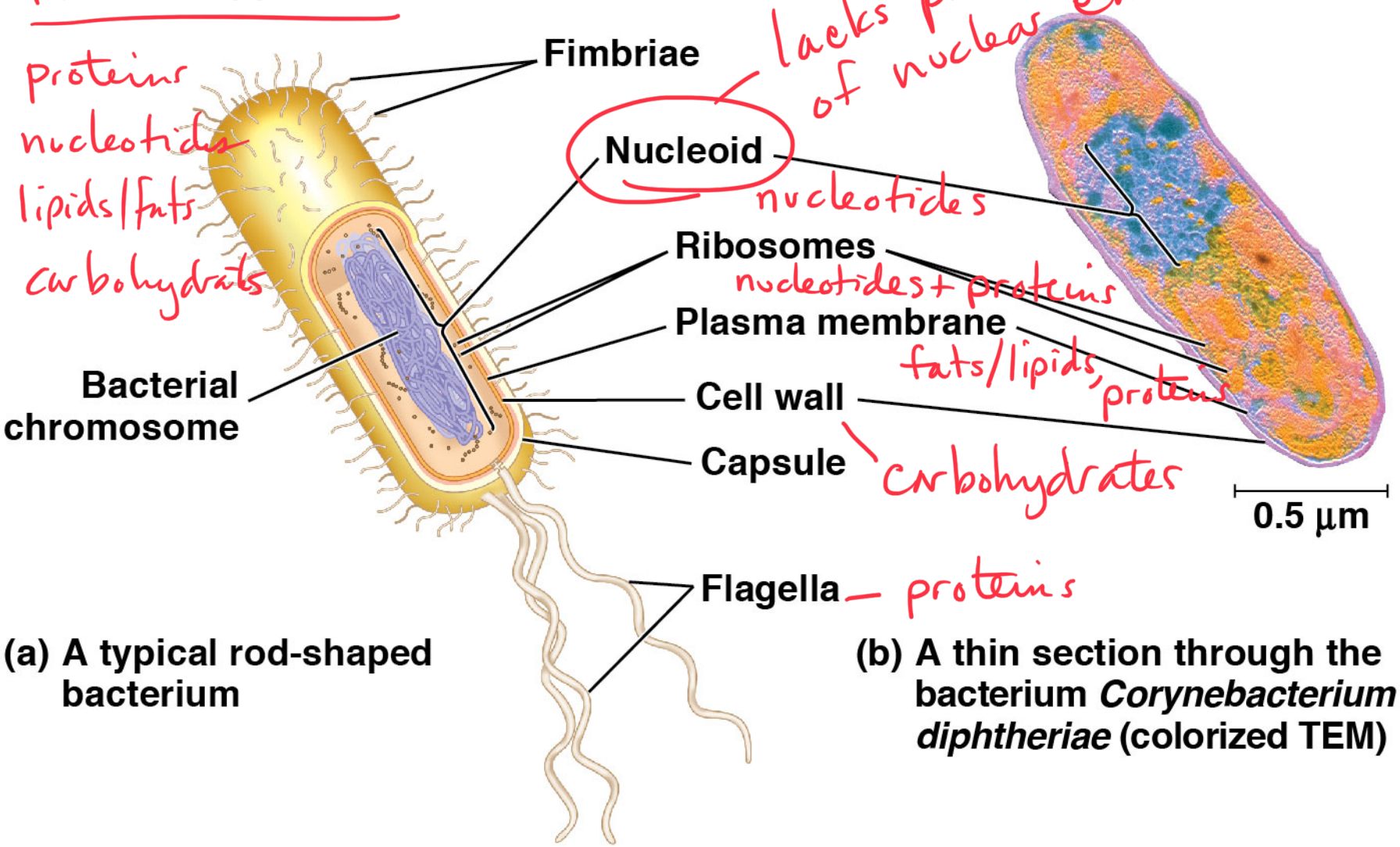
nucleus

Human cells from lining of uterus (colorized TEM)

A PROKARYOTIC CELL (BACTERIA)

