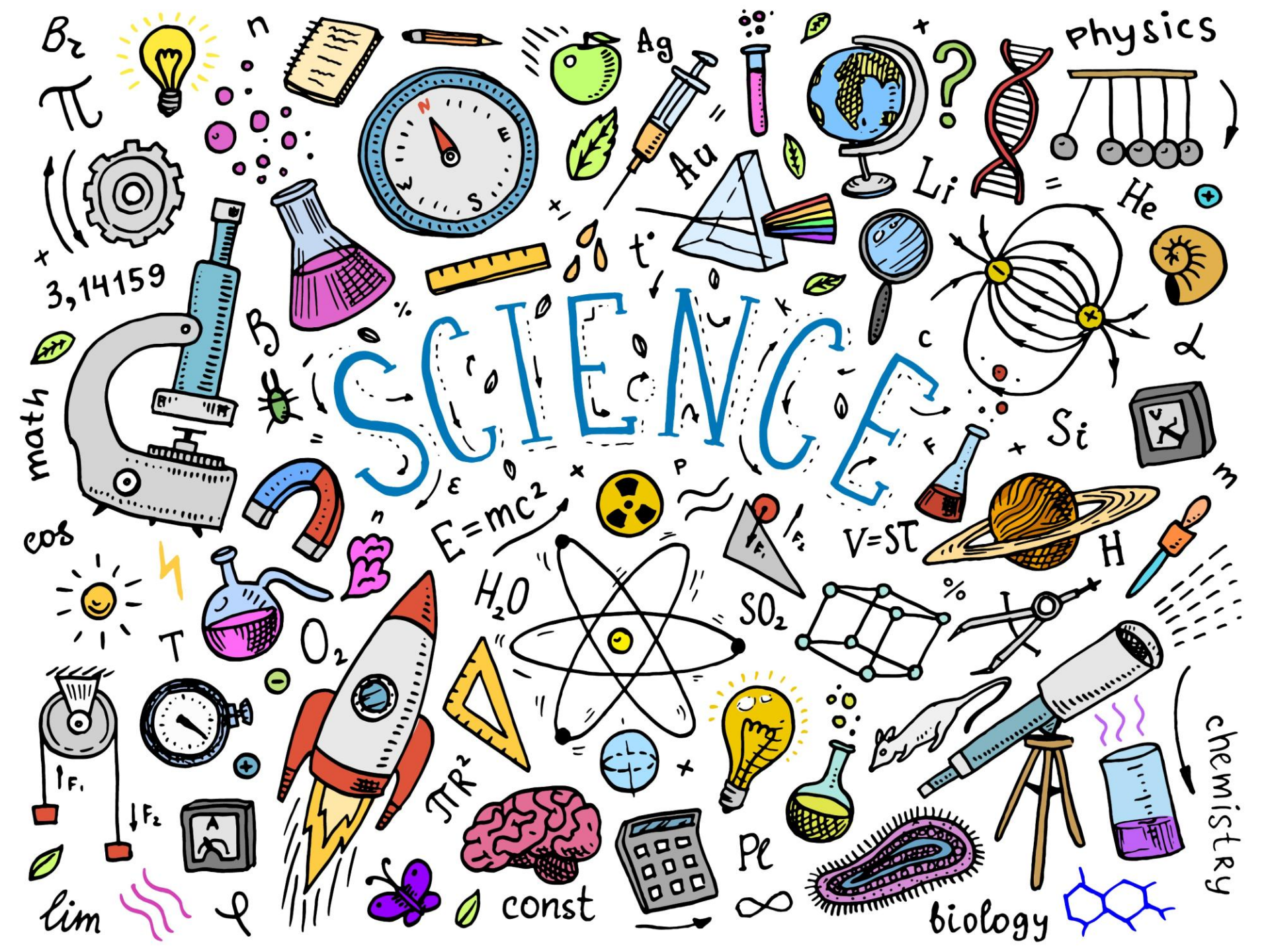
SCIENCE
physics
chemistry
biology
math
3,14159
E=mc²
V=ST
H₂O
SO₂
O₂
Au
Ag
Li
He
Si
Br
cos
lim
const

Nanyang Girls' High School

Secondary One Science

Models of Cells:
The Basic Unit of Life

Cells → Tissues → Organs

• Concept of Models

- Models can be conceptual, mathematical or physical.
- Models simulate real world phenomena.
- Models simplify real world processes or behaviours.
- Models facilitate testing and prediction.

• Concept of Models

- Models can be conceptual, mathematical or physical.
- Models simulate real world phenomena.
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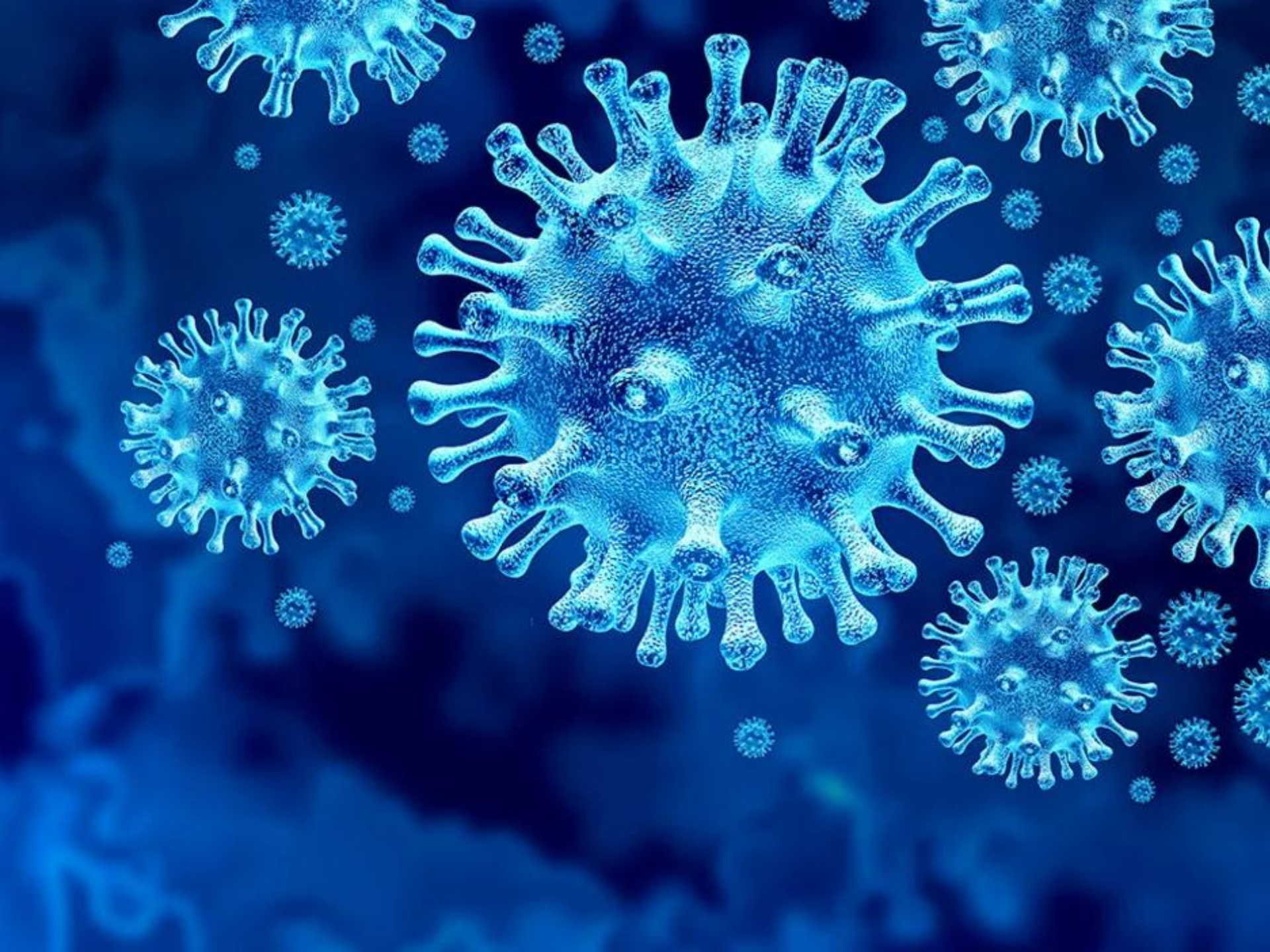
- Models facilitate testing and prediction.

• Concept of Systems

- Systems contain elements that interact with each other to perform a function.
- Systems maybe influenced by other systems.
- Systems follow rules.

Essential Understanding

- All living organisms are composed of one or more cells.
- The cell is the basic unit of structure and organisation in an organism.
- All cells are formed only by the division of pre-existing cells.



