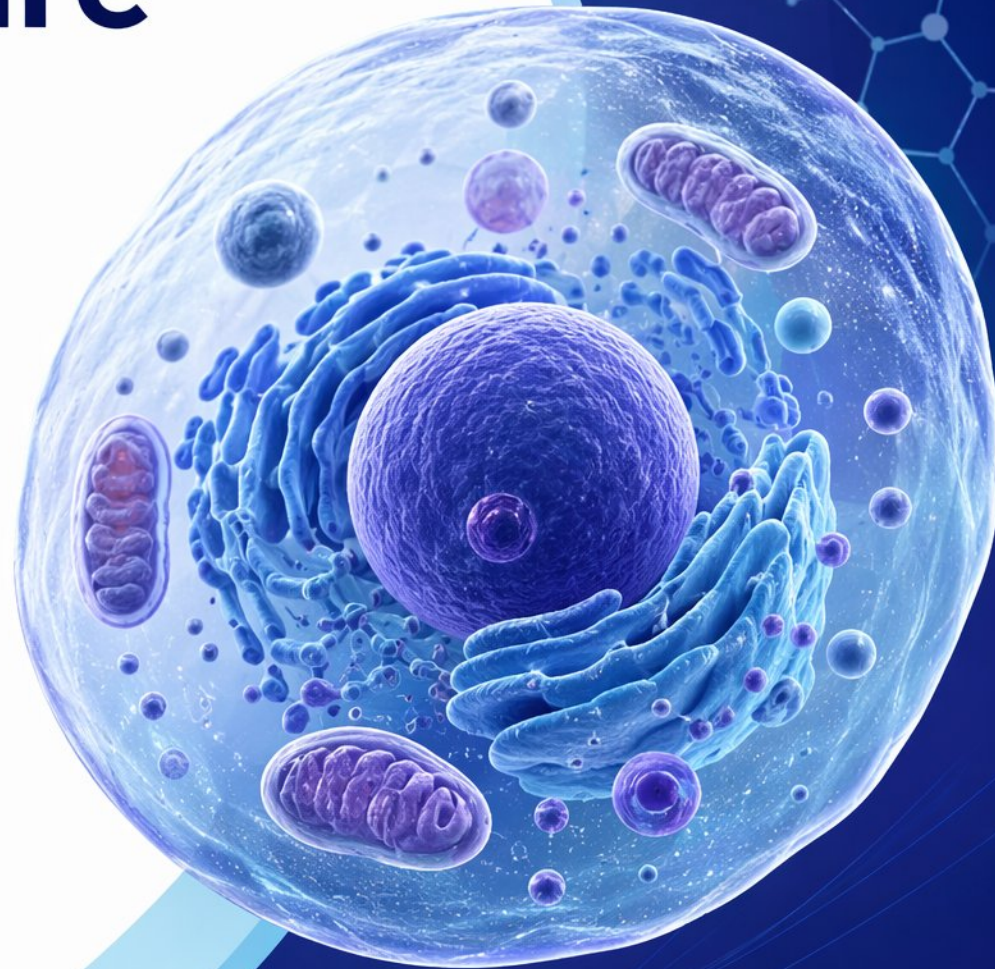


Introduction to Cells: Structure and Function

- Cell: basic structural and functional unit of all living organisms
- Modern cell theory: all life made of cells, fundamental unit, arise from existing cells
- Unicellular (bacteria) vs. multicellular (humans, trees) organisms
- Two broad categories: prokaryotic (no nucleus) and eukaryotic (true nucleus)



Why Size Matters: The Surface-Area-to-Volume Ratio

- Surface-area-to-volume ratio limits how large a cell can grow
- Small SA:V slows diffusion of nutrients and waste removal
- Larger organisms evolve specialized structures, not just bigger cells
- Like a growing town, a cell needs more infrastructure as it expands