4 macromolecules

proteins
nucleotides
lipids/fats
carbohydrates



lacks protection of nuclear envelope

nucleotides

nucleotides + proteins

fats/lipids, proteins

carbohydrates

proteins

(a) A typical rod-shaped bacterium

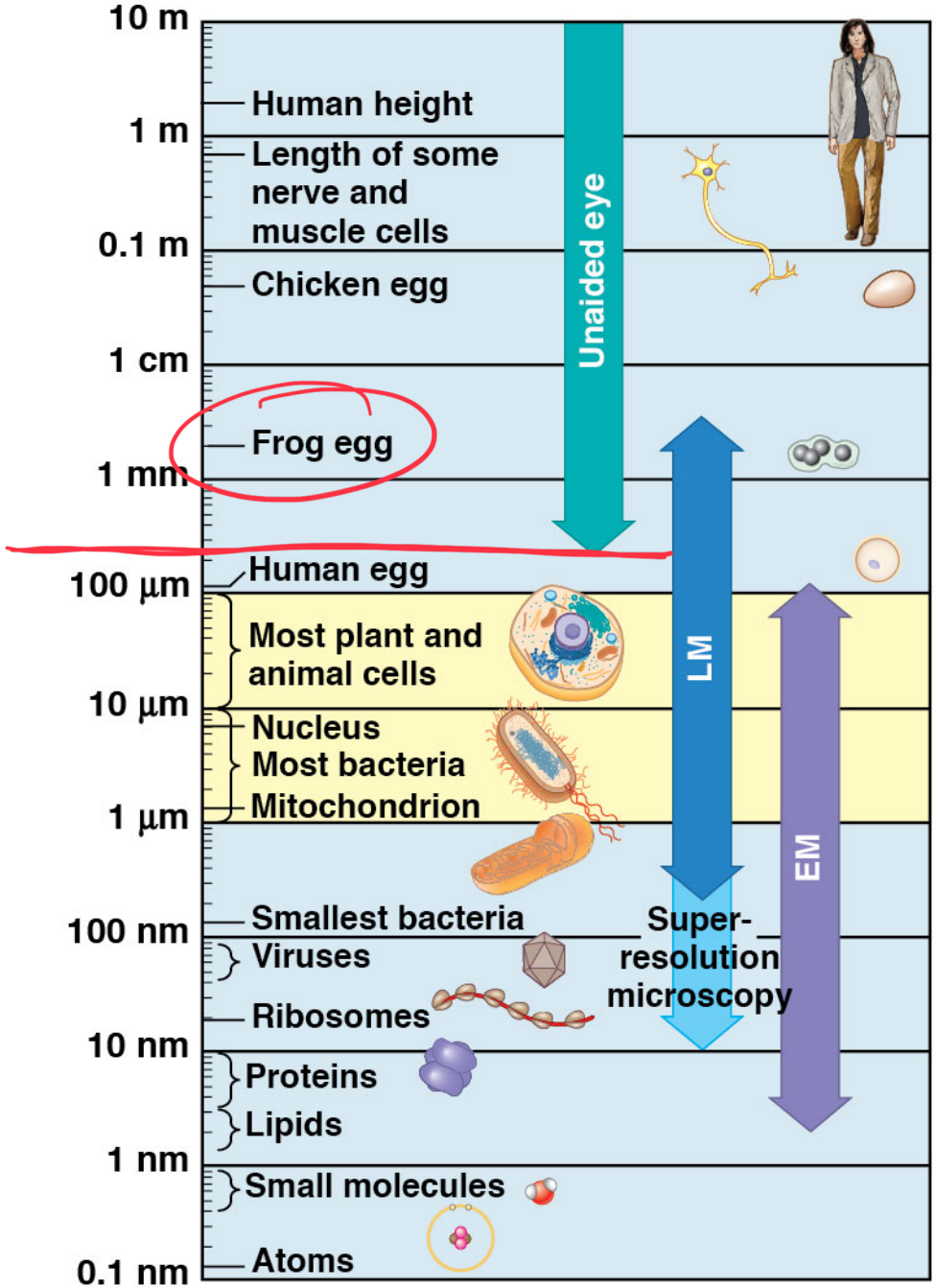
(b) A thin section through the bacterium *Corynebacterium diphtheriae* (colorized TEM)

PROKARYOTE VS. EUKARYOTE

- "before" "kernel"
- No nucleus
- DNA in a nucleoid
- Cytosol → fluid
- No membrane-bound organelles other than ribosomes
- Small size
- Primitive
- i.e. Bacteria & Archaea

Kern!