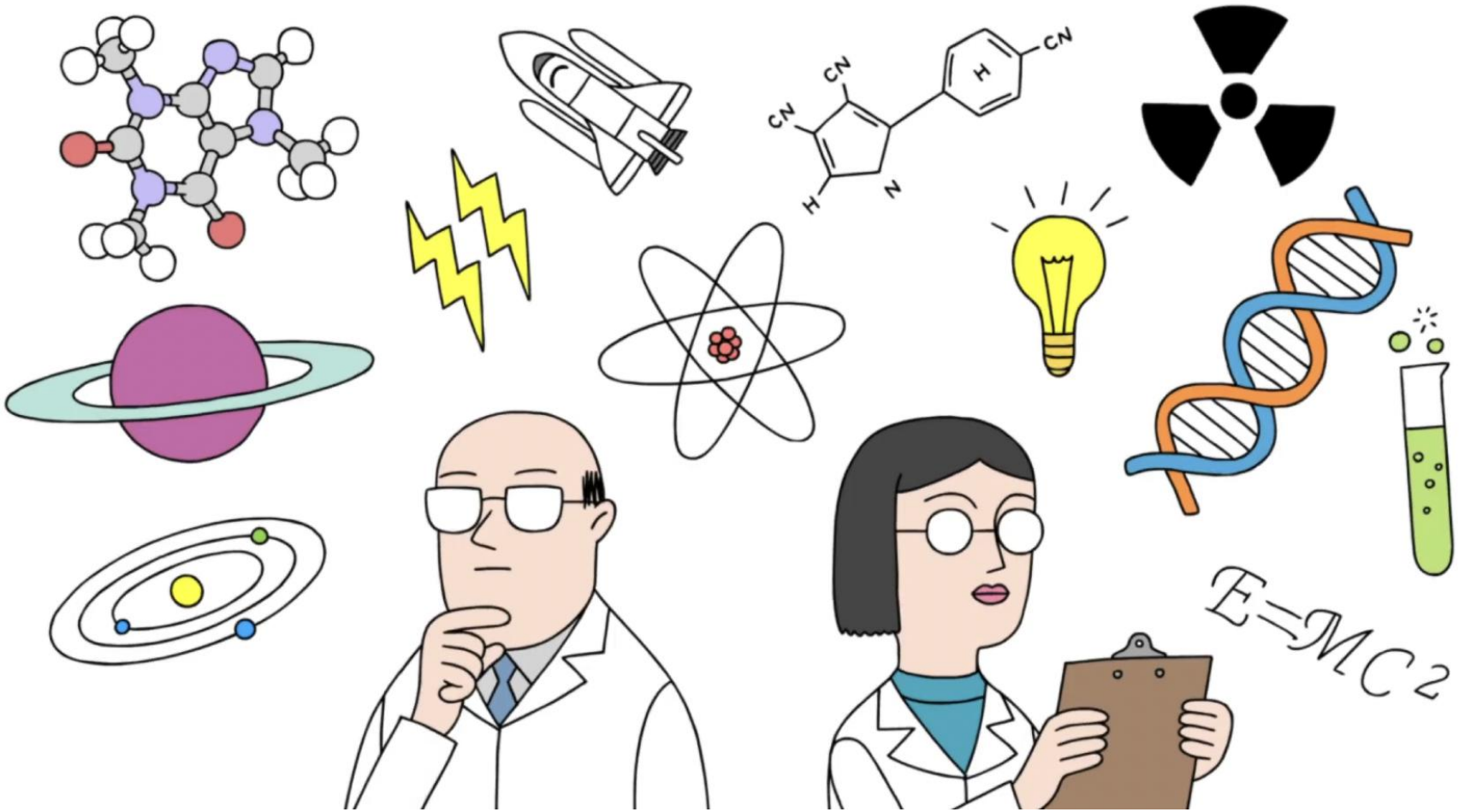
Question:

Can a virus be considered a living thing?

Answer:

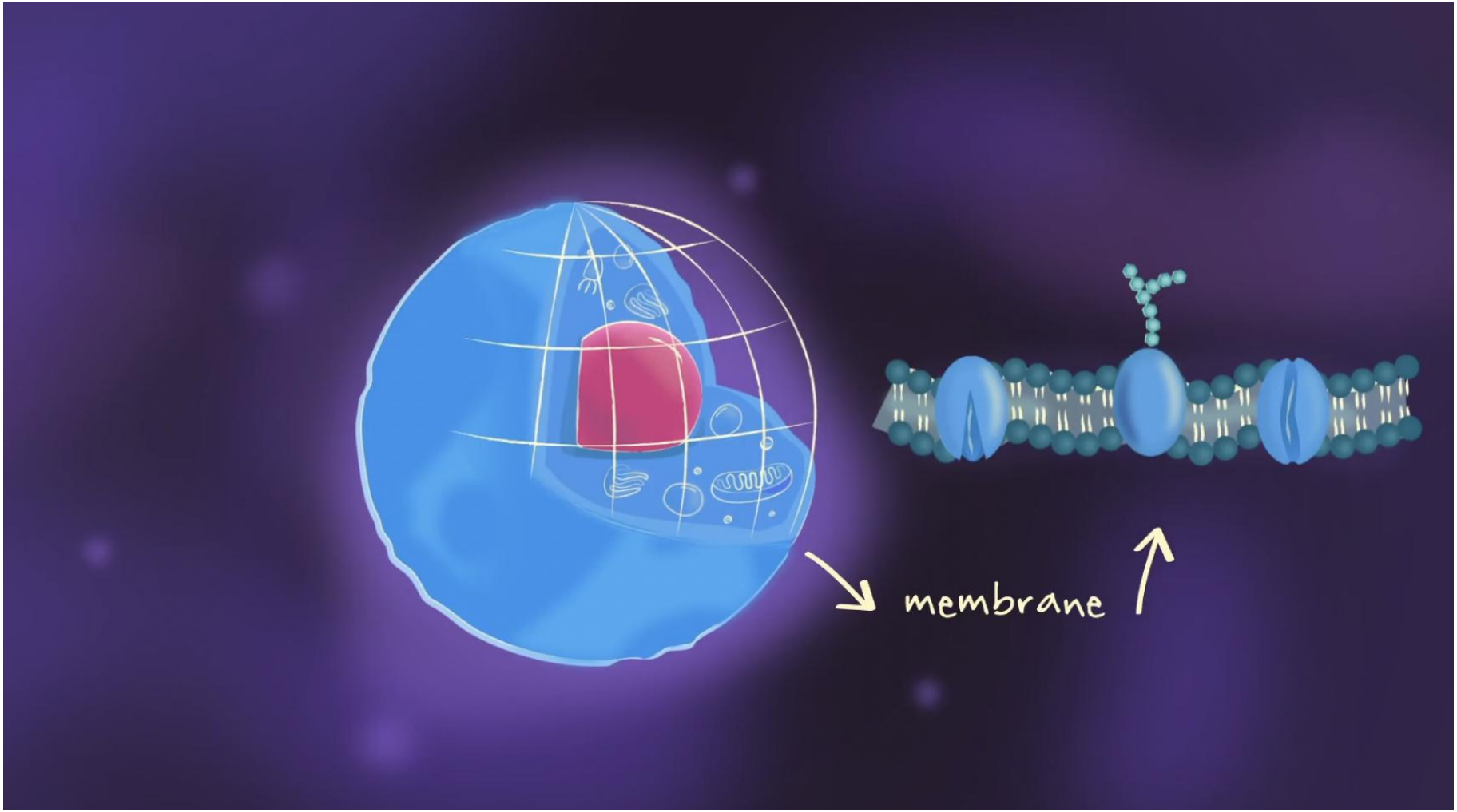
A virus is not considered a living thing. It does not possess the components necessary to reproduce on its own.

Cell Theory



[The wacky history of cell theory - Lauren Royal-Woods - YouTube]

What is the Biggest Single Celled Organism?



https://www.youtube.com/watch?v=FK9xHry877U

Why do Scientists Study Cells?

Why do Scientists Study Cells?

- A deep and thorough understanding of how cells work forms the basis for further understanding of how life works.
- Understanding how cells work in healthy and diseased states, scientists are able to develop treatments, more effective medicines, vaccines to improve the quality of life of humans.