Prokaryotic Cells: The Simplest Living Units



- No nucleus or membrane-bound organelles



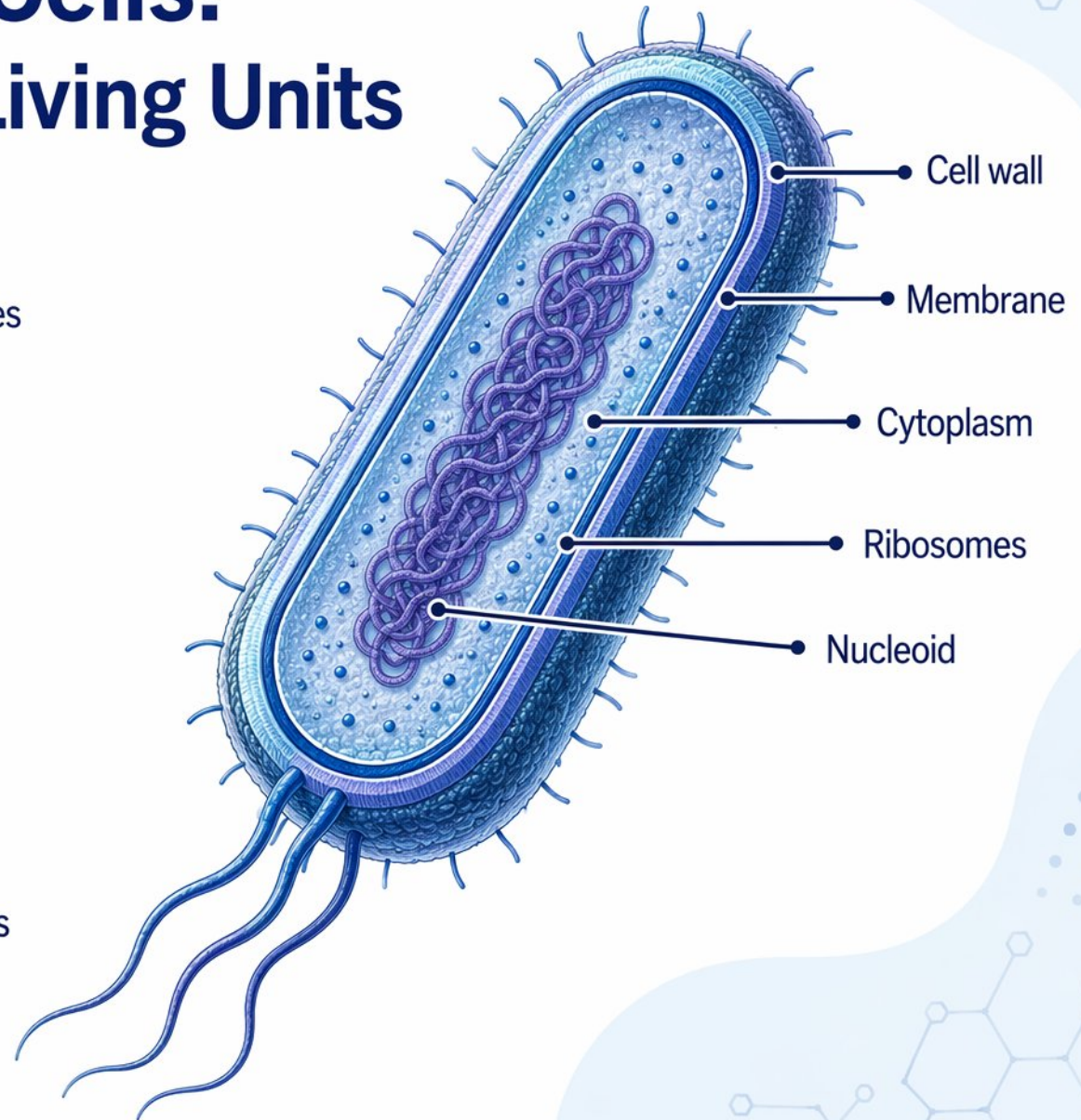
- Two domains: Bacteria and Archaea



- Key structures: cell wall, membrane, cytoplasm, ribosomes, nucleoid



- Complete living cells performing all life processes



Eukaryotic Cells:

The Power of Compartmentalization



- Defined by a true nucleus and membrane-bound organelles



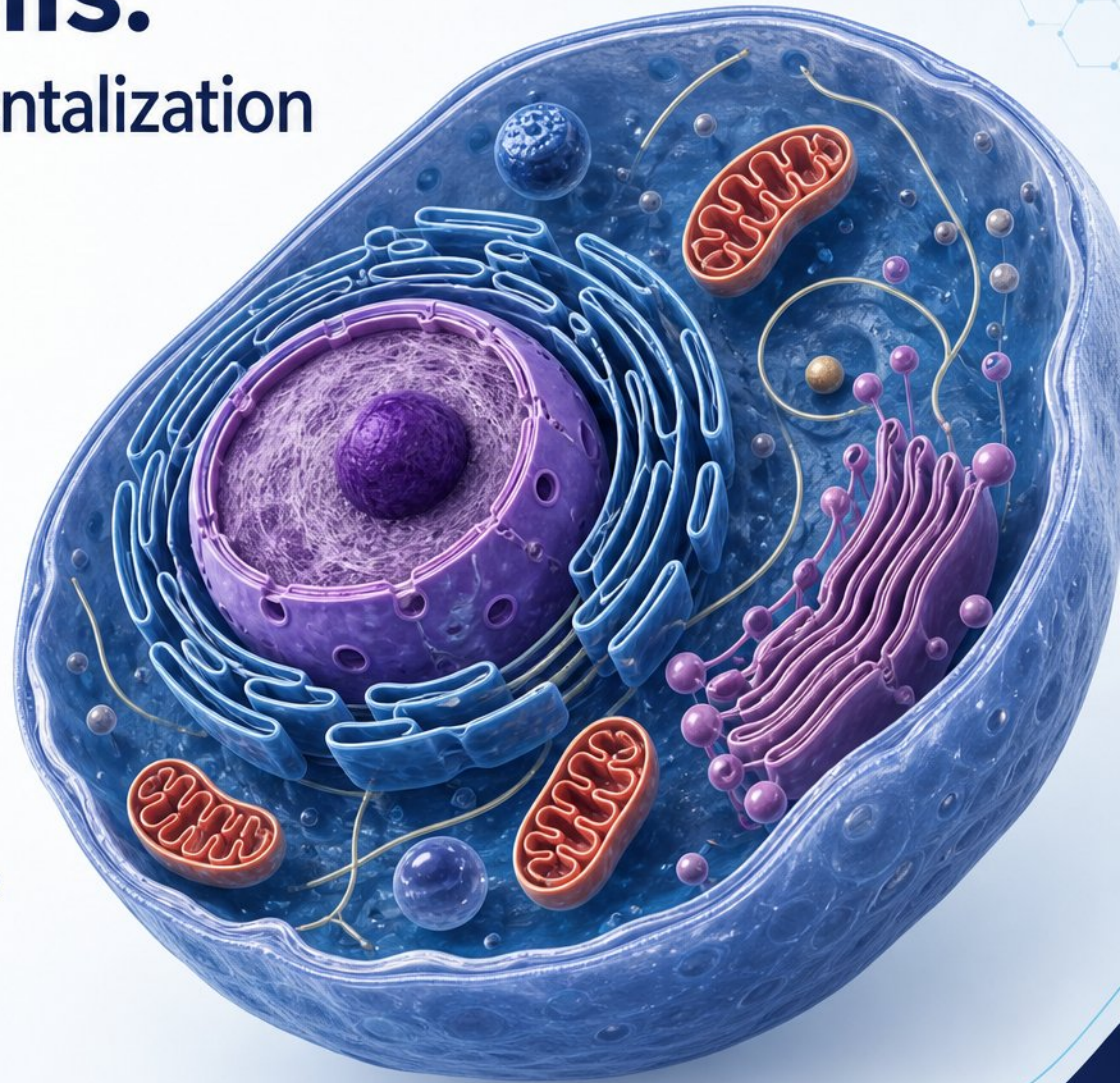
- Four kingdoms: Protists, Fungi, Plants, and Animals