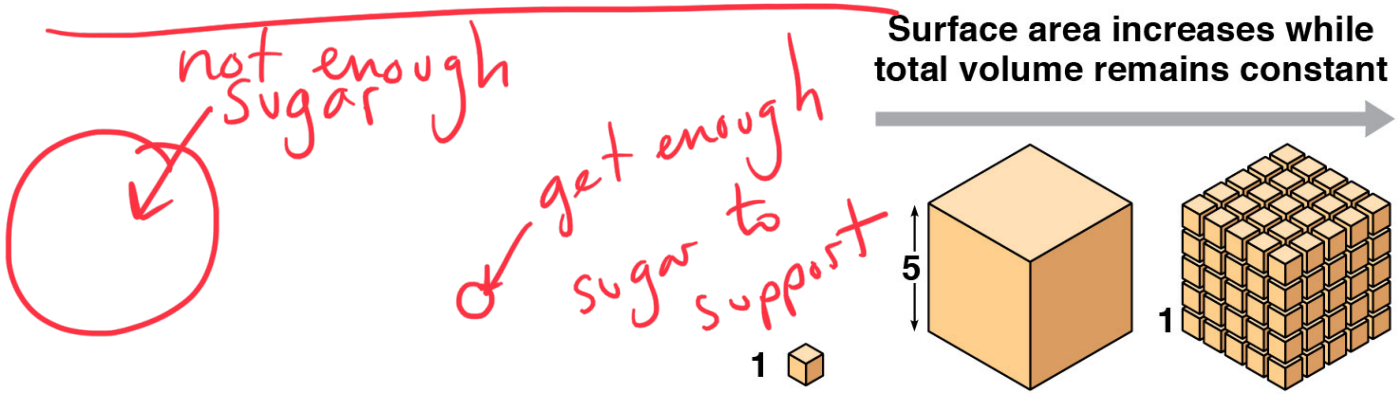
- "true" "kernel"
- Has nucleus and nuclear envelope → protection
- Cytosol
- Membrane-bound organelles with specialized structure/ function
- Much larger in size
- More complex
- i.e. plant/animal cell



- Cells must be small to maintain a large surface area to volume ratio → folding
- Large S.A. allows ↑ rates of chemical exchange between cell and environment