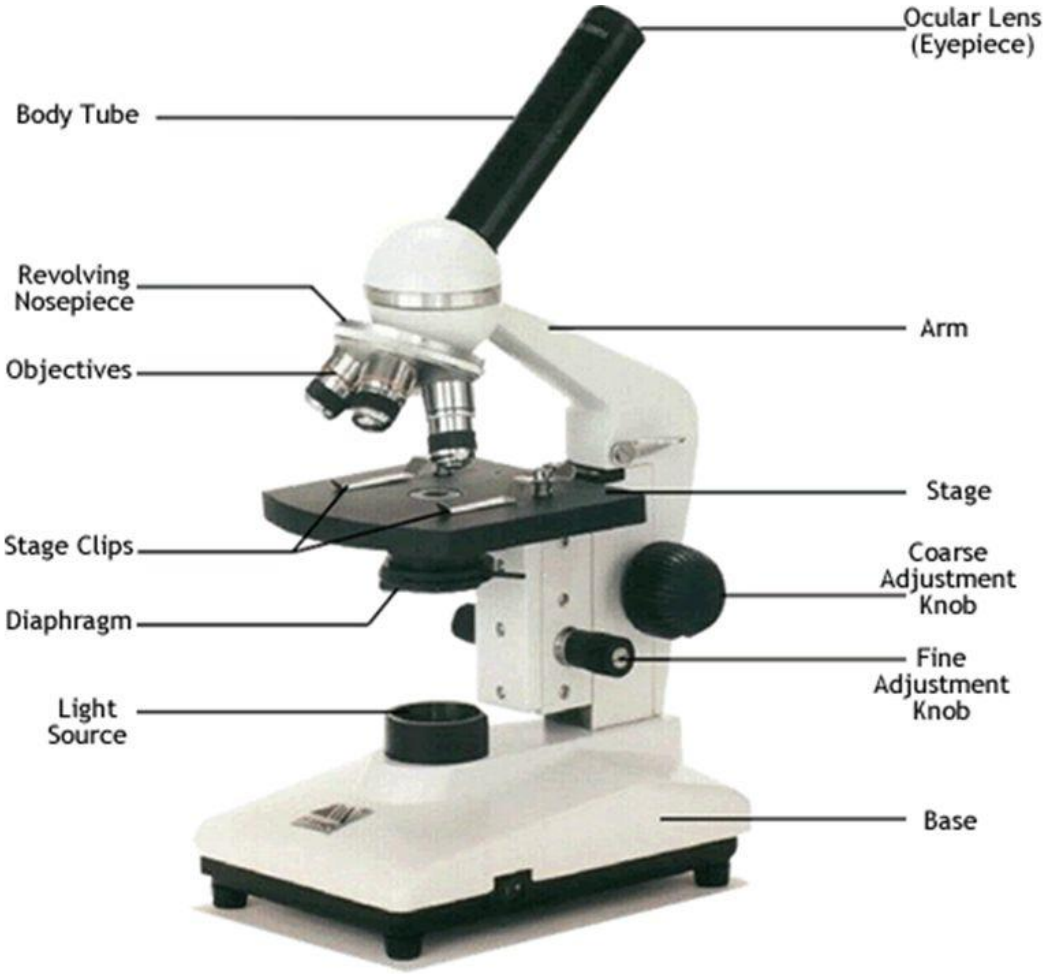
How do Scientists Study Cells?

Optical Microscope

- Von Leeuwenhoek's Microscope
  Late 1600

How do Scientists Study Cells?

Optical Microscope



How do Scientists Study Cells?

Electron Microscope

Electron Microscope

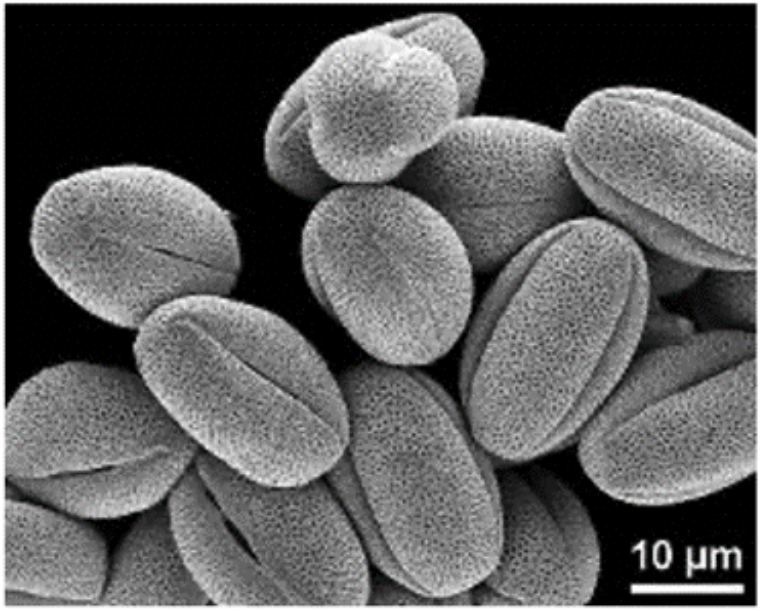
- Uses a beam of electrons instead of light.
- Able to produce image of much higher resolution and magnification.
- Magnification up to 500,000 times.

Electron Microscope

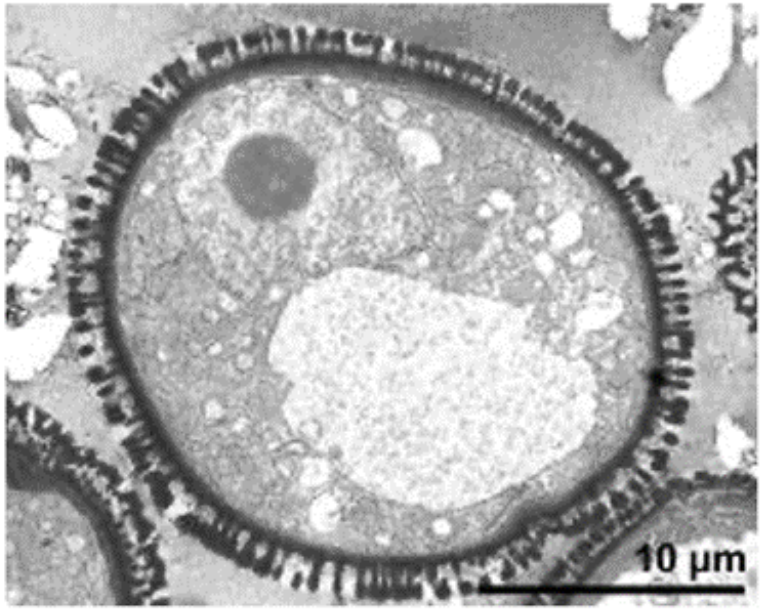
- Two types of images that electron microscopes can produce, depending on how the specimens are prepared: scanning electron micrograph (SEM) and transmission electron micrograph (TEM).

- SEM shows the external surface of the specimens while TEM shows the internal structures of the specimens.

Electron Microscope



Scanning electron micrograph of many pollen grains.



Transmission electron micrograph of a pollen grain.

Comparing light and electron microscopes

Light micrograph	Transmission Electron micrograph
• Coloured images • Lower resolution* • Magnify up to 1000 x	• Black and white images, but can be artificially colourised • Higher resolution* • Magnify up to 500,000 x

*In microscopy, the term 'resolution' is used to describe the ability of a microscope to distinguish detail. In other words, this is the minimum distance at which two distinct points of a specimen can still be seen as separate entities.

How is a Cell Adapted to Perform its Function?

How is a Cell Adapted to Perform its Function?

- A cell consists of many different parts that work together to ensure that it is able to carry out its function effectively.