- Compartmentalization boosts efficiency and complexity

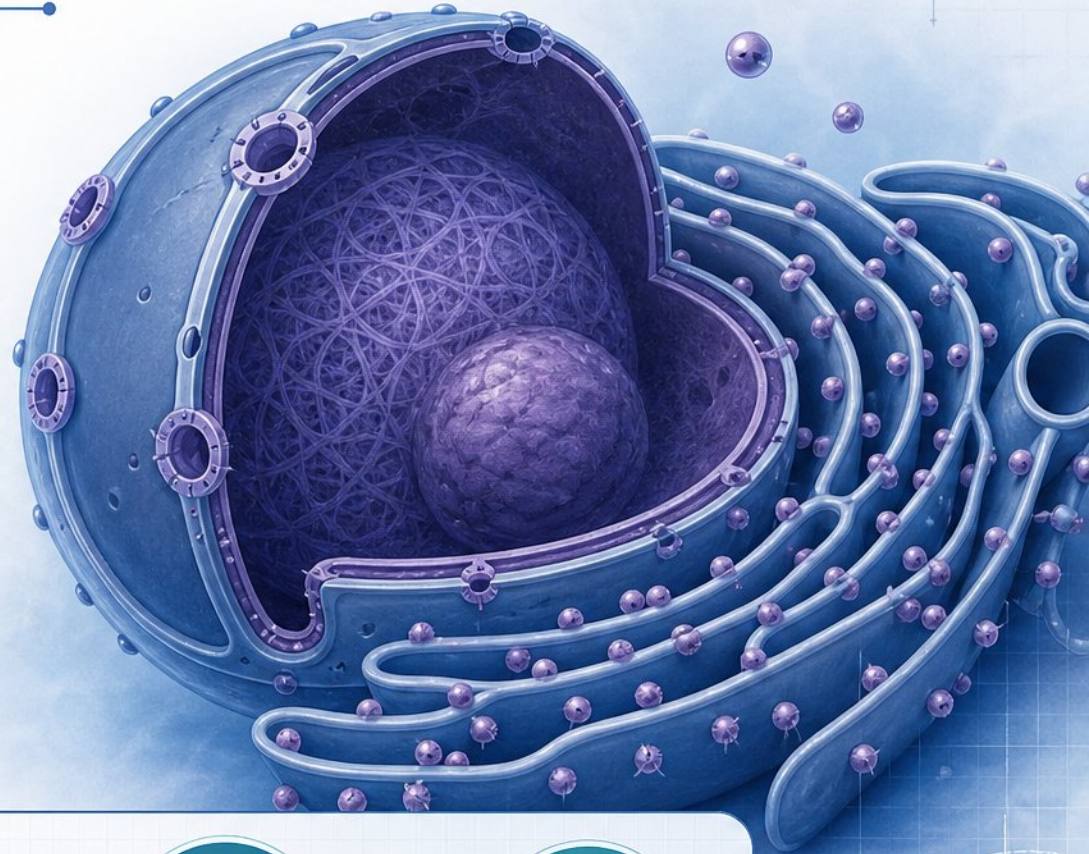


- Up next: nucleus, endomembrane system, and energy transformers



The Nucleus and Ribosomes: Information and Protein Synthesis

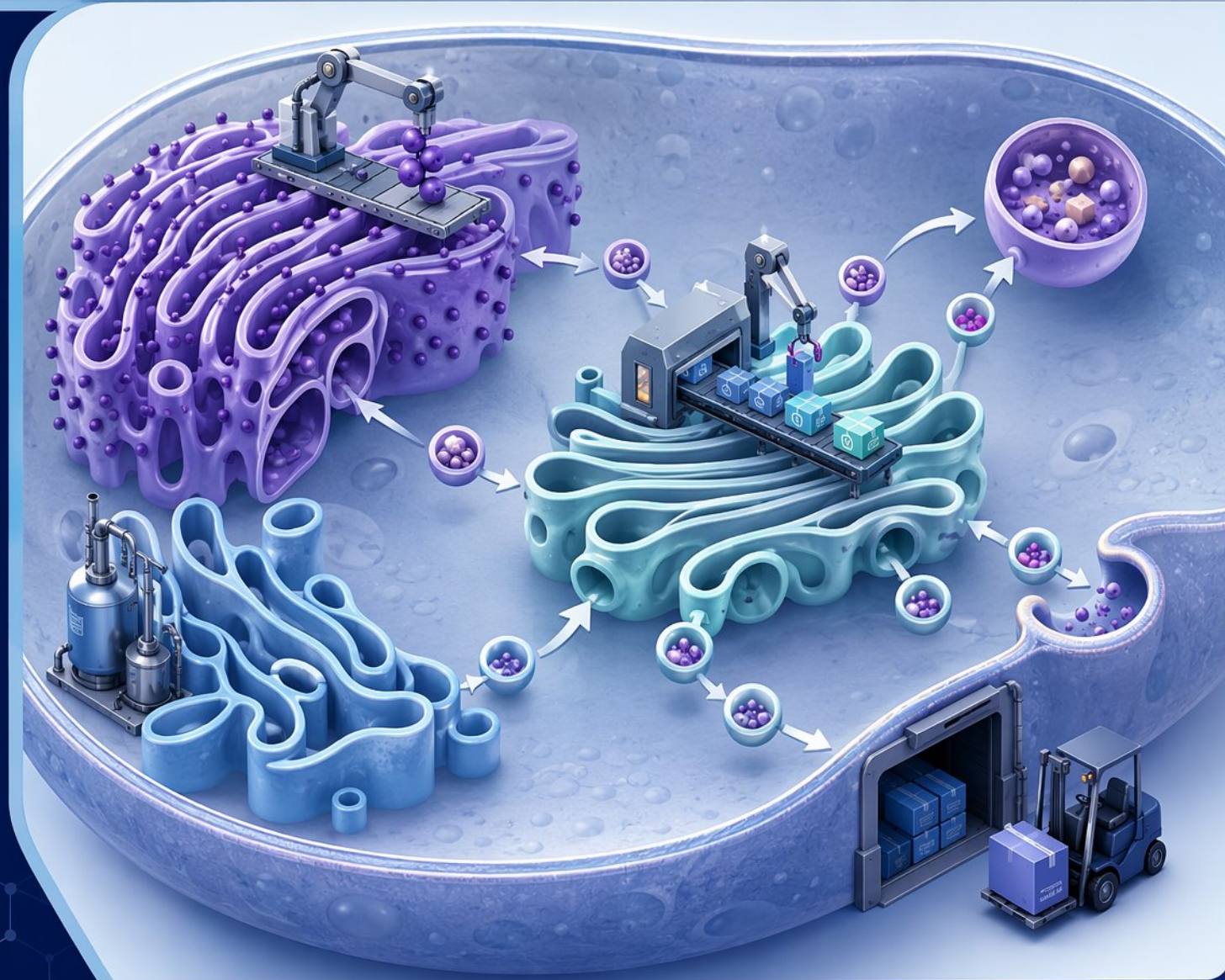
- Nucleus: control center storing DNA, bounded by a double membrane
- Nuclear pores regulate RNA and molecule passage in and out
- Ribosomes: protein-building machines, free or on rough ER
- DNA → RNA → ribosomes → protein synthesis





