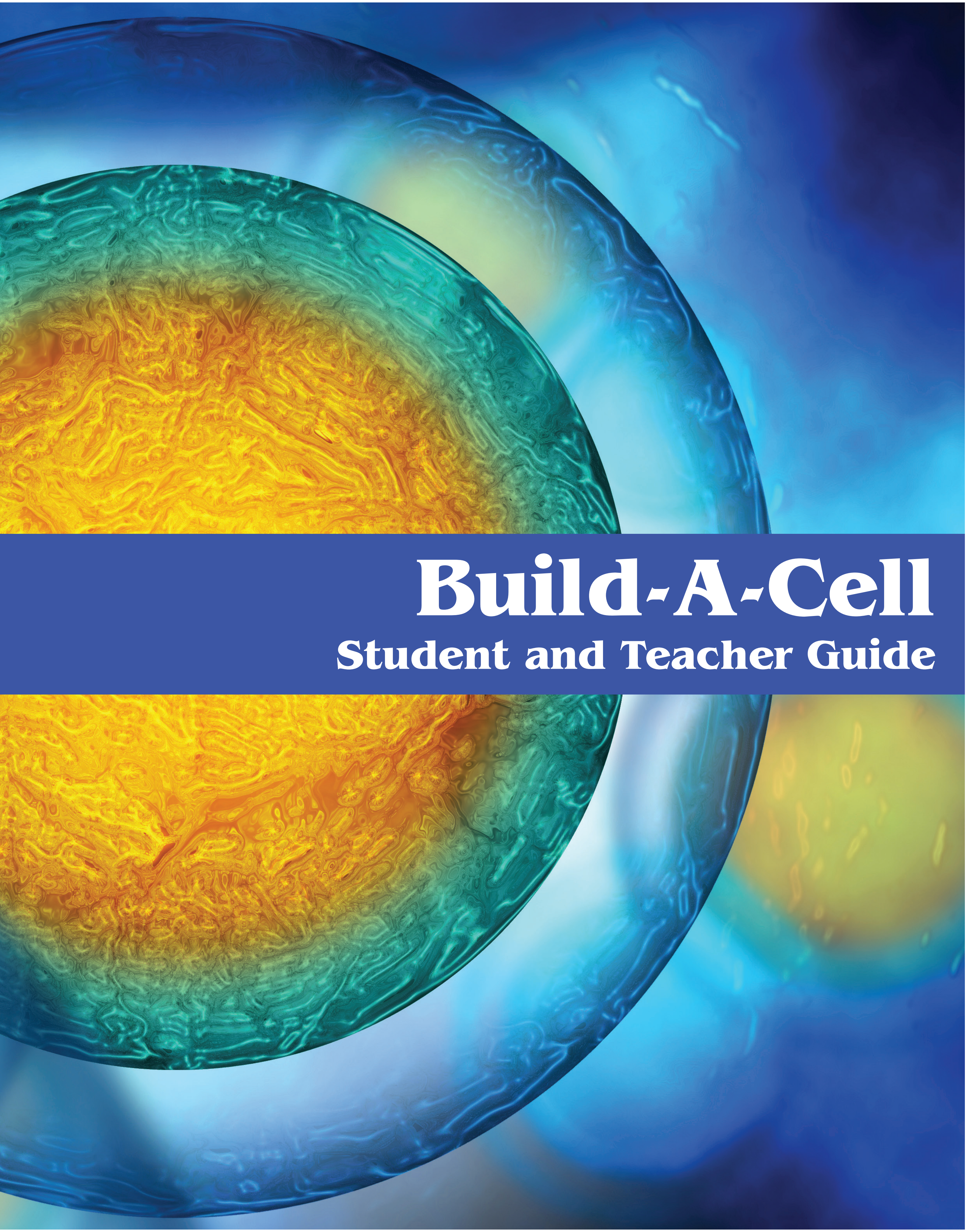
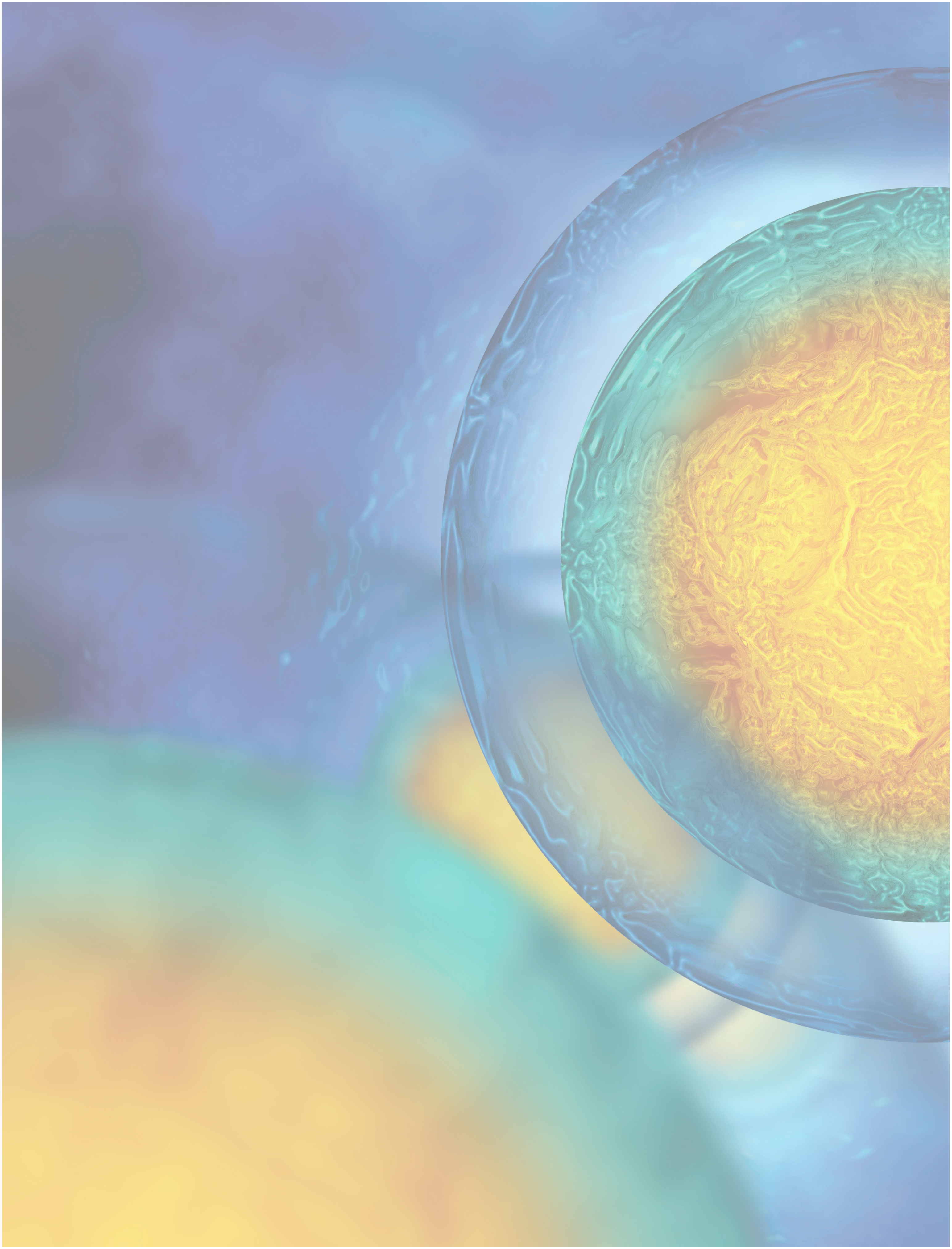


Build-A-Cell

Student and Teacher Guide



Build-A-Cell
Student and Teacher Guide

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Build-A-Cell Student and Teacher Guide

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Build-A-Cell Components

- Two copies of a thermoformed key to internal and external structures in print and braille
- Three tactile cell templates representing bacterial, plant, and animal cells. The templates consist of colored tactile external structures (e.g., cell membrane) surrounding an interior of black loop material that represents the cytosol. The cytosol is the semi-fluid substance in which all internal cell components reside, and the cytoplasm refers to all parts of the cell (e.g., cytosol, organelles, ribosomes) contained by the cell membrane excluding the nucleus.
- Three sets of tactile organelles and internal structures for each cell type and a pack of hook material dots
- Three loop-material-covered sheets for organelle storage
- Build-A-Cell Student and Teacher Guide in large print
- Build-A-Cell Student and Teacher Guide in braille (UEB) in a separate binder

Instructors: Place one or two hook material dots on the back of each of the internal cell structures and organelles before using the kit.