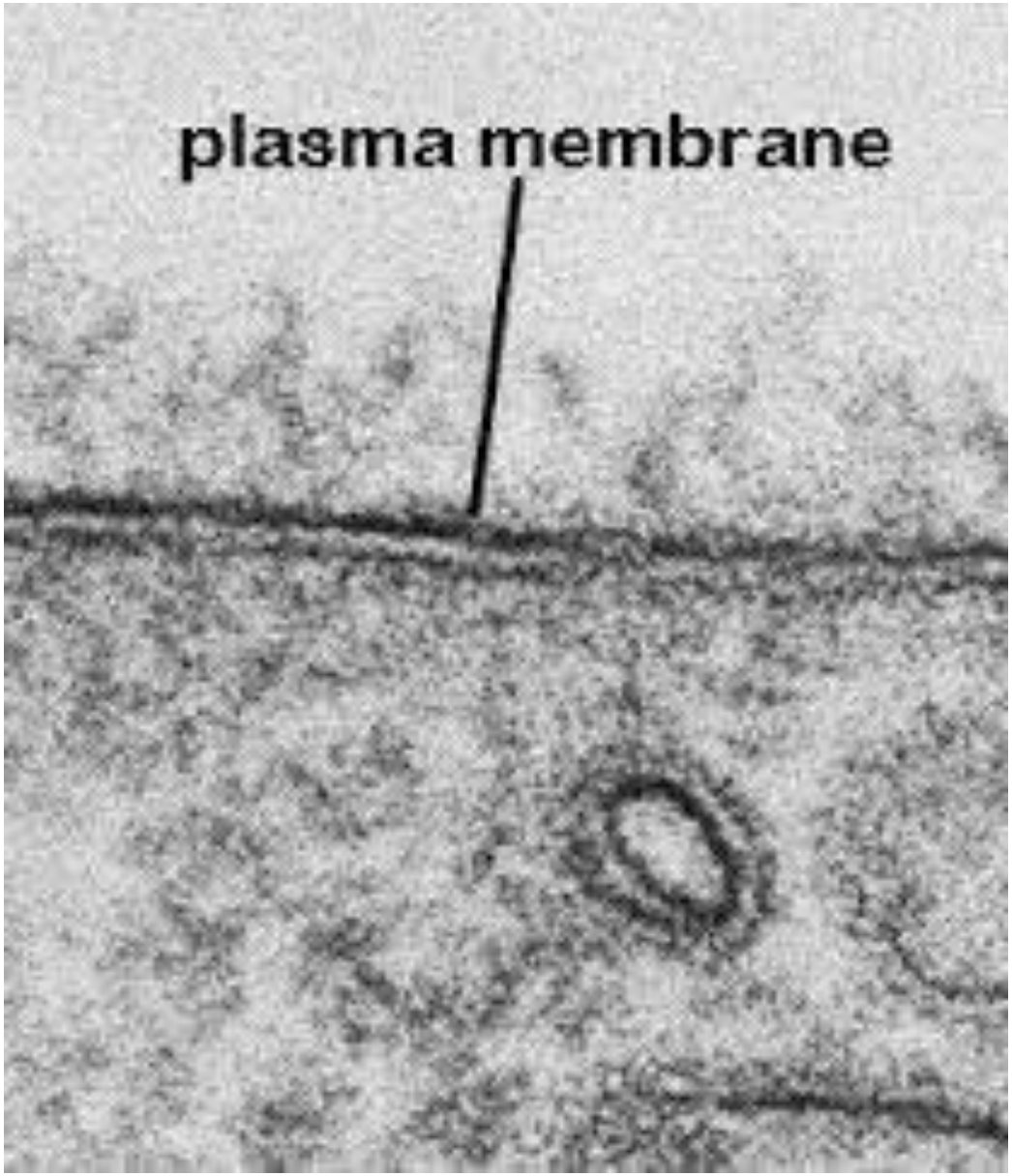
Cell (Plasma) Membrane

Structure

- *Partially or selectively permeable* [do NOT use the term semi-permeable].
- A very thin layer of fats and proteins.

Function

- Controls the movement of substances in and out of cell.


plasma membrane

Cytoplasm

Structure

- Contains largely water with different types of substances such as proteins, carbohydrates, fats and salts.

- Contains specialised structures called organelles with specific functions.

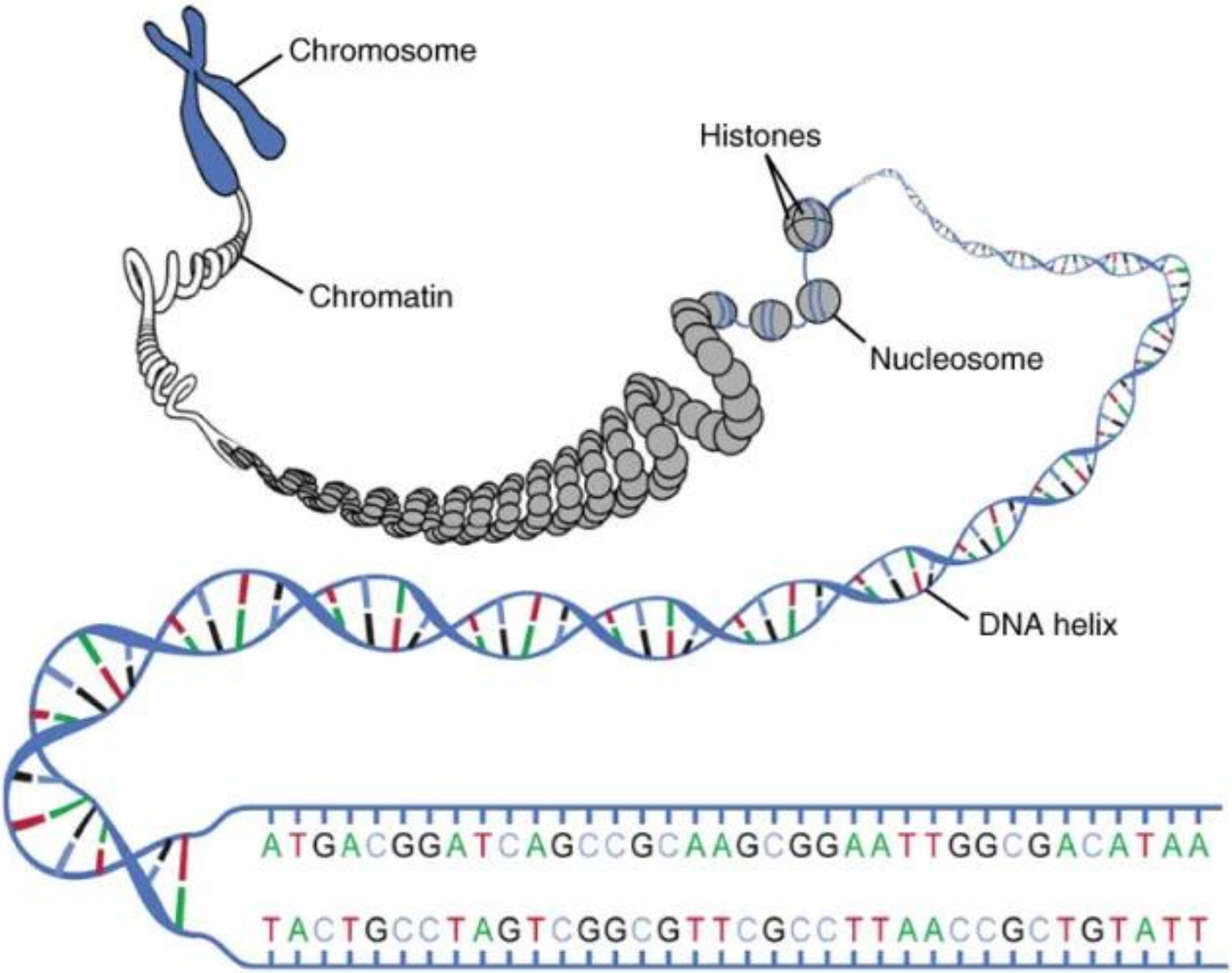
Function

- It is where most cell activities e.g. chemical reactions occur.

Nucleus

Structure

- Contains *chromatin.*
- *Chromatin* coils to form rod-like structures called *chromosomes.*
- Chromosomes are made of a substance called deoxyribonucleic acid (DNA).
- Each chromosome carries many *genes.*
- A *gene* is a section of a DNA that carries instructions for a specific characteristic.


Chromosome
Histones
Chromatin
Nucleosome
DNA helix
ATGACGGATCAGCCGCAAGCGGAATTGGCGACATAA
TACTGCCTAGTCGGCGTTCGCCTTAACCGCTGTATT

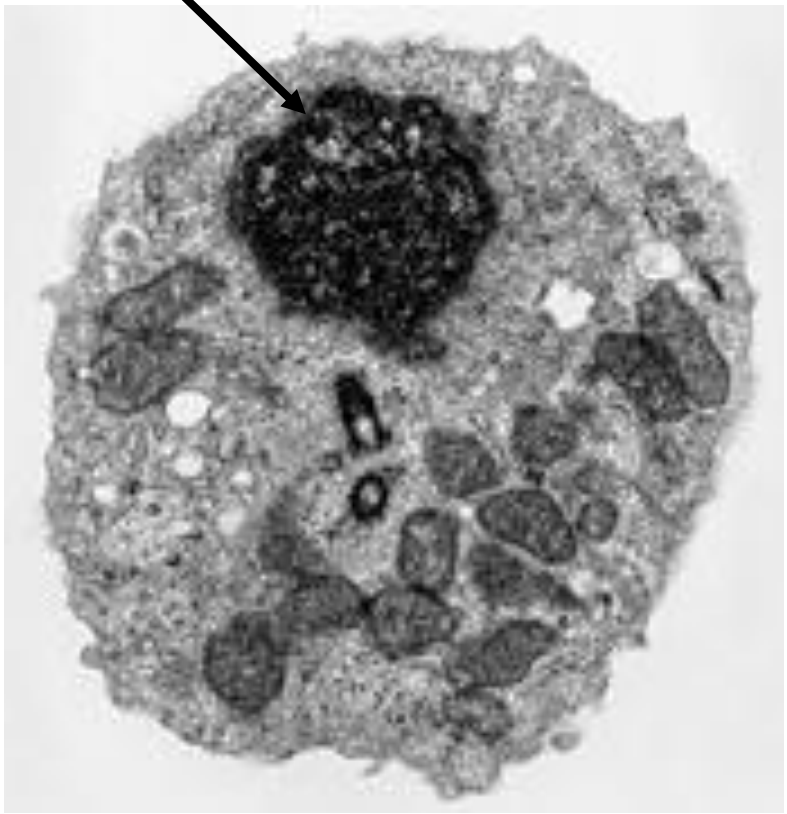
Nucleus

Function

- Controls cellular activities; cell will die if nucleus is removed.