The Endomembrane System: A Cellular Factory

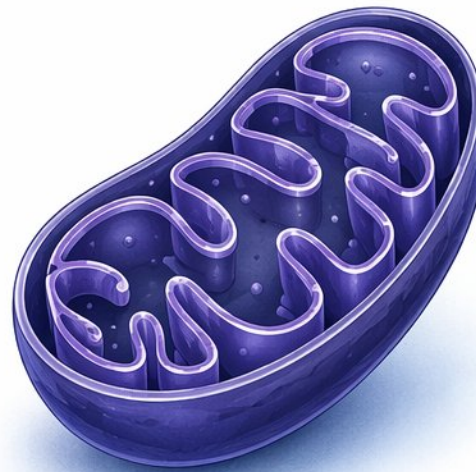
- Interconnected network of ER, Golgi, vesicles, and lysosomes
- Rough ER: ribosome-studded, synthesizes and modifies proteins
- Smooth ER: lipid synthesis and detoxification
- Golgi apparatus: modifies, sorts, and ships proteins
- Transport vesicles move materials between compartments



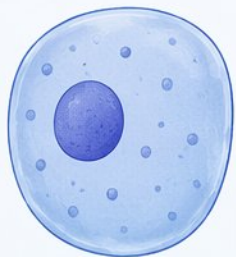
Mitochondria and Chloroplasts: The Energy Transformers

- **Mitochondria:** site of cellular respiration, converting food energy into ATP
- **Chloroplasts:** site of photosynthesis, converting light energy into sugars
- **Endosymbiotic theory:** both evolved from ancient engulfed prokaryotes
- Animal cells contain only mitochondria; plant cells contain both organelles