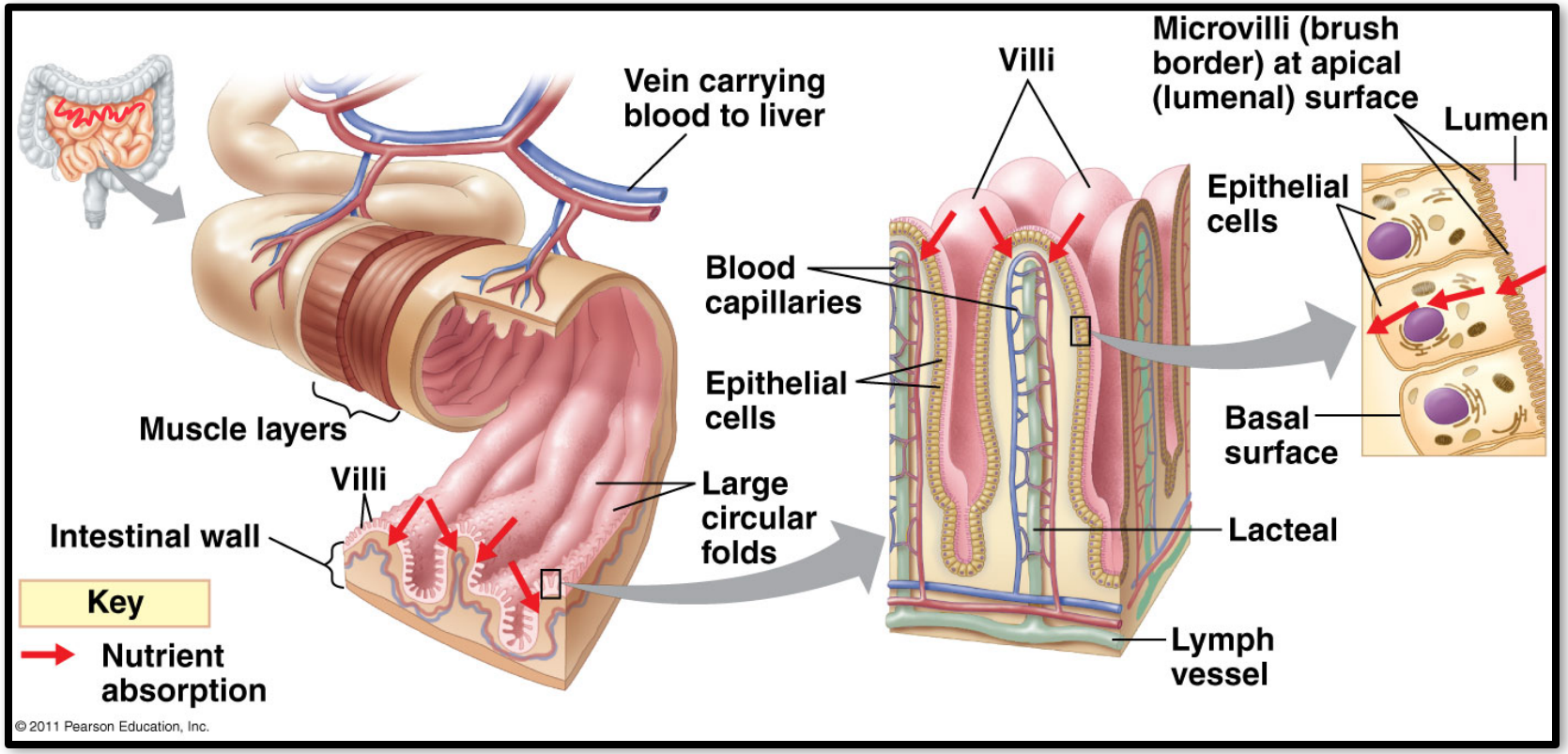
not enough sugar

get enough sugar to support



Total surface area [sum of the surface areas (height × width) of all box sides × number of boxes]	6	150	750
Total volume [height × width × length × number of boxes]	1	125	125
Surface-to-volume (S-to-V) ratio [surface area ÷ volume]	6	1.2	6

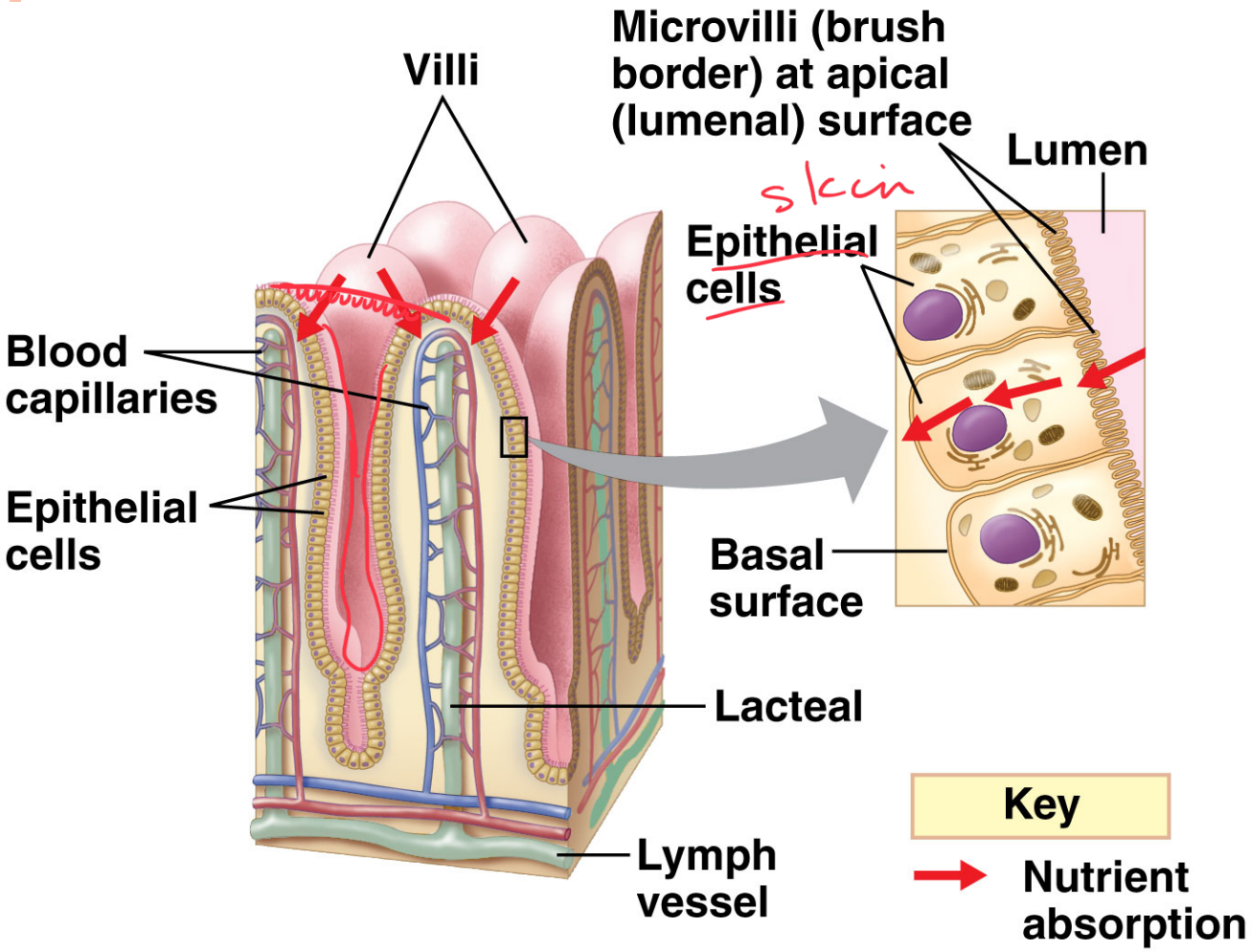
SURFACE AREA EXAMPLE (ANIMAL):