Key to Internal Cell Structures

⠁ plasmid (a)

⠉ chloroplast (c)

⠑ rough endoplasmic reticulum (e)

⠛ Golgi apparatus (g)

⠇ lysosome (l)

⠍ mitochondrion (m)

⠝ nucleus (n)

⠕ nucleoid region (o)

⠏ polysomes (p)

⠗ ribosomes (r)

⠎ smooth endoplasmic reticulum (s)

⠥ nucleolus (u)

⠧ vacuole (v)

⠭ peroxisome (x)

⠽ cytoskeleton (y)

⠵ centrosome with centrioles (z)

Introduction

This model system is designed to assist students, teachers of the visually impaired (TVIs), and classroom teachers with lessons on the internal and external structure of bacterial, plant, and animal cells. The fundamental characteristics of and differences between various cell types have been known for a long time and are discussed in almost all biology textbooks. While all cells share certain structural parts—for example, a cell membrane—cells of different evolutionary origins have components that set them apart from each other.

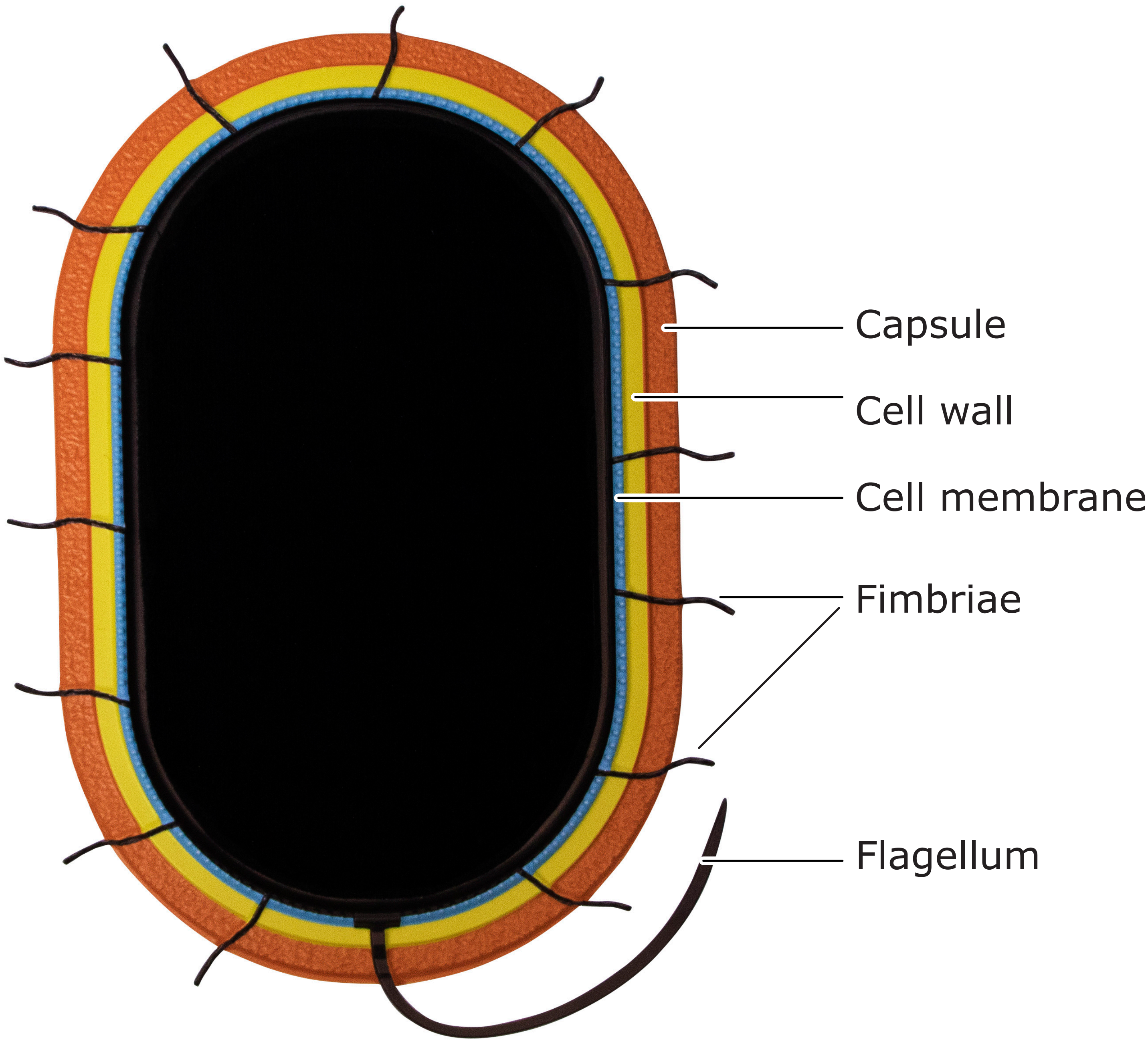
This model system is useful to introduce and teach the concepts of cell structure, as well as to check student understanding and comprehension.

A Note Regarding Cell Size

The three cell types included with this model system are presented as more or less the same size. In reality, a single bacterial cell is typically 1–5 microns in diameter, a dimension range that is not possible to see without the aid of a microscope. To get an idea of just how small that is, consider that 2 microns is equal to one ten-thousandth of an inch (0.0001 inch), which is thinner than a strand of spider silk. On the other hand, plant and animal cells are about ten to one hundred times larger than a bacterial cell. The typical size range of these cells is 10–100 microns across, about the thickness of a human hair or the diameter of a pollen grain.

Bacterial Cell Template

Common bacterial shapes include rods, spheres, and spirals; the shape of the bacterial cell in this model is a rod. The layered parts of this bacterial cell template, starting from the outermost layer, include the capsule, cell wall, and cell membrane.



Capsule

The outer orange, sandy-textured layer of the bacterial cell template represents the capsule. It is a thick layer of sticky substances that protects the bacterium and helps it stick to other bacteria and surfaces in its environment. Not all bacteria have a capsule.

Cell Wall

The middle yellow, smooth layer just inside the capsule represents the cell wall. It is made of interlinked sugar molecules, different from those found in plant cells. The cell wall provides structural support and gives the bacterium its shape. Most, but not all, bacteria have a cell wall.

Cell Membrane

The inner blue, dot-textured layer represents the cell membrane, which all bacteria possess. It comprises a bilayer of phospholipids embedded with proteins.

Fimbriae

The thin, black lines emerging from the cell membrane in a perpendicular orientation represent fimbriae (singular, fimbria). These structures are made of protein and help bacteria adhere to other cells or surfaces in the environment. Some, but not all, bacteria possess fimbriae. (Do not confuse fimbriae with cilia, which are structures found in some animal cells.)