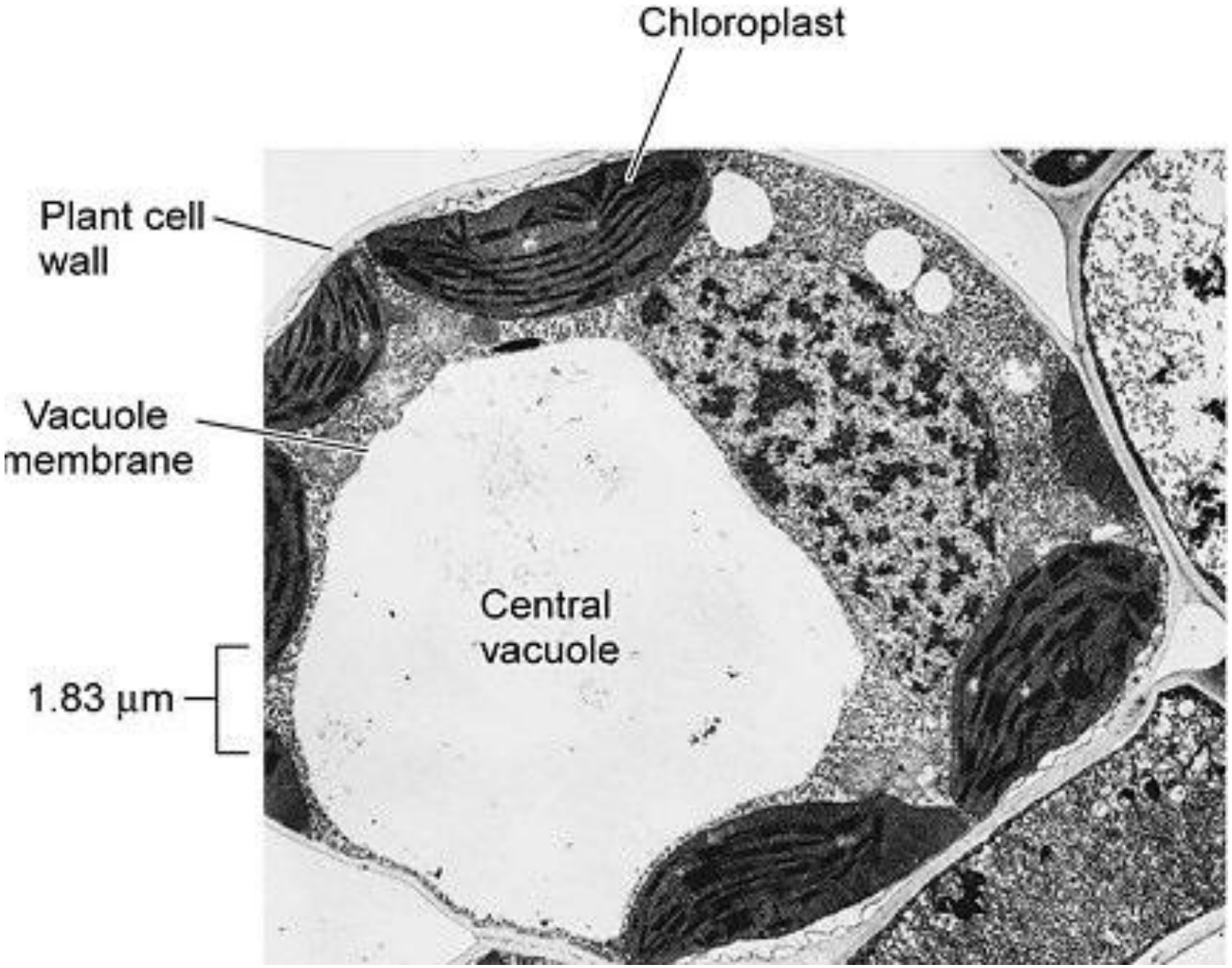
- Contains deoxyribonucleic acid (DNA) - the hereditary or genetic material in living things passed down from parents to offspring.

Nucleus



Vacuole

	Animal cell	Plant cell
Structure	a fluid-filled space in a cell surrounded by a membrane	
	has numerous small vacuoles	has a large central vacuole
Function	vacuoles store liquid, nutrients and waste materials	vacuole stores cell sap, containing liquid (water), nutrients (sugars, dissolved mineral salts etc.) and waste materials


Chloroplast
Plant cell wall
Vacuole membrane
Central vacuole
1.83 µm

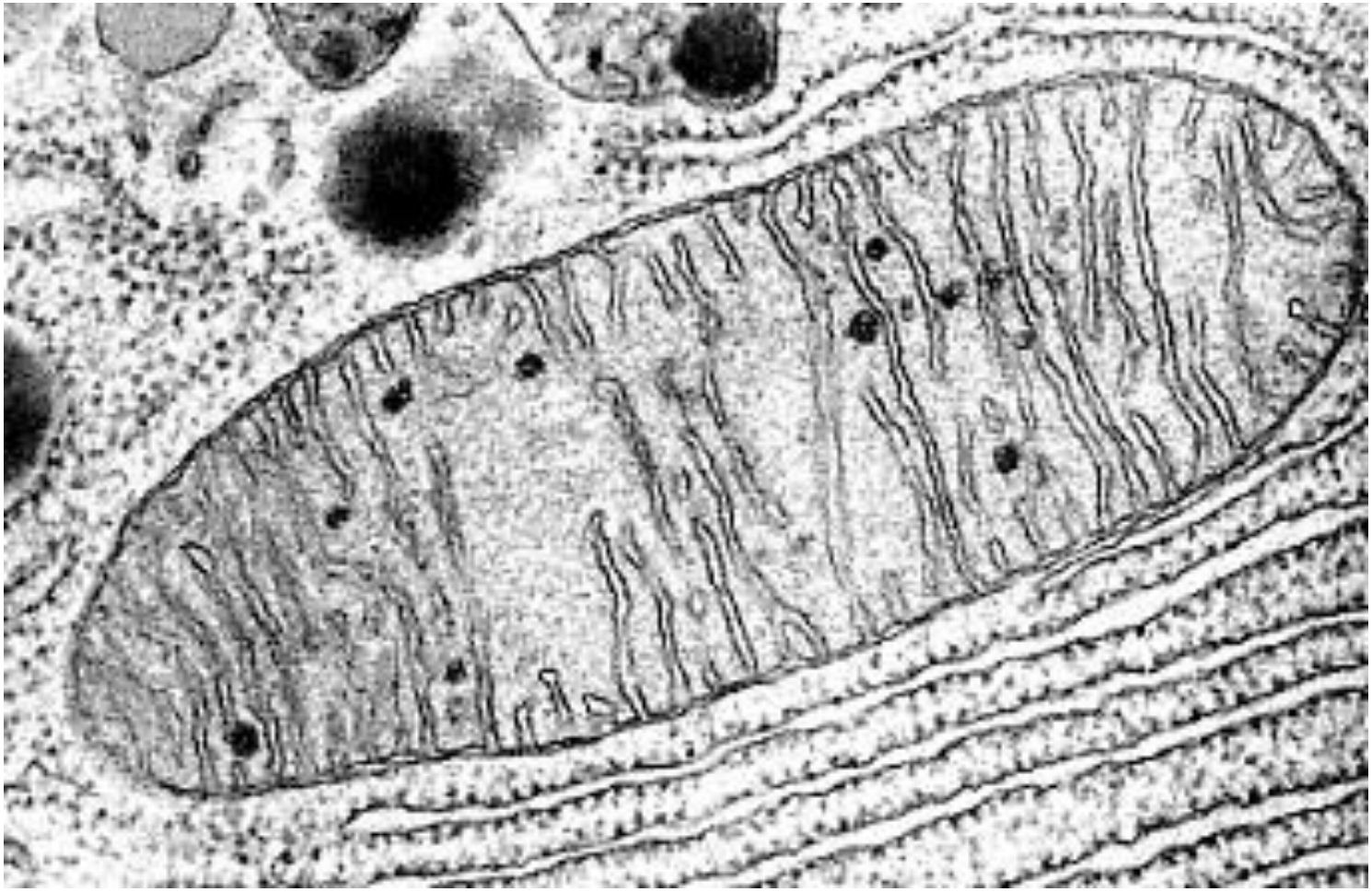
Mitochondrion (singular)
Mitochondria (plural)

Structure

- A rod-shaped structure / organelle.

Function

- Cellular respiration occurs here.
- During cellular respiration, food substances are oxidised to release energy.
- Energy released is used by cell for cellular activities, e.g. growth.



Question: Which cell is likely to contain large numbers of mitochondria?

Question: Which cell is likely to contain large numbers of mitochondria?

Answer:

A cell that requires a large amount of energy will have a large number of mitochondria. Some examples are the heart muscle cell, liver cell, kidney cell etc.