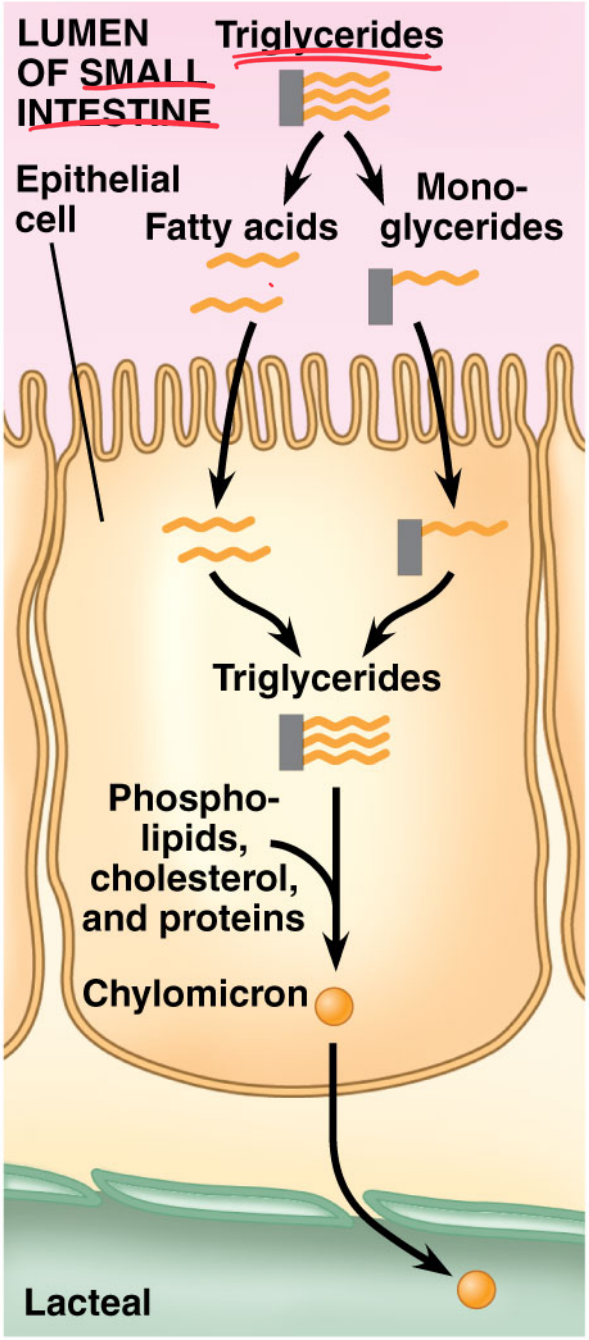


Small Intestine: *highly folded surface* to increase absorption of nutrients

- Villi: finger-like projections on SI wall
- Microvilli: projections on each cell