Flagellum

The longer and thicker filamentous structure located at the bottom of the cell model and curving to the right is the bacterial flagellum. Bacteria can have one, many, or no flagella at all. Bacterial flagella emerge from the cell membrane, are long and flexible, and are made of protein. The bacterial flagellum is similar in appearance to flagella found in animal cells, but they are very different in molecular structure. With its whip-like action, a flagellum assists in the movement of a bacterium toward or away from a stimulus.

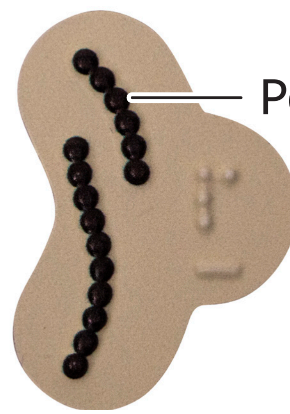
Structures Found Inside Bacterial Cells

Nucleoid Region

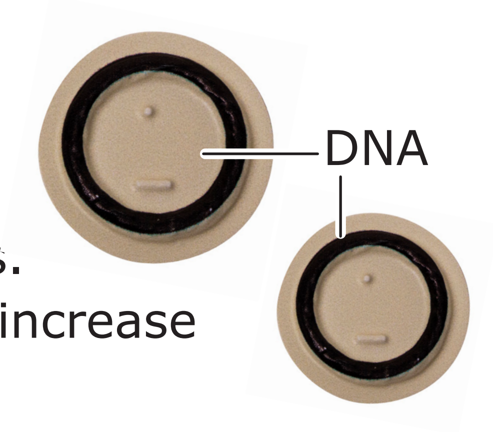
Bacteria are prokaryotic cells. This means they do not have a membrane-bound nucleus or any membrane-bound organelles. Instead of a nucleus, bacteria have a nucleoid region. Located in the center of the cell, the nucleoid contains a single chromosome mad of one long deoxyribonucleic acid (DNA) molecule in the form of a closed loop.

Ribosomes and Polysomes

Ribosomes are tiny complexes of ribonucleic acid (RNA) and protein and are the sites of protein synthesis in all cells. Ribosomes are not membrane-bound and, therefore, not considered organelles. Ribosomes can be found singly and free in the cytoplasm of bacterial cells or linked together to form a chain-like polysome.



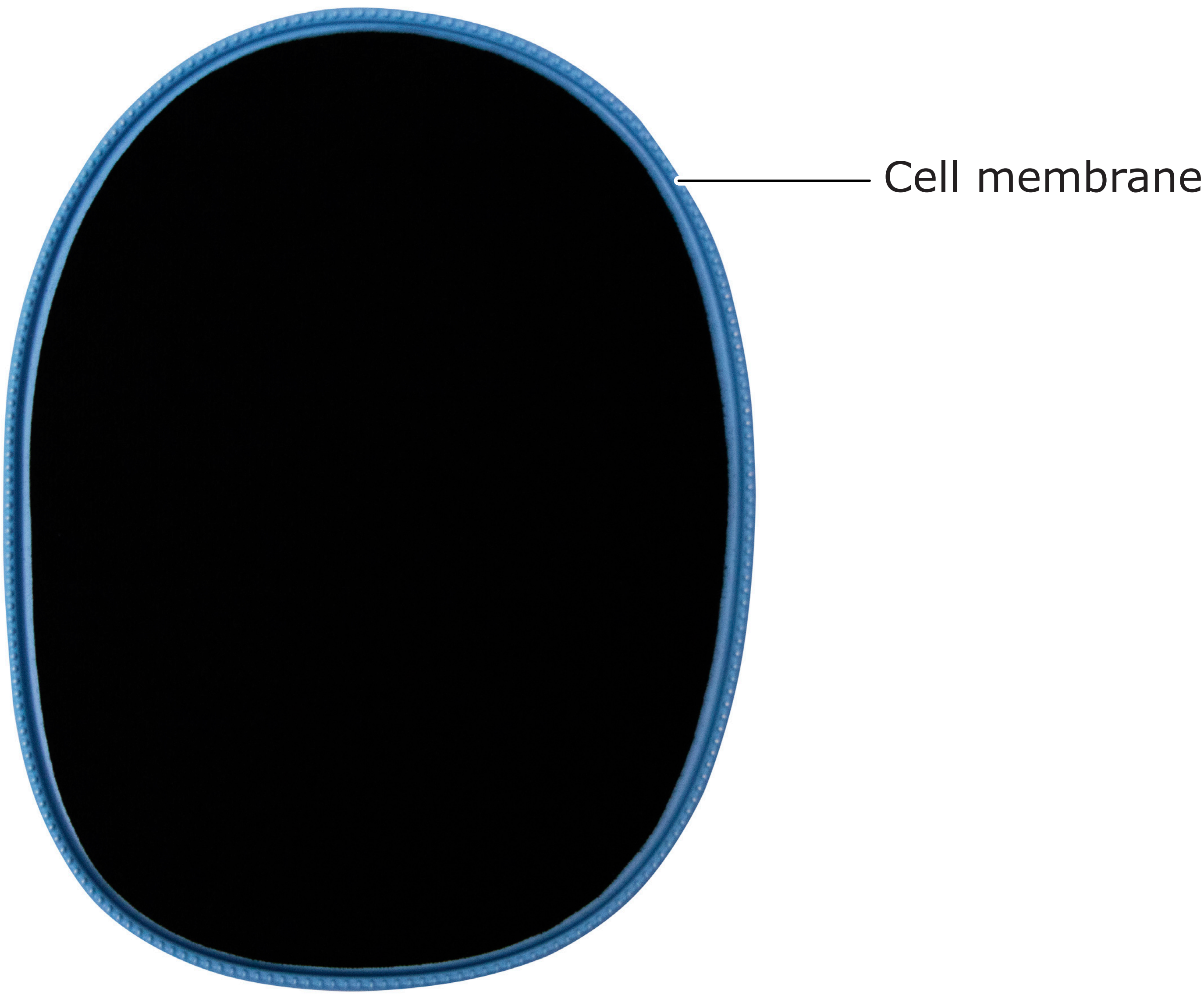
Plasmids



Some bacteria also possess smaller loops of DNA, in addition to the main chromosome, that are known as plasmids. Plasmids contain contingency genes that increase the survival of a bacterium under certain environmental conditions.

Animal Cell Template

Animal cells come in many shapes; the animal cell in this model is somewhat oblong.