Chloroplast

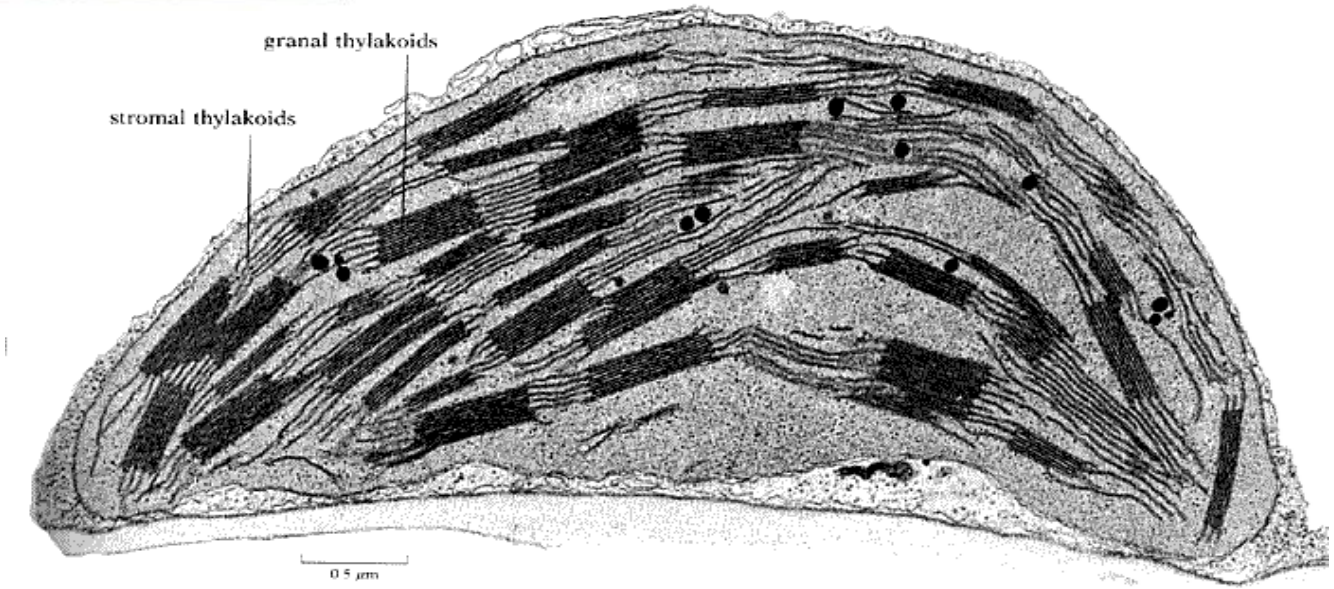
Structure

- An oval-shaped structure/organelle.
- Contains a green pigment called chlorophyll that traps or absorbs light energy.

Function

- Allows photosynthesis to occur by absorbing light energy.
- The light energy is then used to convert carbon dioxide and water into sugars for the plant. Oxygen is produced in the process.

chloroplast



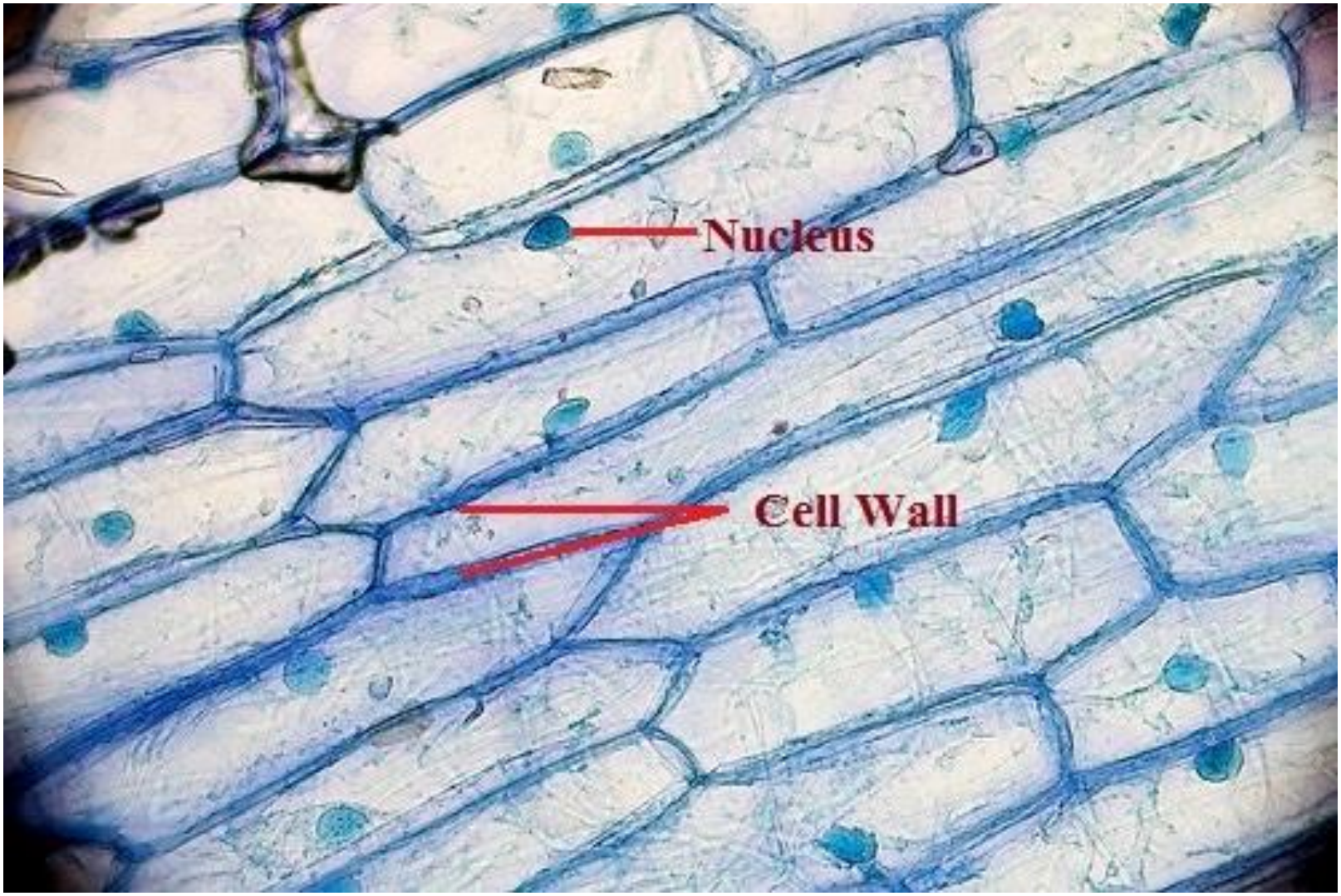
Cell Wall

Structure

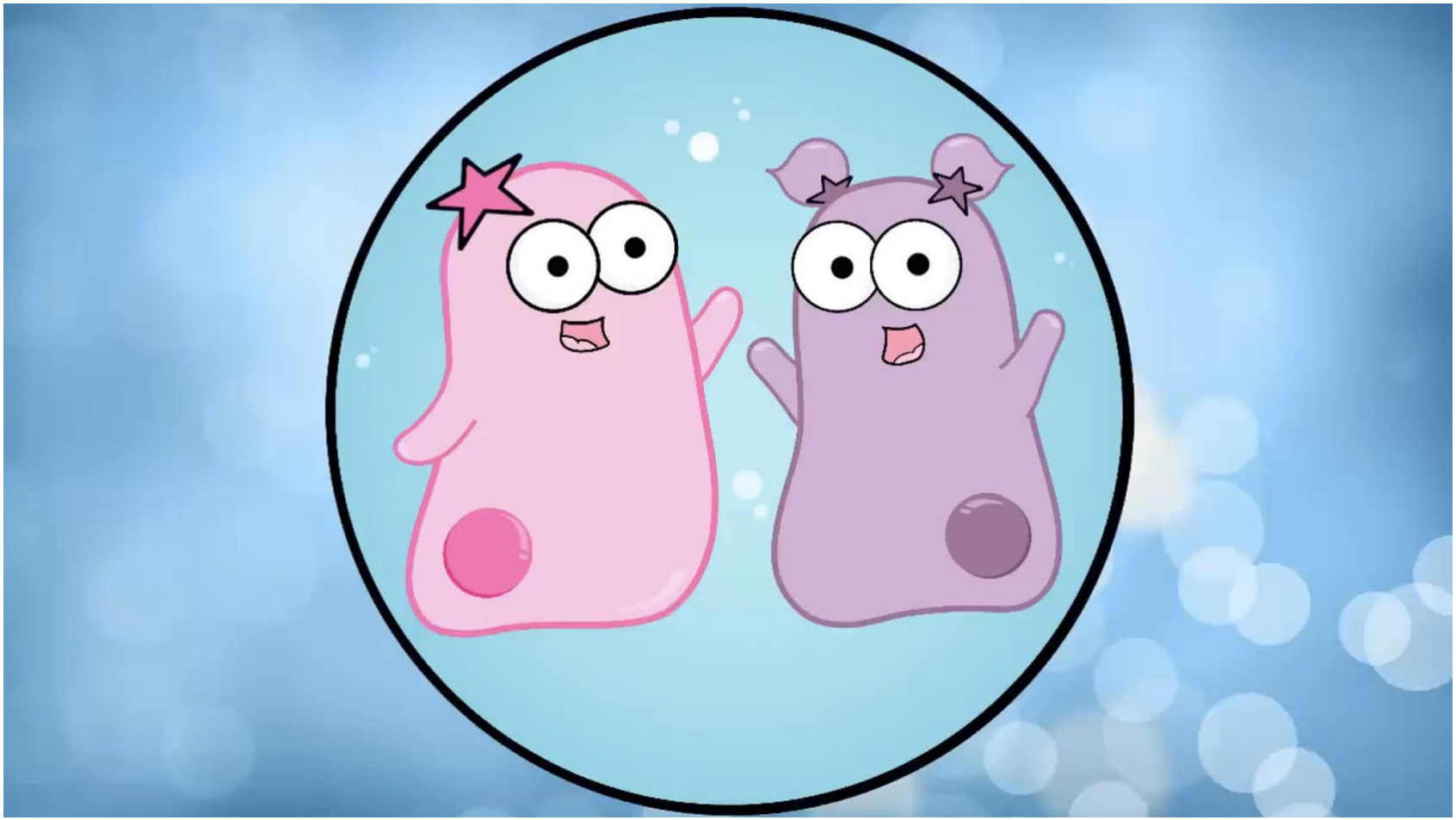
- Every plant cell has a cell wall.
- It is mainly made up of cellulose.
- It is fully permeable; allows substances to move into and out of the cell.