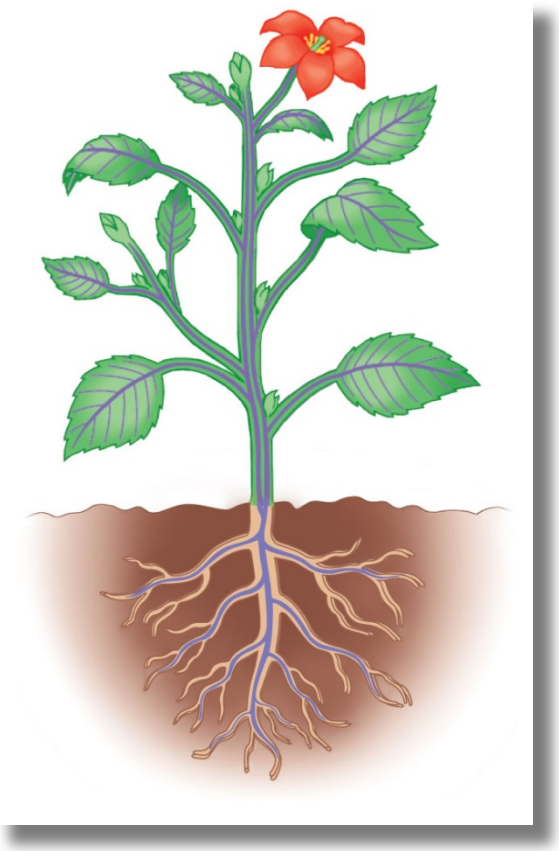
Folds → Villi → Microvill

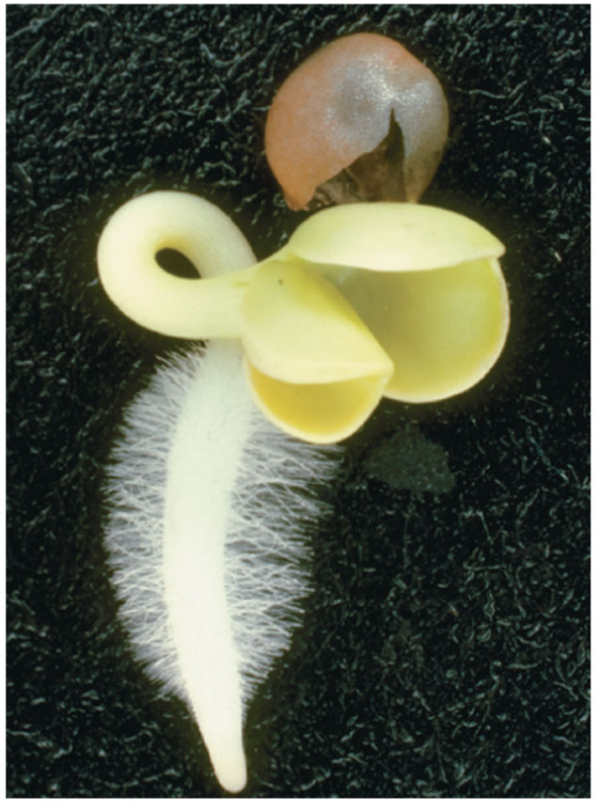




SURFACE AREA EXAMPLE (PLANT):

Root hairs: extensions of root epidermal cells; increase surface area for absorbing water and minerals





NUCLEUS

genetic material kept

chromosomes protected inside nucleus

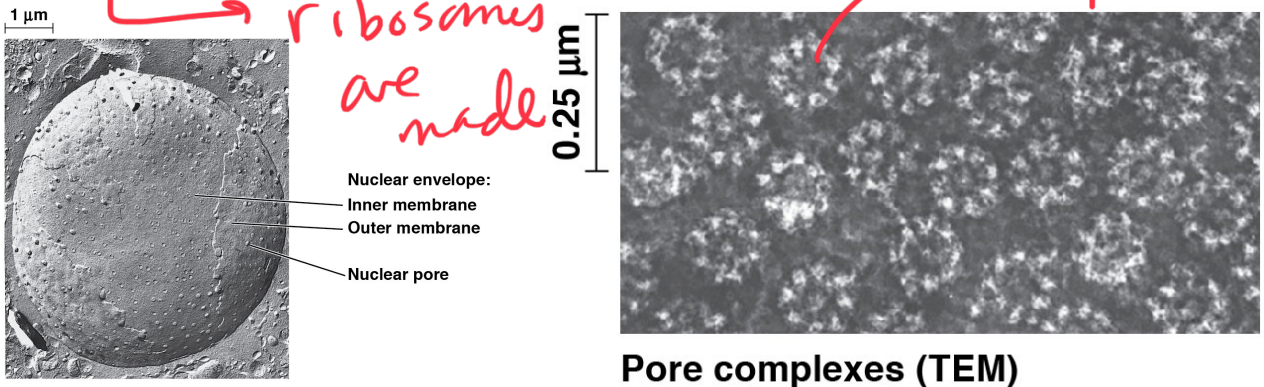
- Function: control center of cell
- Contains DNA (& mRNA) → messenger RNA
- Surrounded by double membrane (**nuclear envelope**)
  - Continuous with the rough ER → lipids/fats (nonpolar)
- **Nuclear pores**: control what enters/leaves nucleus
- **Chromatin**: complex of DNA + proteins; makes up chromosomes