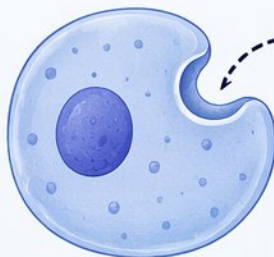
Mitochondrion



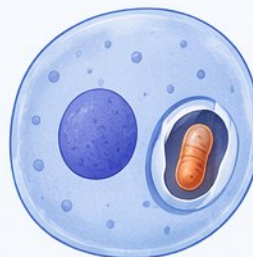
Chloroplast



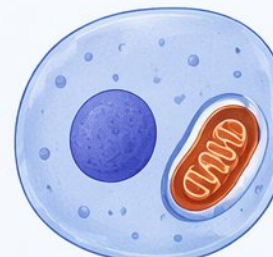
Ancestral host cell



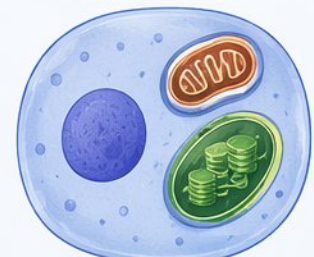
Engulfment of an ancient prokaryote



Prokaryote resides inside the host



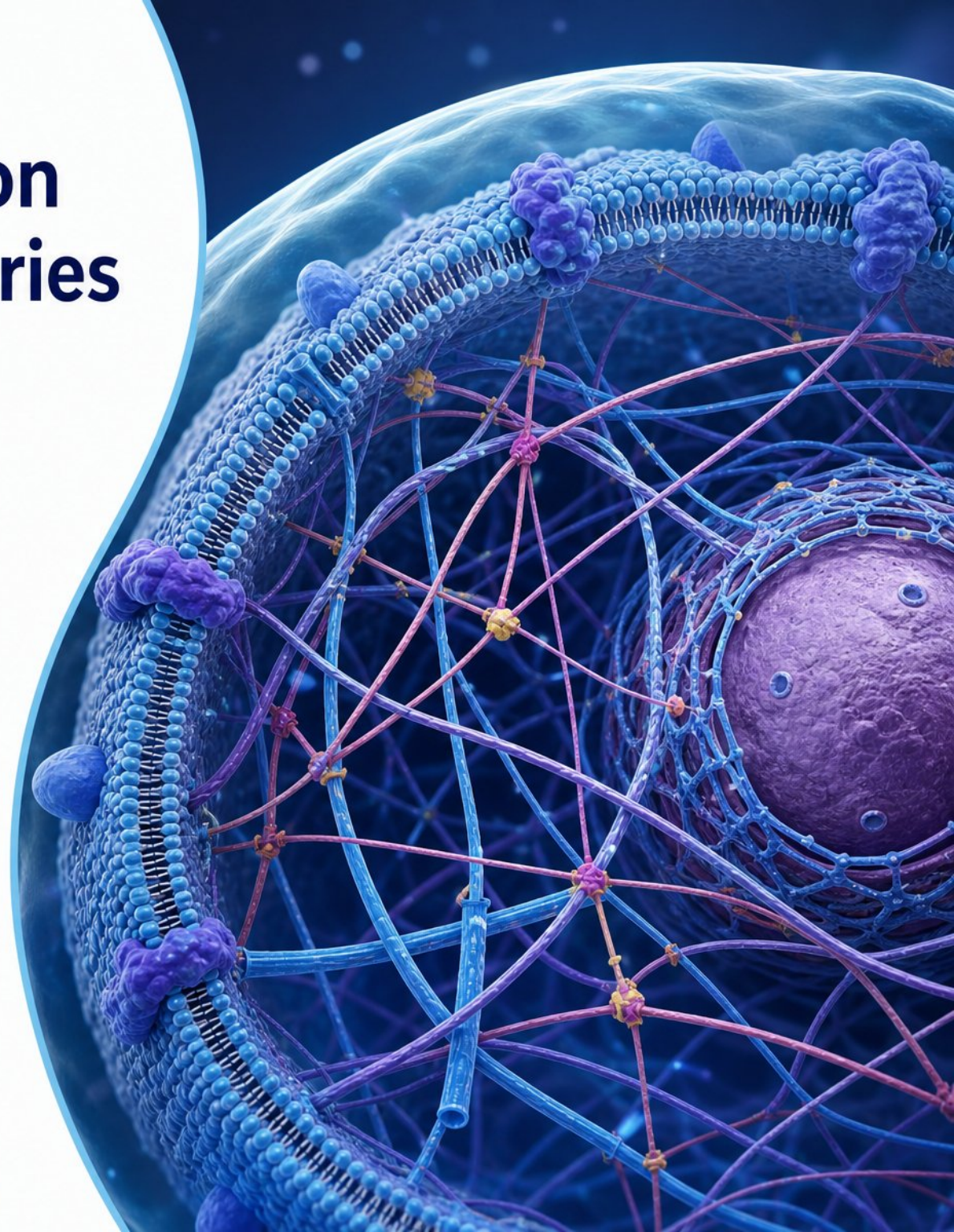
Symbiotic relationship establishes



Over time, specialized organelles evolve

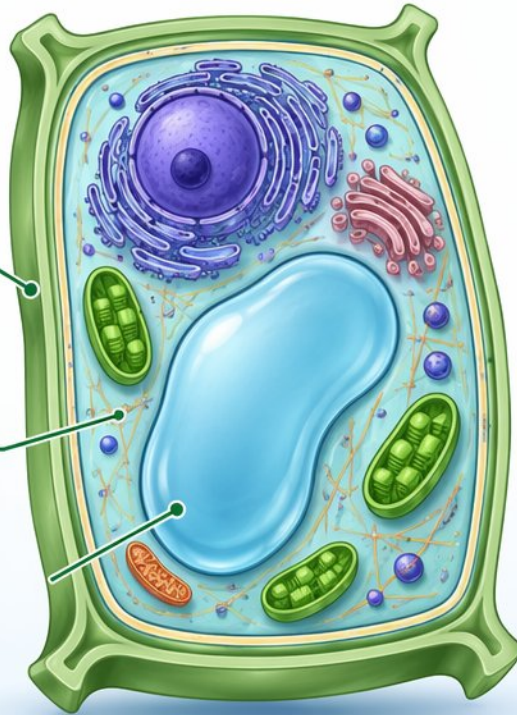
The Cytoskeleton and Cell Boundaries

- **Cytoskeleton:** Microfilaments, intermediate filaments, and microtubules provide shape and support
- **Fluid mosaic membrane:** A selectively permeable phospholipid bilayer with embedded proteins
- **Cell wall:** A rigid, protective layer outside the membrane in plants, fungi, and many prokaryotes
- These structures enable cell shape, movement, support, and internal transport



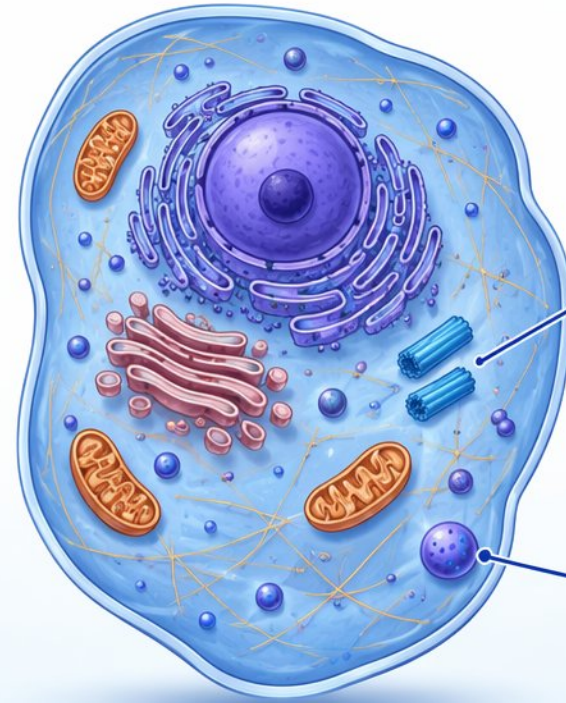
Plant vs. Animal Cells: A Side-by-Side Comparison

PLANT CELL



Plant-specific:
cellulose cell wall,
chloroplasts,
large central
vacuole

ANIMAL CELL



Animal-specific:
centrioles for
division



Animal-specific:
lysosomes for
digestion

VS.