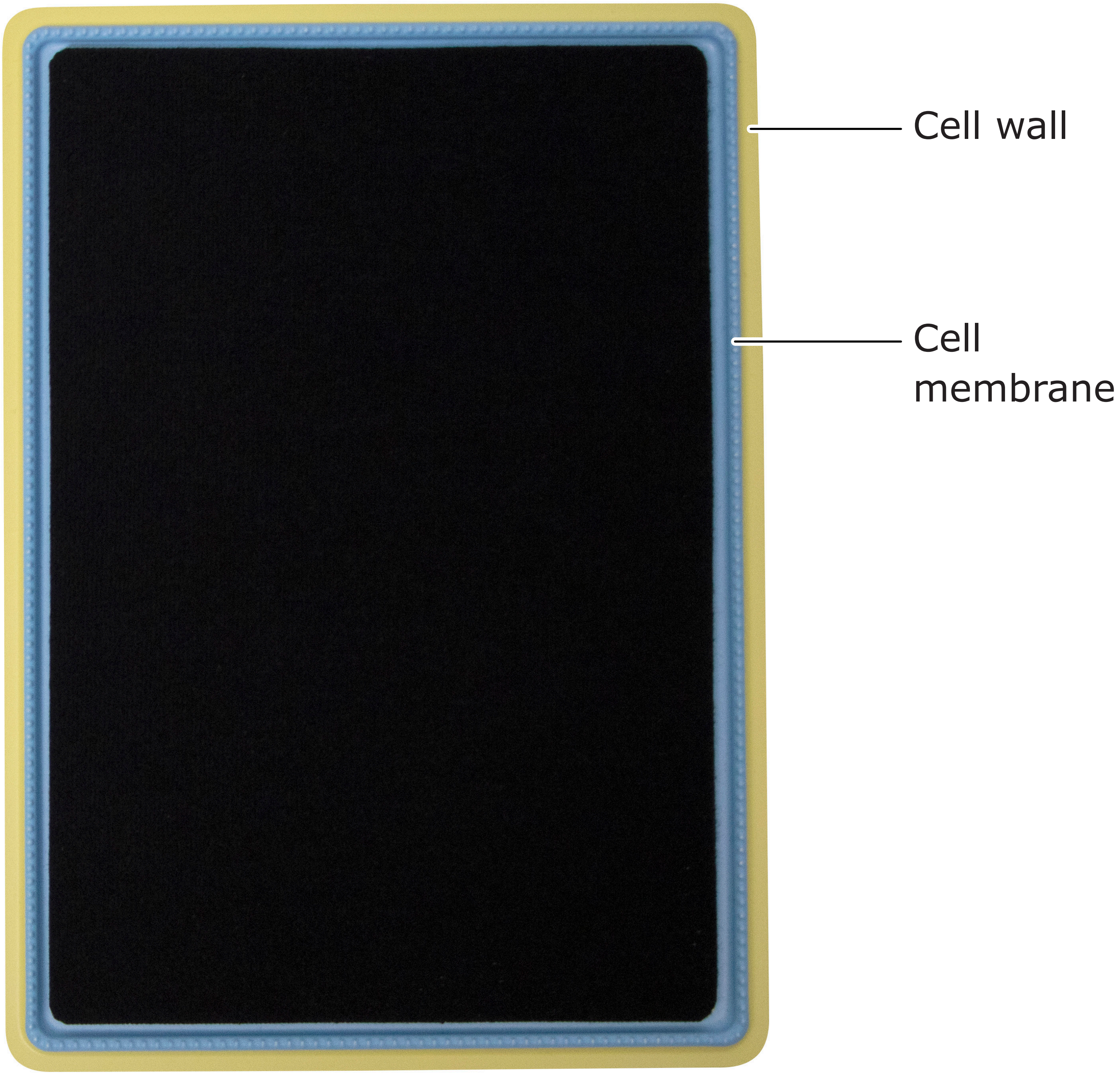


Cell Membrane

The blue, dot-textured outer layer represents the cell membrane, which is present in all animal cells. The cell membrane comprises a phospholipid bilayer embedded with proteins.

Plant Cell Template

Plant cells typically have flat sides that form boxy shapes such as cubes, rectangles, and polygons with six or more sides. The shape of the plant cell in this model is rectangular.



Cell Wall

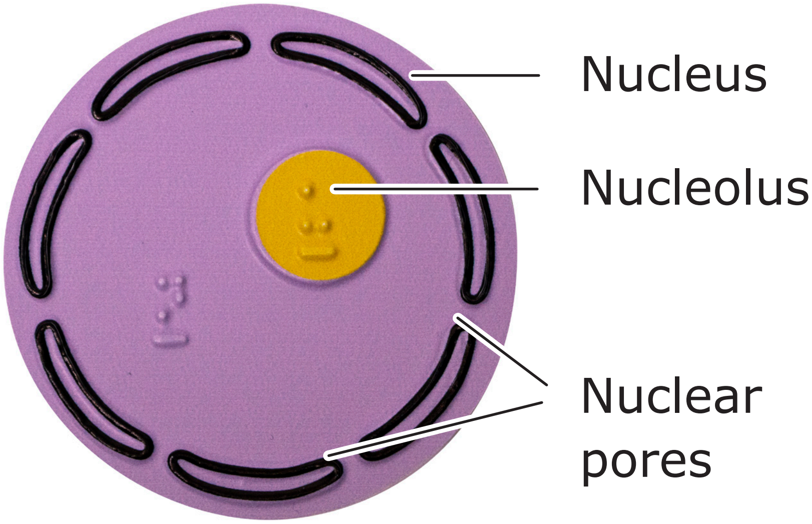
The outer yellow, smooth layer of the plant cell template represents the cell wall, which in plants is made of cellulose and other linked sugars. The cell wall is rigid and maintains the structure and shape of the plant cell. A cell wall surrounds all plant cells.

Cell Membrane

The blue, dot-textured layer represents the cell membrane, a structure found in all plant cells. The cell membrane comprises a phospholipid bilayer embedded with proteins.

Organelles and Structures Found Inside Animal and Plant Cells

Animal and plant cells are eukaryotic, which means that they have a true nucleus that is surrounded by a nuclear envelope. Eukaryotic cells also possess membrane-bound organelles.



Nucleus

The nucleus is an organelle that contains the genetic material (DNA) in the form of linear chromosomes, as well as the nucleolus. The nucleus is bounded by a nuclear envelope, which is a double membrane with pores. Proteins and ribonucleic acid (RNA) move into and out of the nucleus via these pores.

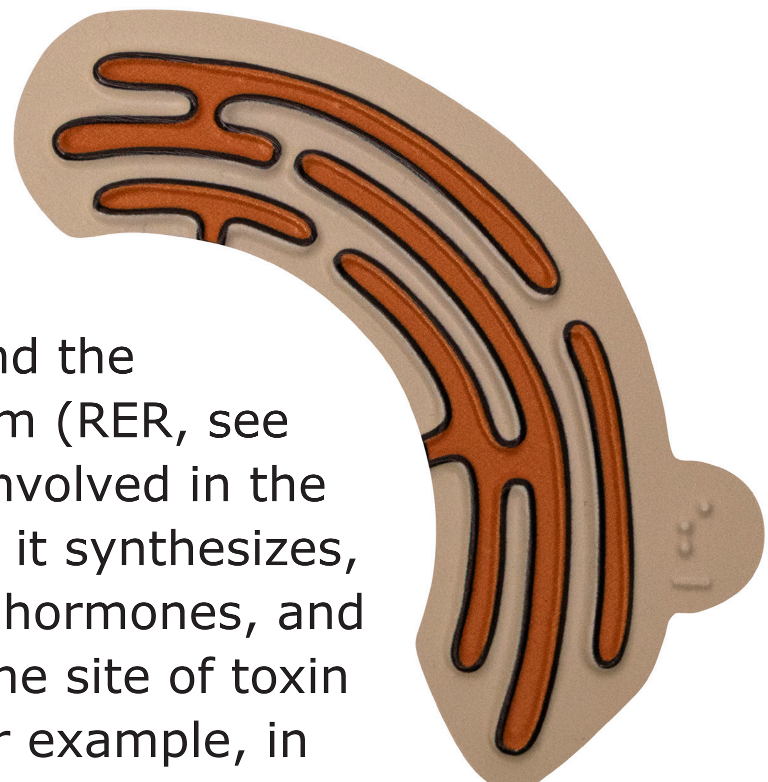
Nucleolus

The nucleolus appears as a dense structure within the nucleus. The nucleolus is the region in the cell where ribosomal subunits are constructed out of RNA. Ribosomal subunits move out of the nucleus through the nuclear pores. Some cells have more than one nucleolus within their nuclei.