nucleotide

- **Nucleolus**: region where ribosomal subunits (rRNA + proteins) are formed

ribosomes are made

nuclear pores



Surface of nuclear envelope (TEM)

Pore complexes (TEM)

DNA → RNA takes place in nucleus

transcription in nucleus

nuclear pore

Nucleus

Nucleolus

Chromatin

Nuclear envelope:

Inner membrane

Outer membrane

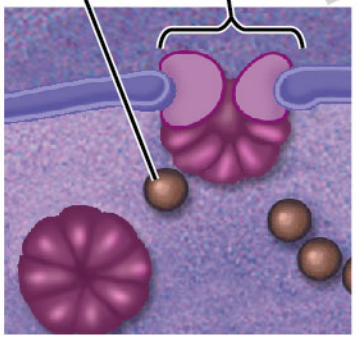
Nuclear pore

Rough ER

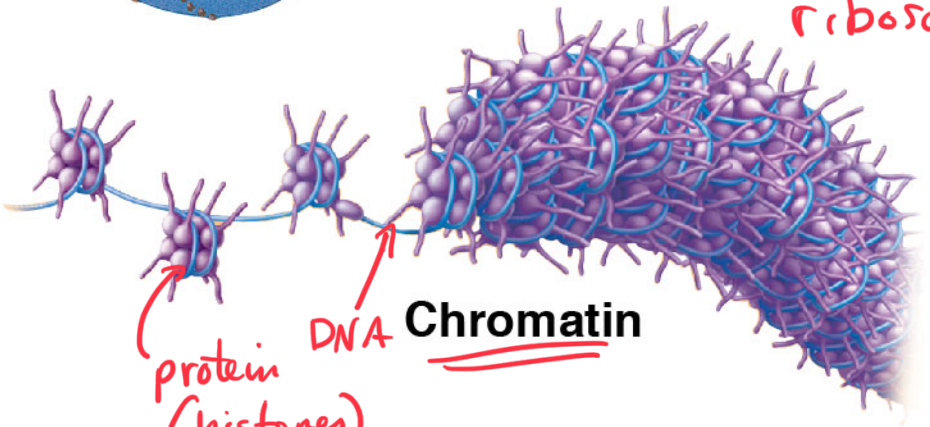
presence of ribosome

Pore complex

Ribosome



Close-up of nuclear envelope



protein (histones)

DNA

Chromatin

RIBOSOMES

DNA → RNA → protein

translation

outside nucleus

- Function: protein synthesis
- Composed of rRNA + protein

nucleotide + protein

- Large subunit + small subunit
- Types:

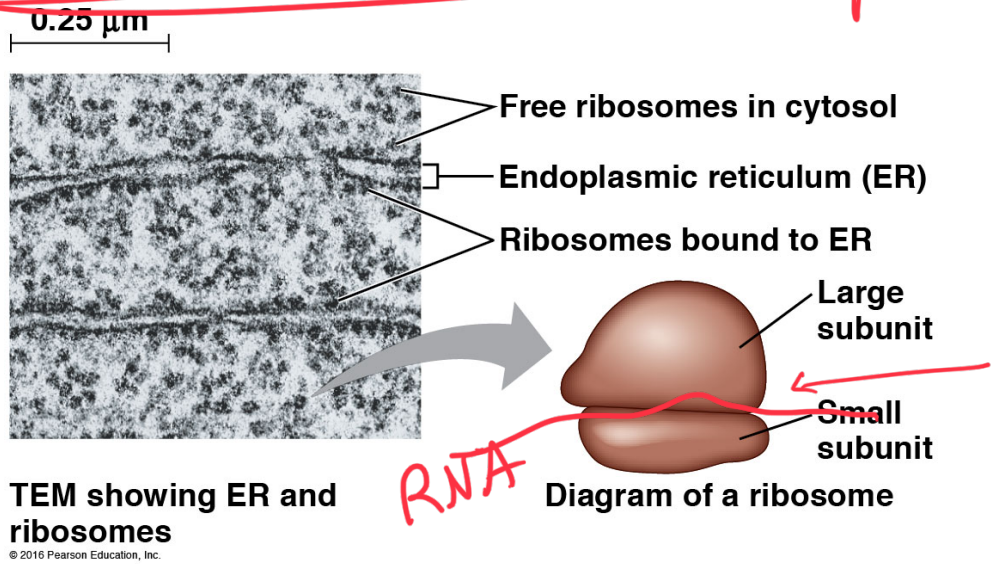
"cassette"