Shared structures:

nucleus, ER, Golgi,
mitochondria, ribosomes,
membrane, cytoskeleton

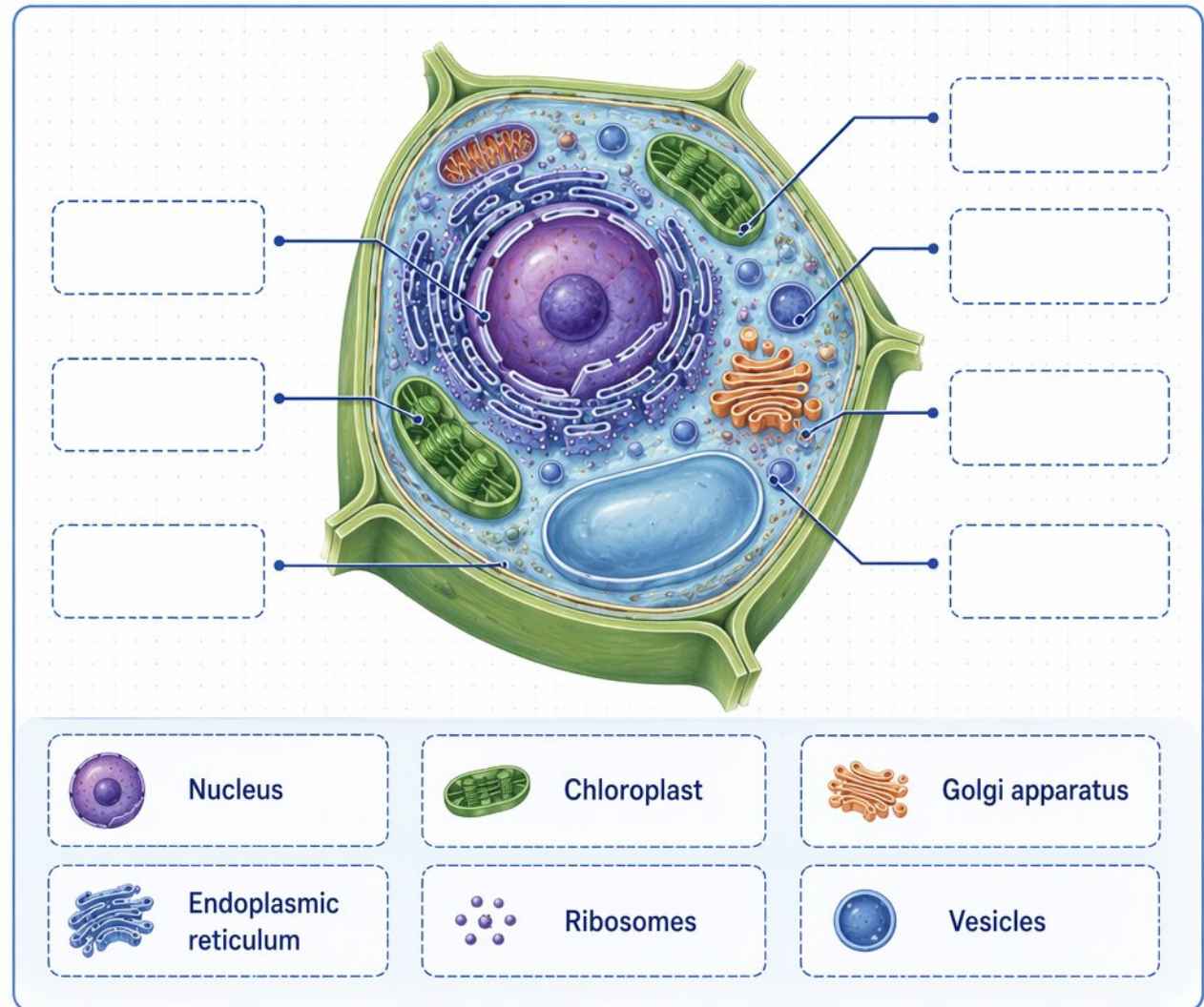


**Both are eukaryotic,
adapted for autotrophy
or heterotrophy**



Virtual Exploration: Identifying Organelles Under the Microscope

- Identify key organelles in a eukaryotic cell diagram
- Light microscope: nucleus, cell wall, chloroplasts
- Electron microscope needed for ribosomes, vesicles
- Connect location, structure, and function of each part
- Labeling exercise to solidify vocabulary and layout