Function

- Protects and supports the cell.
- Provides rigidity and gives the cell a regular shape.
- Prevents the cell from bursting.


Nucleus
Cell Wall

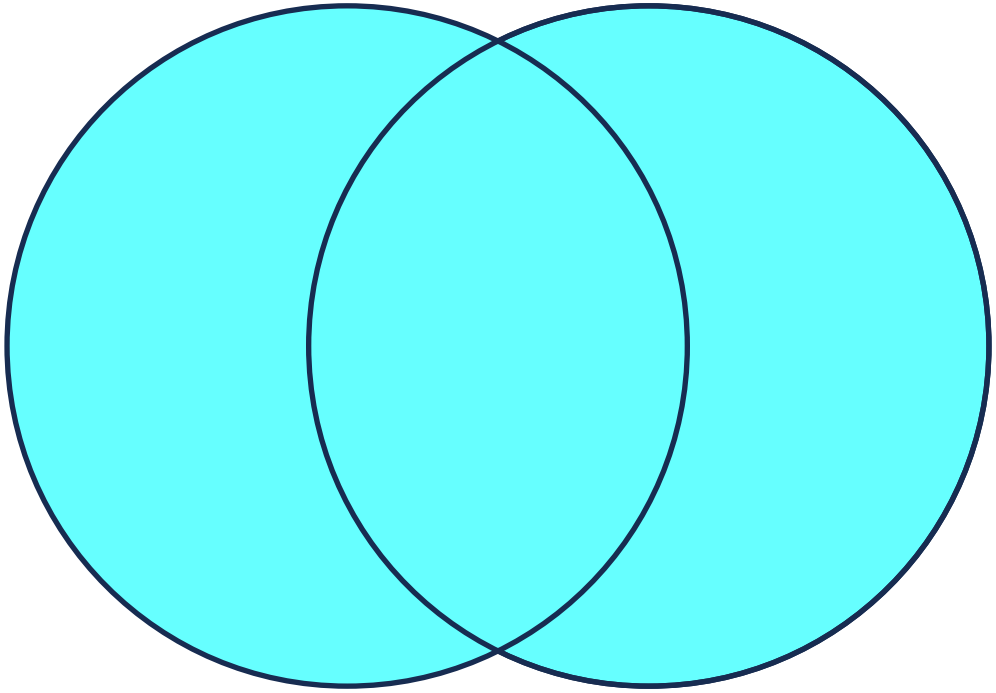
The Grand Tour of Cells



https://www.youtube.com/watch?v=8IlzKri08kk

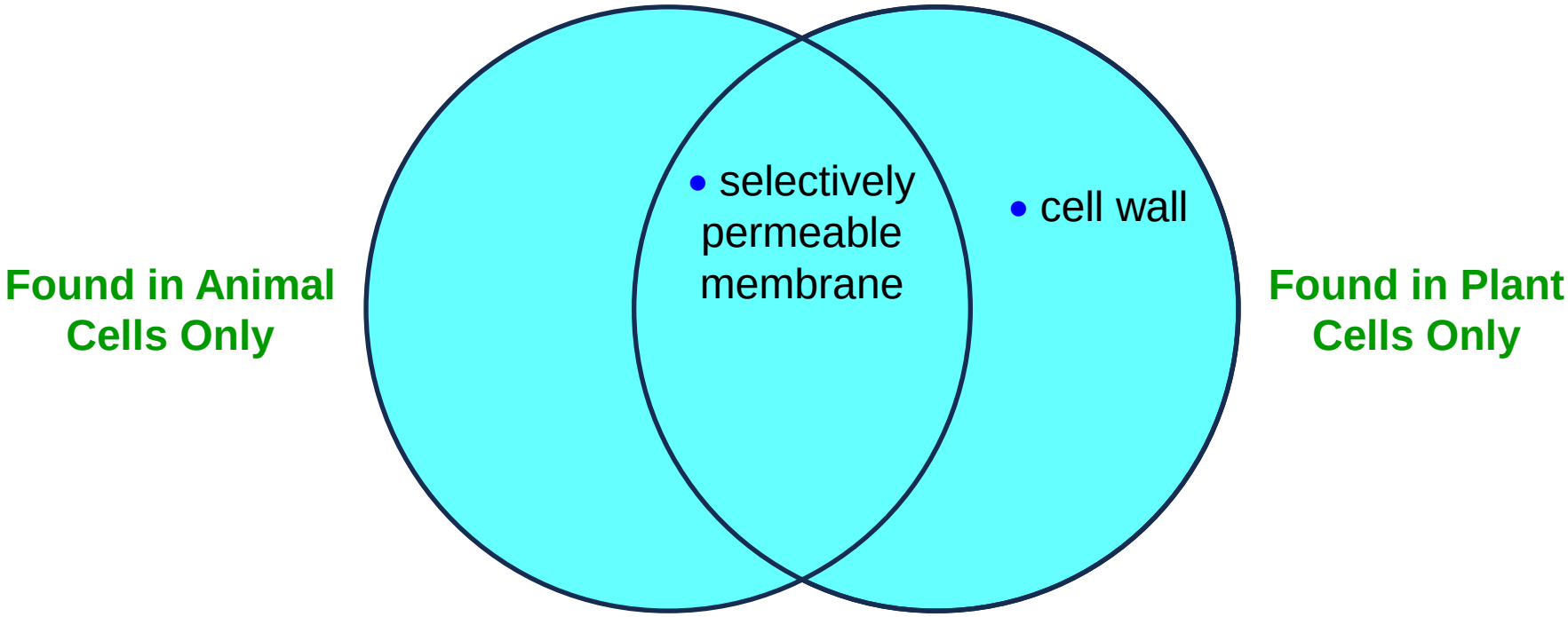
Compare and Contrast Animal Cells and Plant Cells

Found in Animal Cells Only



Found in Plant Cells Only

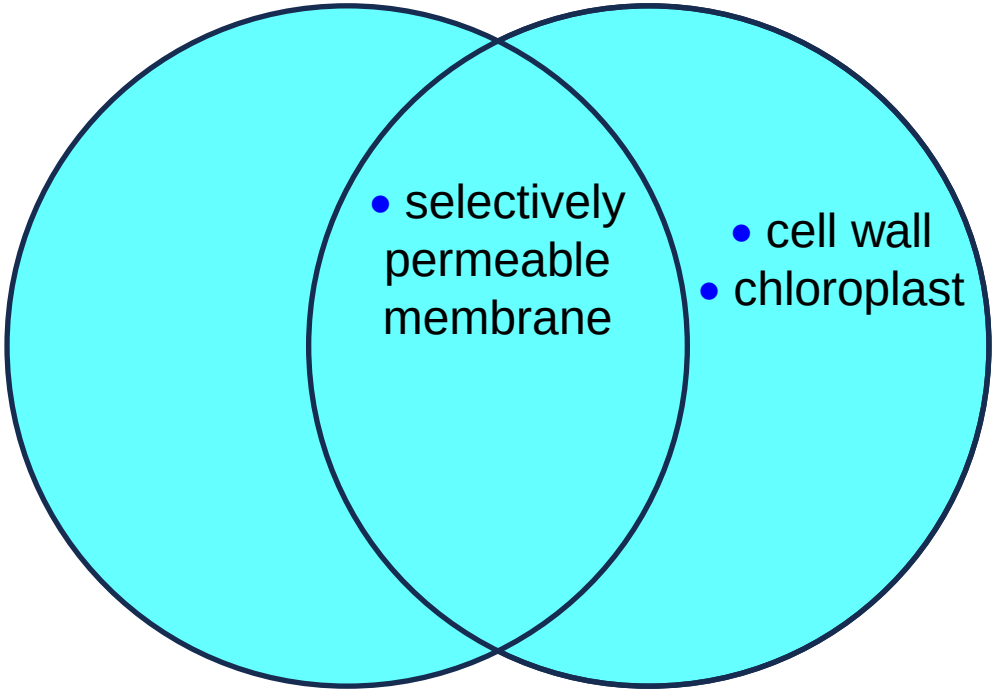
Compare and Contrast Animal Cells and Plant Cells



• Plant cells have a cell wall and a cell membrane, but animal cells only have a cell membrane. The cell wall provides the plant cell with strength, shape and rigidity, thereby contributing to the overall rigidity of the plant, helping to keep it upright.