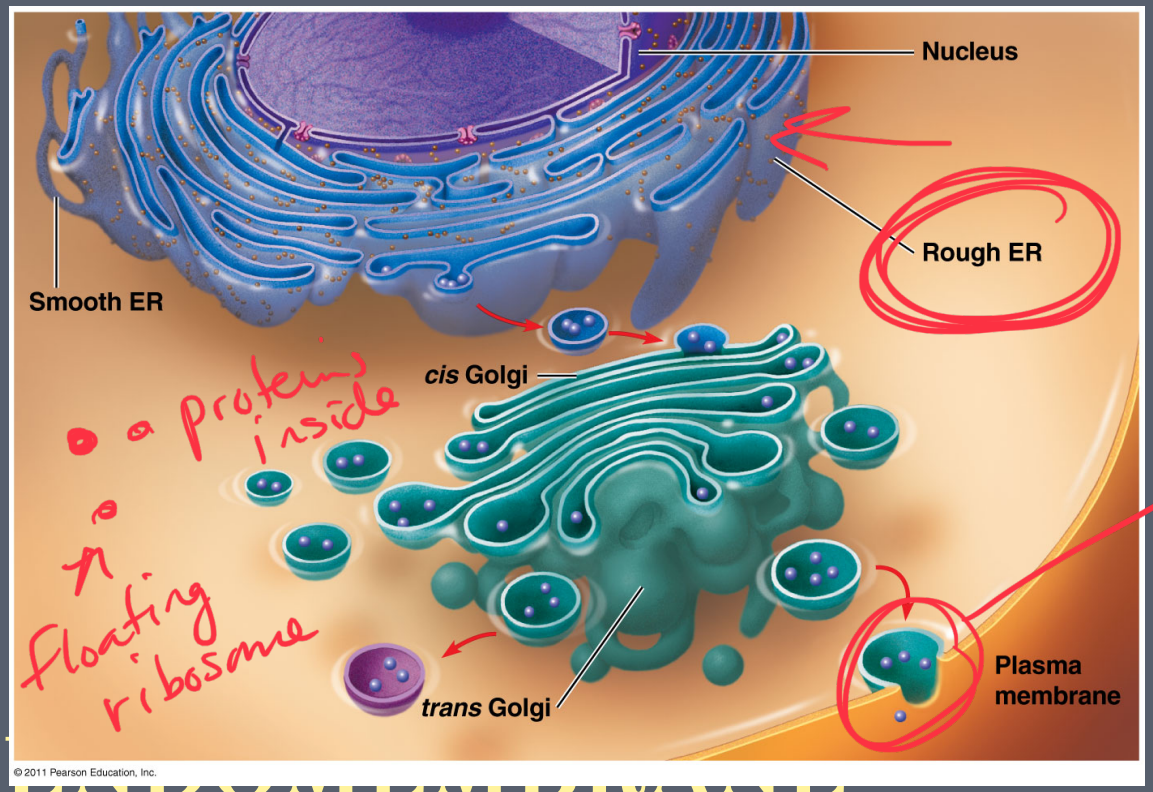
1. **Free ribosomes**: float in cytosol, produce proteins used within cell

Fluid

2. **Bound ribosomes**: attached to ER, make proteins for export from cell

Endoplasmic Reticulum





ENDOMEMBRANE SYSTEM:

Regulates protein traffic & performs metabolic functions

ENDOPLASMIC RETICULUM (ER)

- Network of membranes and sacs
- Types:

technically – outside the cell

1. **Rough ER**: ribosomes on surface
   - Function: package proteins for secretion, send transport vesicles to Golgi, make replacement membrane

mimics the extracellular environment

2. **Smooth ER**: no ribosomes on surface
   - Function: synthesize lipids, metabolize carbs, detox drugs & poisons, store Ca^{2+}

ENDOPLASMIC RETICULUM (ER)