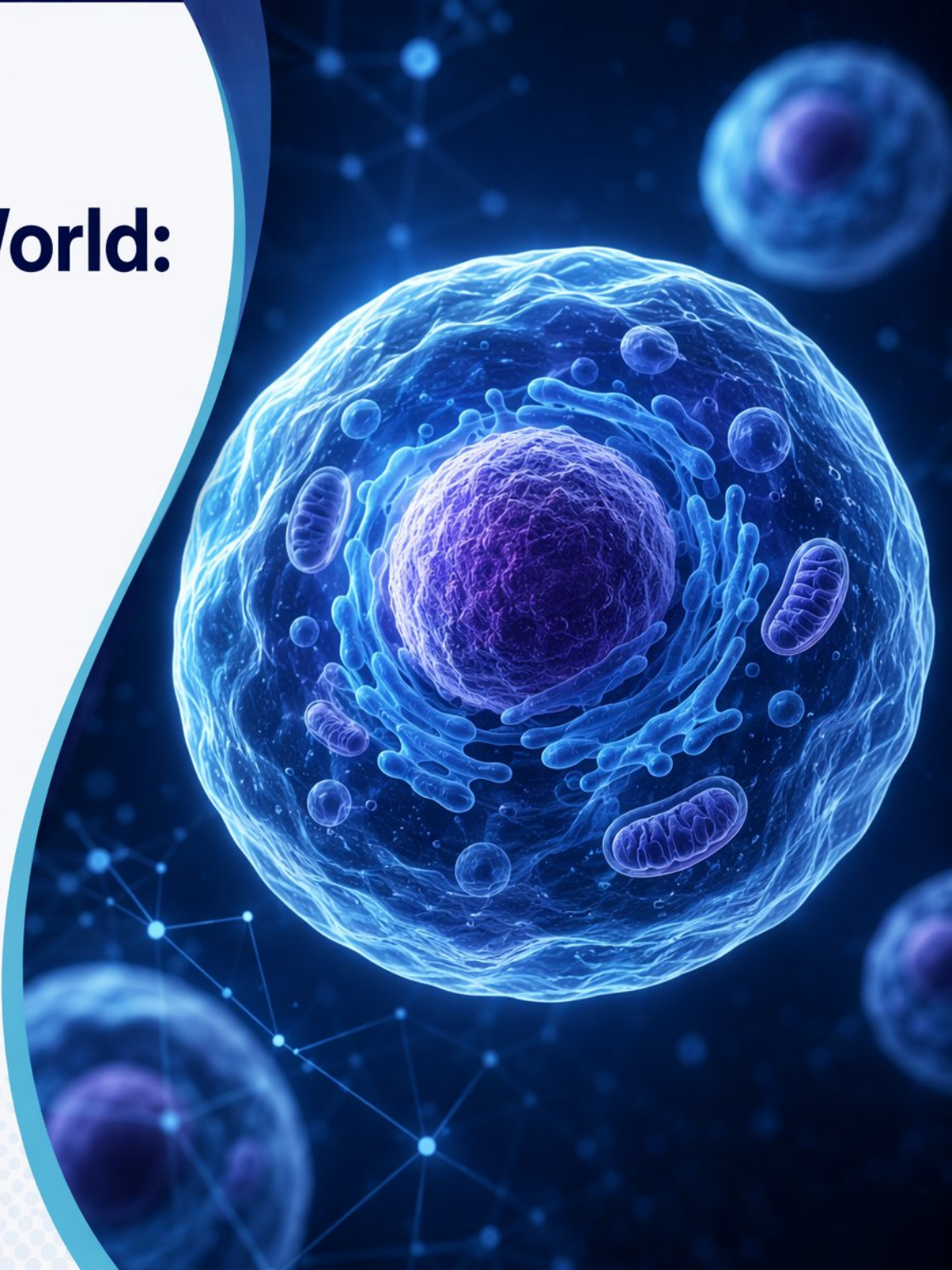
From Organelles to Systems: Cells Working Together

- Organelles form an integrated system, not isolated parts
- Pancreatic cells coordinate to produce and secrete insulin
- Biological hierarchy: organelles → cells → tissues → organs → systems
- Leaf cells cooperate across layers for efficient photosynthesis
- Individual cell activity drives whole-organism function



Cells in the Real World: Why This Matters

- Foundation for biology, medicine, and biotechnology
- Cancer results from breakdown of cell cycle control
- Antibiotics selectively target prokaryotic ribosomes
- Genetic engineering modifies cellular processes directly
- Stem cell therapy and personalized medicine rely on cell knowledge



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