Ribosomes

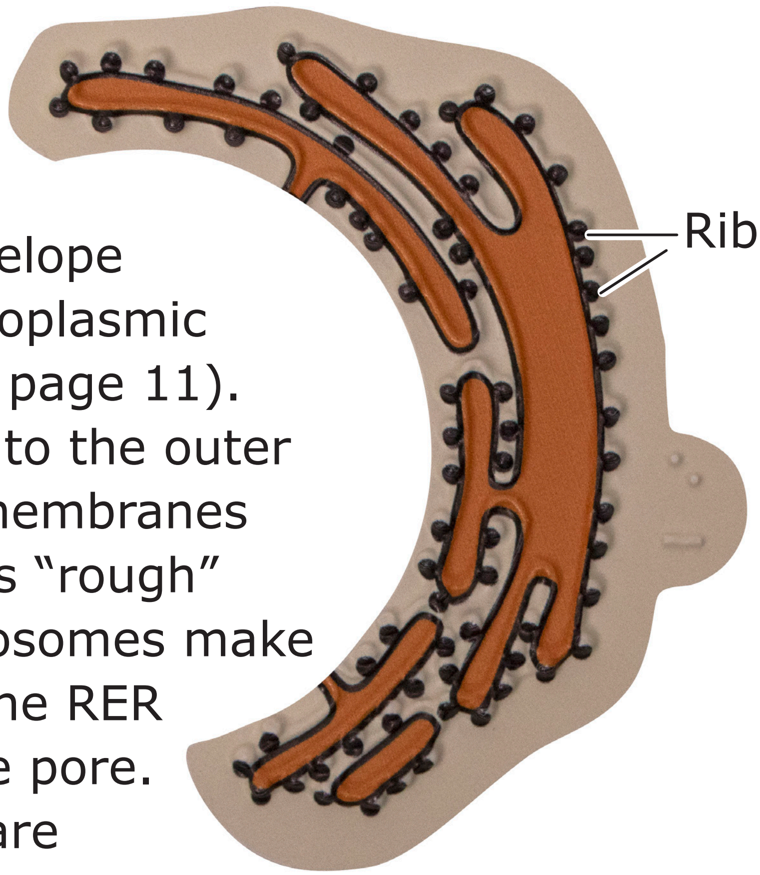
Ribosomes are tiny complexes of ribonucleic acid (RNA) and protein and are the sites of protein synthesis in all cells. Ribosomes are not membrane-bound and, therefore, not considered organelles. Ribosomes can be found singly and free in the cytoplasm of all cells, or attached to the rough endoplasmic reticulum in plant and animal cells (see page 12).

Smooth Endoplasmic Reticulum



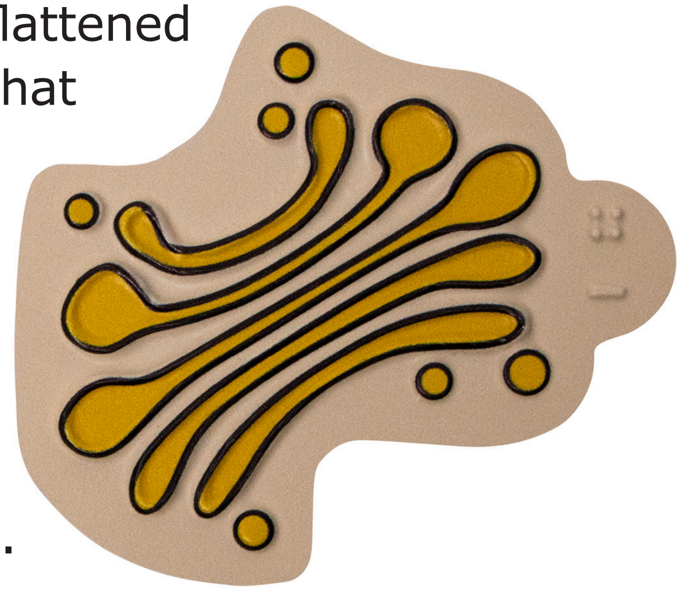
The Smooth Endoplasmic Reticulum (SER) is a system of interconnected membranous tubules and sacs that are continuous with the nuclear envelope and the Rough Endoplasmic Reticulum (RER, see page 12). This organelle is involved in the distribution of the molecules it synthesizes, which include fats, steroids, hormones, and membrane lipids. It is also the site of toxin breakdown in some cells (for example, in the vertebrate liver). The SER is considered smooth because it lacks the ribosomes found on the outer surface of the RER.

Rough Endoplasmic Reticulum



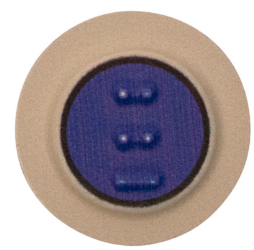
The Rough Endoplasmic Reticulum (RER) is a system of interconnected membranous tubules and sacs that are continuous with the nuclear envelope and the Smooth Endoplasmic Reticulum (SER, see page 11). Ribosomes attached to the outer surface of the RER membranes give this organelle its “rough” appearance. The ribosomes make proteins that enter the RER through a membrane pore. Proteins in the RER are modified and then exported out of the cell, exported to other regions within the cell, or sent to the Golgi apparatus for further modification. Like the SER, the RER is a source of membranes for other parts of the cell.

Golgi Apparatus



The Golgi apparatus is a set of flattened and layered membranous sacs that receives membrane-enclosed proteins from the RER. After the proteins are modified, sorted, and re-enclosed in membranes, they are transported to other regions of the cell, or even outside the cell.

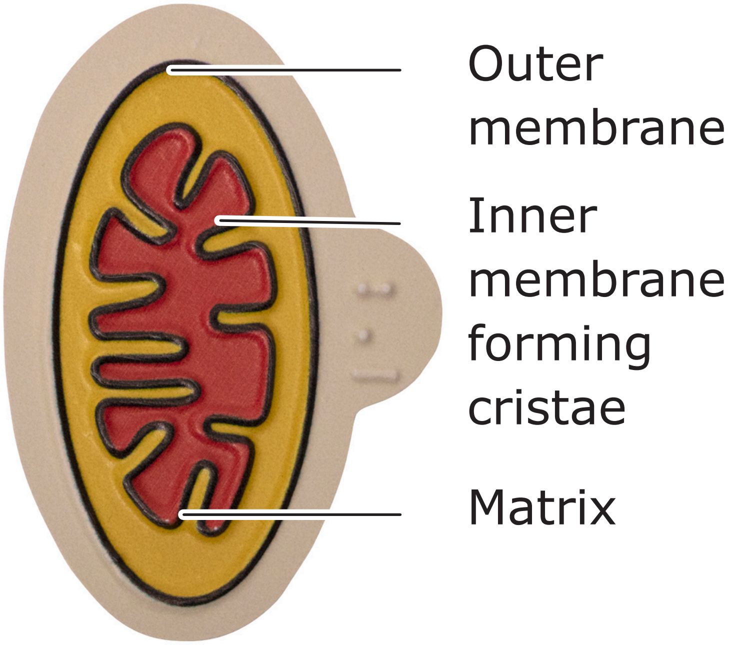
Peroxisome



The peroxisome is a membrane-bound organelle containing enzymes that dismantle toxic substances and break down fat molecules to fuel aerobic respiration in mitochondria. These functions result in the formation of hydrogen peroxide, a potentially harmful chemical that is neutralized by other enzymes in this organelle.

Mitochondrion

Found in both plant and animal cells, the mitochondrion is also known as the powerhouse of the cell. It is the site of energy transformation, or the conversion of stored energy in fats or sugars to adenosine triphosphate (ATP). The mitochondrion is bounded by two membranes: an outer enclosing membrane and an inner membrane that is folded to form regions called cristae. The central part of the organelle is called the matrix.

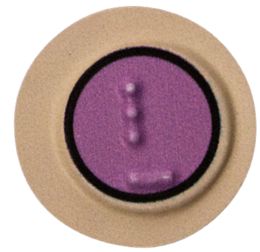


Cytoskeleton

The cytoskeleton is a complex of protein fibers of different lengths and thicknesses that provides internal support in eukaryotic cells. The cytoskeleton is dynamic and readily changes form. The cytoskeleton is involved in cellular movement, maintaining or changing cell shape, and moving organelles, vesicles, and chromosomes.

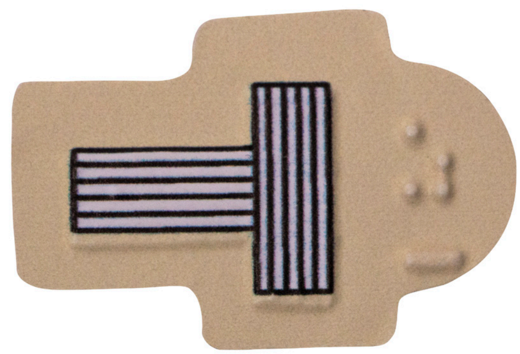
Organelles and Structures Found Inside Animal Cells Only

Lysosome



The lysosome is a membrane-bound organelle found only in animal cells. It contains digestive enzymes that enable the cell to break down large molecules for recycling or to access nutrients after a cell has engulfed a food particle.

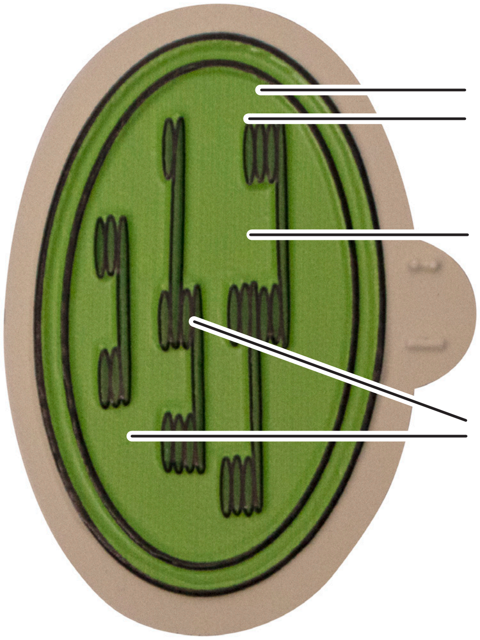
Centrosome With Two Centrioles



The centrosome is usually located near the nucleus of an animal cell and contains two centrioles oriented at right angles to each other; it is not bounded by a membrane. The centrosome is the location where spindle microtubules emerge during the nuclear division processes of mitosis and meiosis. The centrioles are barrel-shaped structures composed of short protein fibers arranged in a ring. The two perpendicularly arranged centrioles in this model are presented in longitudinal section and show the short parallel protein fibers of each one.

Organelles Found Inside Plant Cells Only

Chloroplast

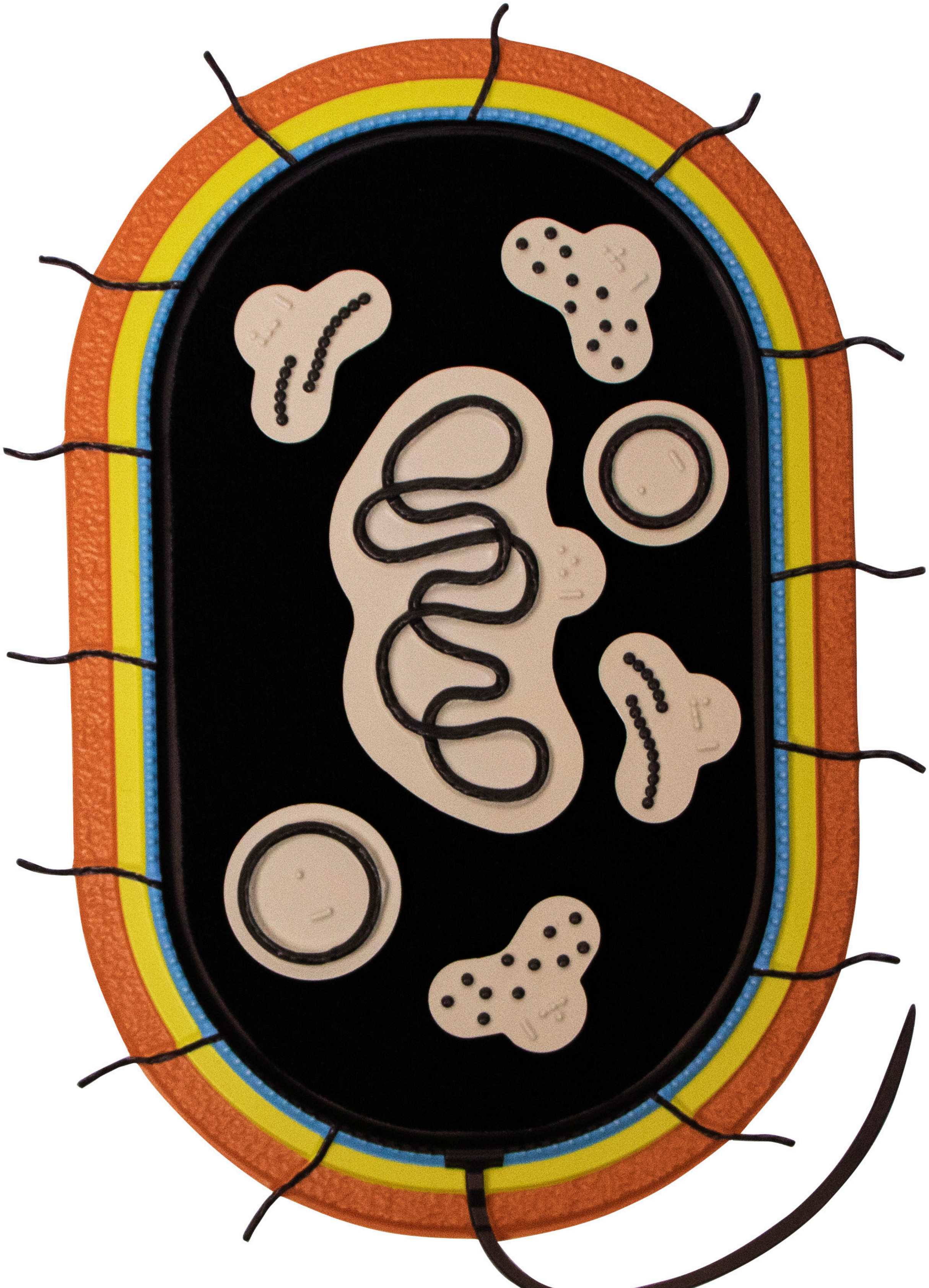


Chloroplasts are found in green plant cells, algae, and unicellular eukaryotic cells that undergo photosynthesis. The chloroplast is bounded by two outer membranes, both of which enclose an inner compartment called the stroma. A third membrane system is organized into flattened and stacked discs called thylakoids, which reside in the stroma. The chloroplast is where light energy is transformed into the chemical energy of sugar and ATP.

Vacuole

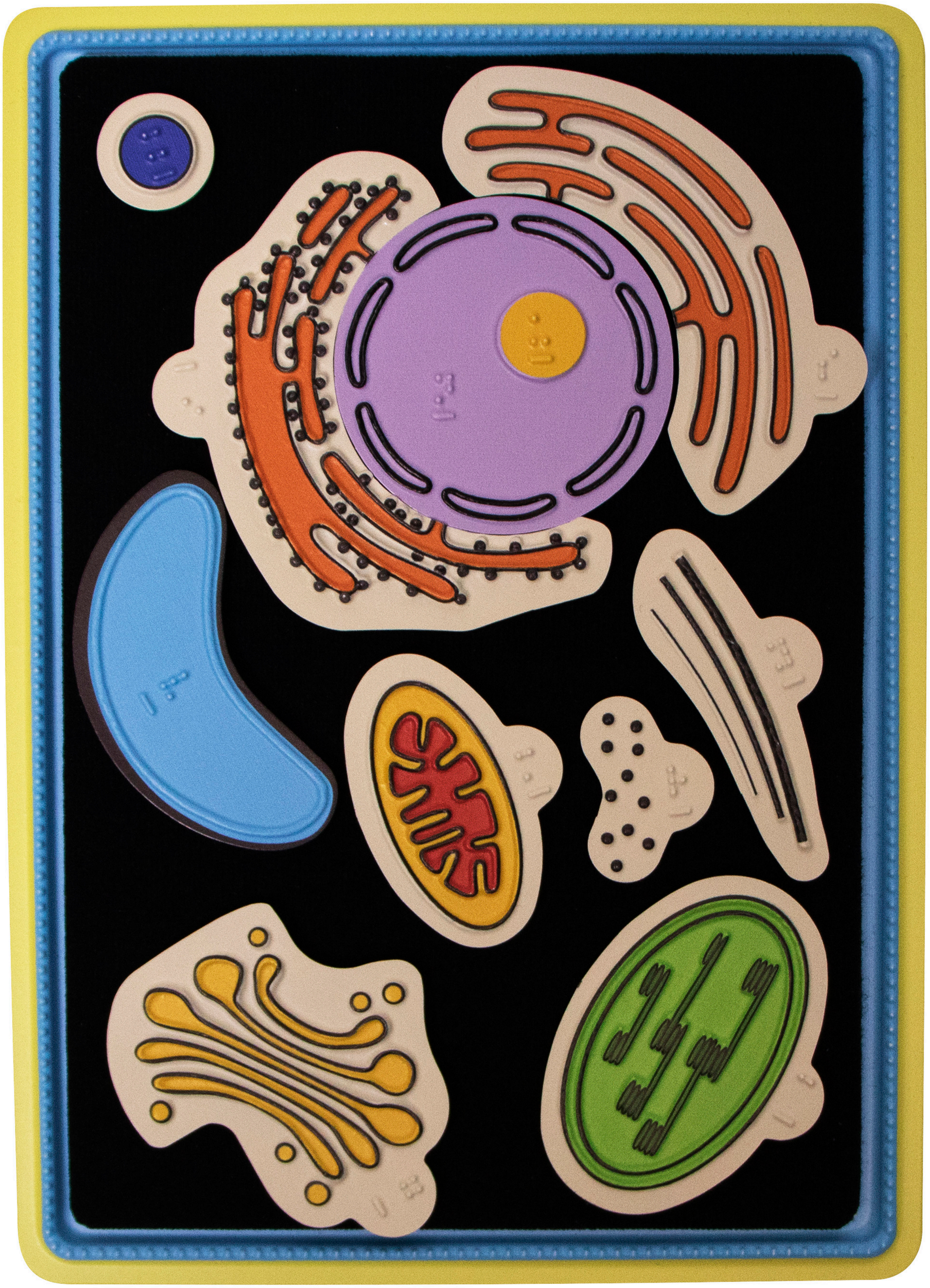
The vacuole is a multi-functional, membrane-bound organelle found in plant cells. Depending on the organism and cell type, vacuoles serve as storage depots for water, ions, pigments, proteins, enzymes, and even poisons that deter animals from eating the organism.

Assembled Bacterial Cell



Assembled Animal Cell

Assembled Plant Cell



Alignment With Next Generation Science Standards[1]

Disciplinary Core Ideas: Life Sciences

MS-LS1-1 From Molecules to Organisms: Structures and Processes.

A. Structure and Function

All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).

Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

MS-LS1-2 From Molecules to Organisms: Structures and Processes.

A. Structure and Function

Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.

Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.

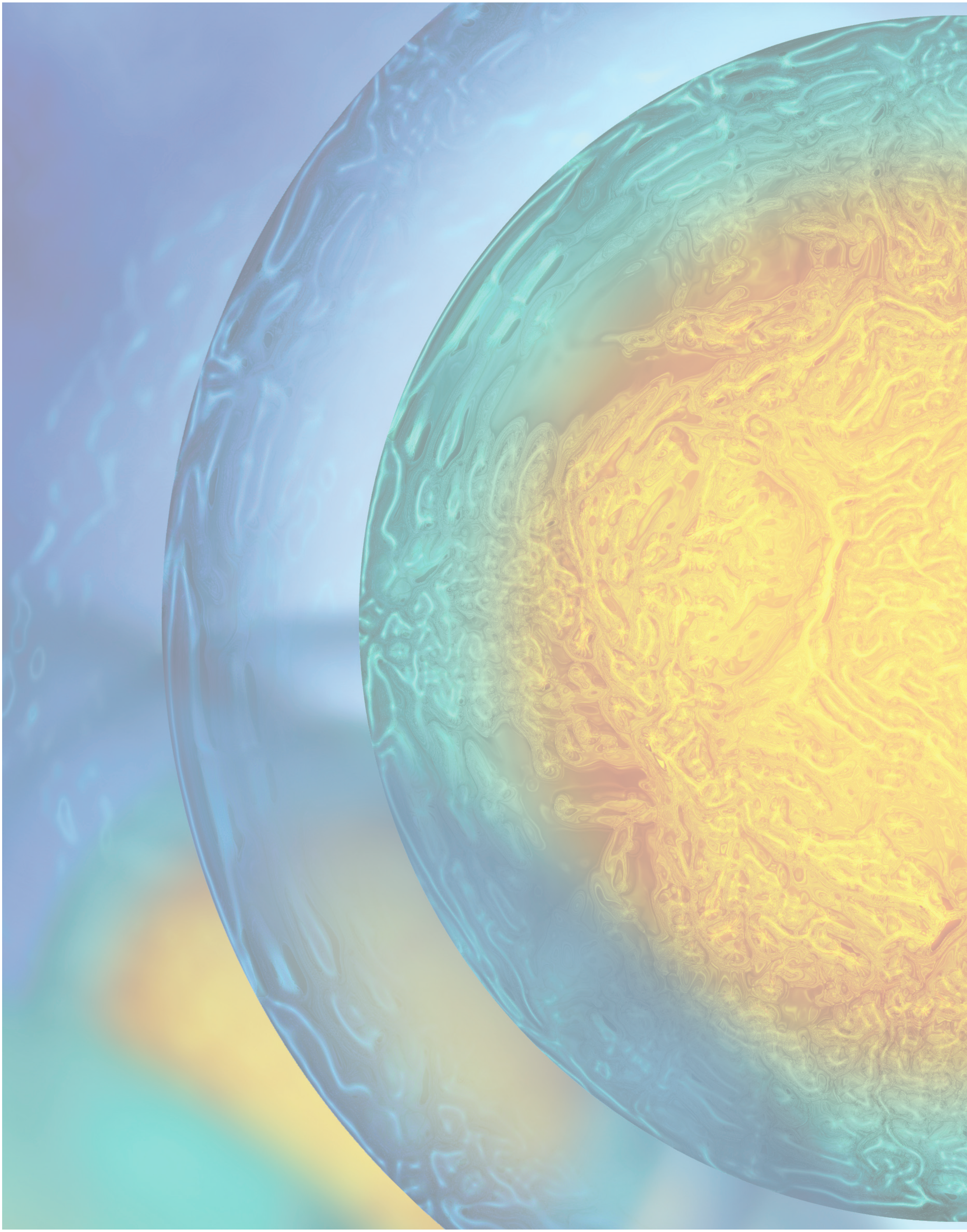
MS-LS1-3 From Molecules to Organisms: Structures and Processes.

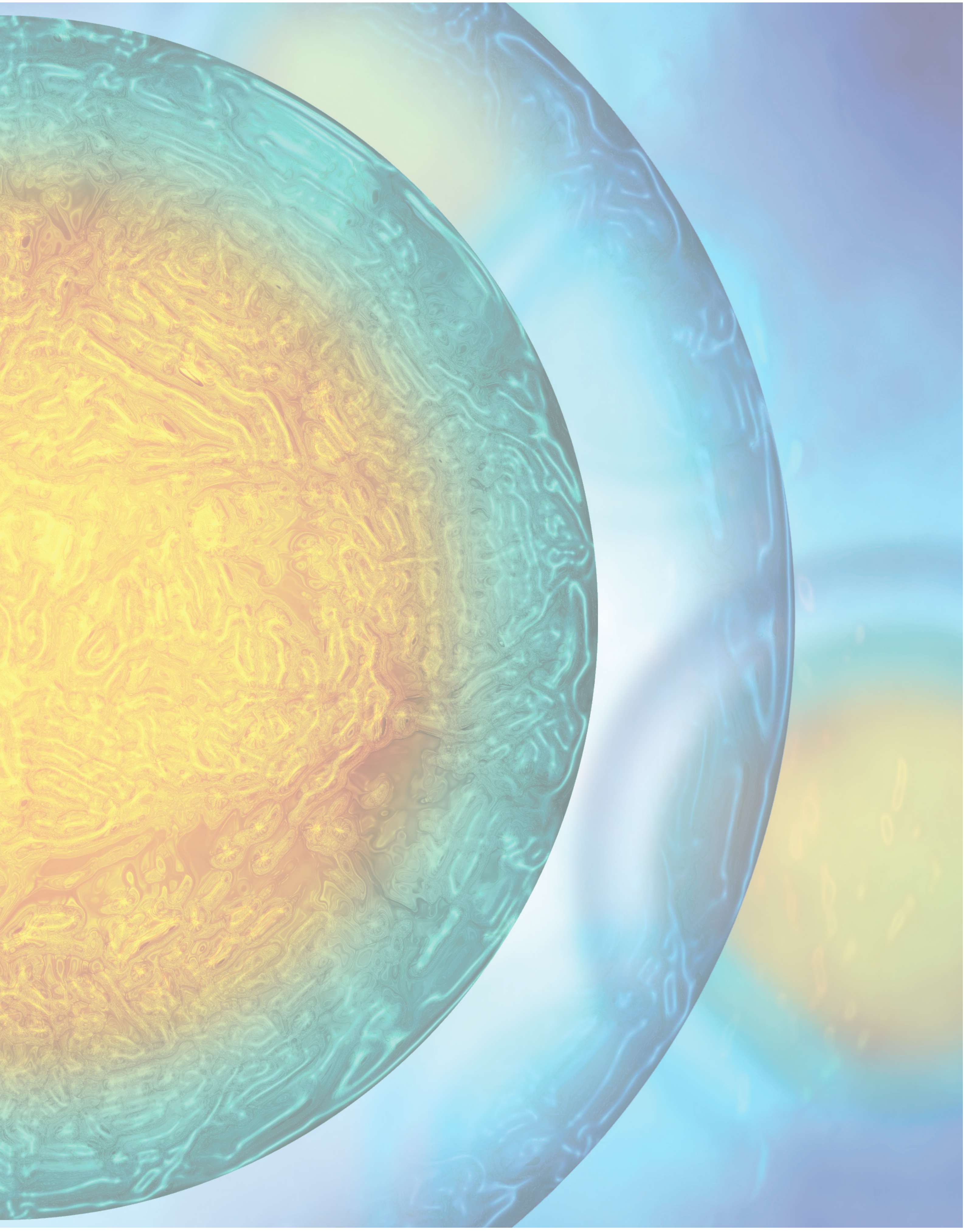
A. Structure and Function

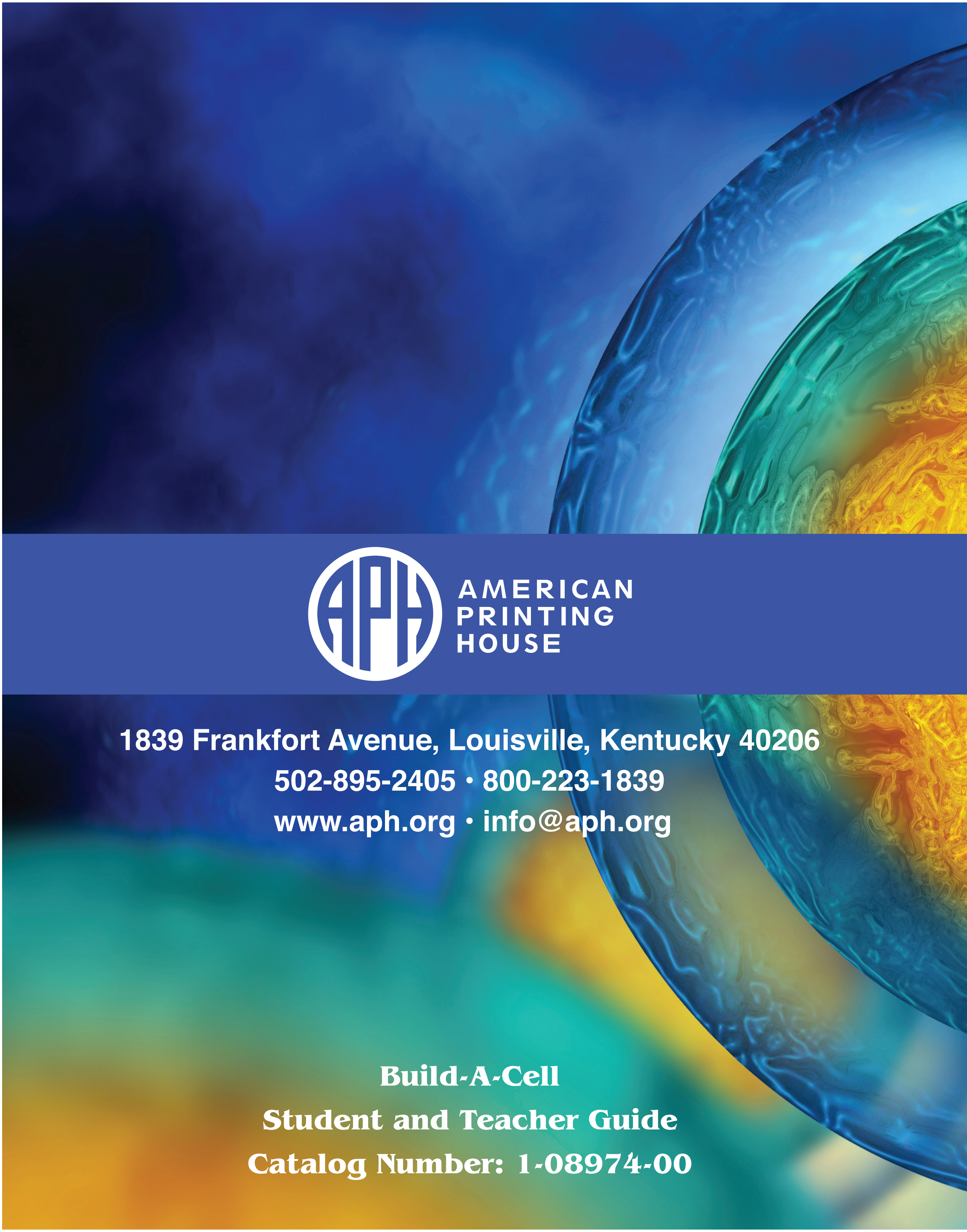
In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.

Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

[1]NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press.







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