Compare and Contrast Animal Cells and Plant Cells

Found in Animal Cells Only

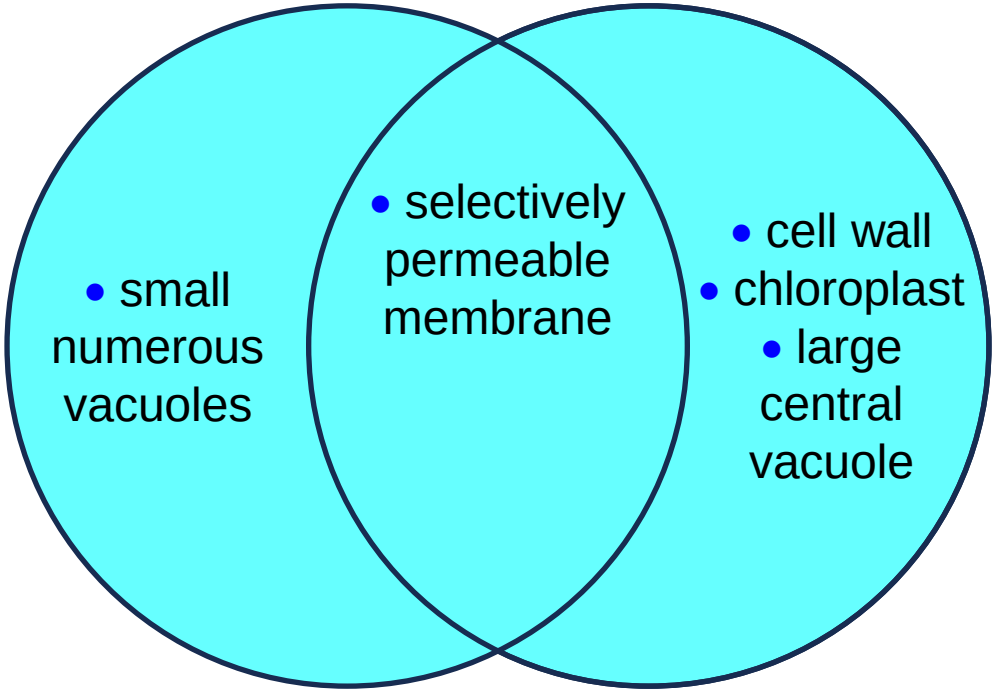


Found in Plant Cells Only

- Plant cells have chloroplasts, but not animal cells. Plants do not get their sugar (glucose) molecules from eating, unlike animals. To produce sugar molecules used in cellular respiration by the mitochondria to release energy, plants need chloroplasts to trap sunlight through the process of photosynthesis.

Compare and Contrast Animal Cells and Plant Cells

Found in Animal Cells Only

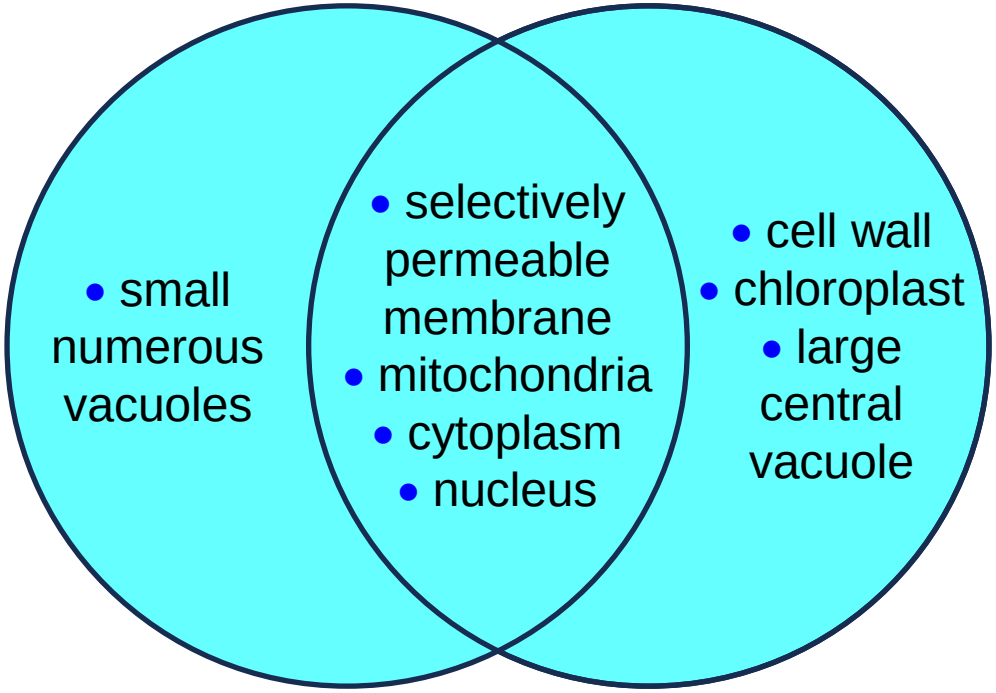


Found in Plant Cells Only

- Plant cells have a large permanent central vacuole, whereas animal cells have numerous small vacuoles. Its primary role is to maintain pressure against the inside of the cell wall, giving the cell shape and helping to support the plant.

Compare and Contrast Animal Cells and Plant Cells

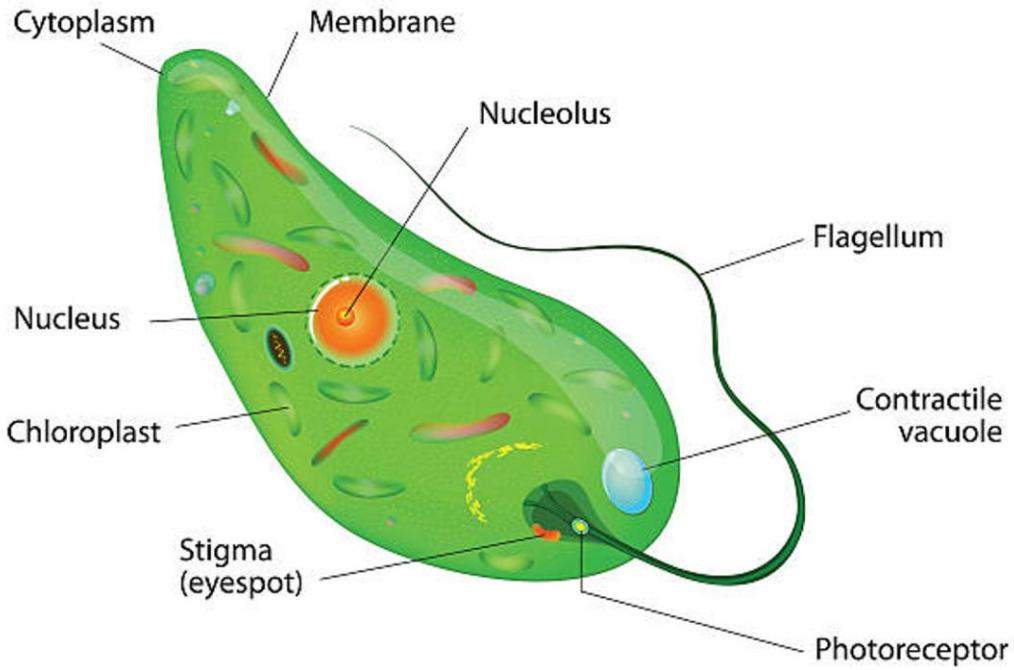
Found in Animal Cells Only



Found in Plant Cells Only

• Animal cells and plant cells both have mitochondria (release energy), cytoplasm (location of cellular actiivities) and a nucleus (control cellular activities).

Based on your understanding of typical animal and plant cells, study the unicellular organism shown in the diagram below:



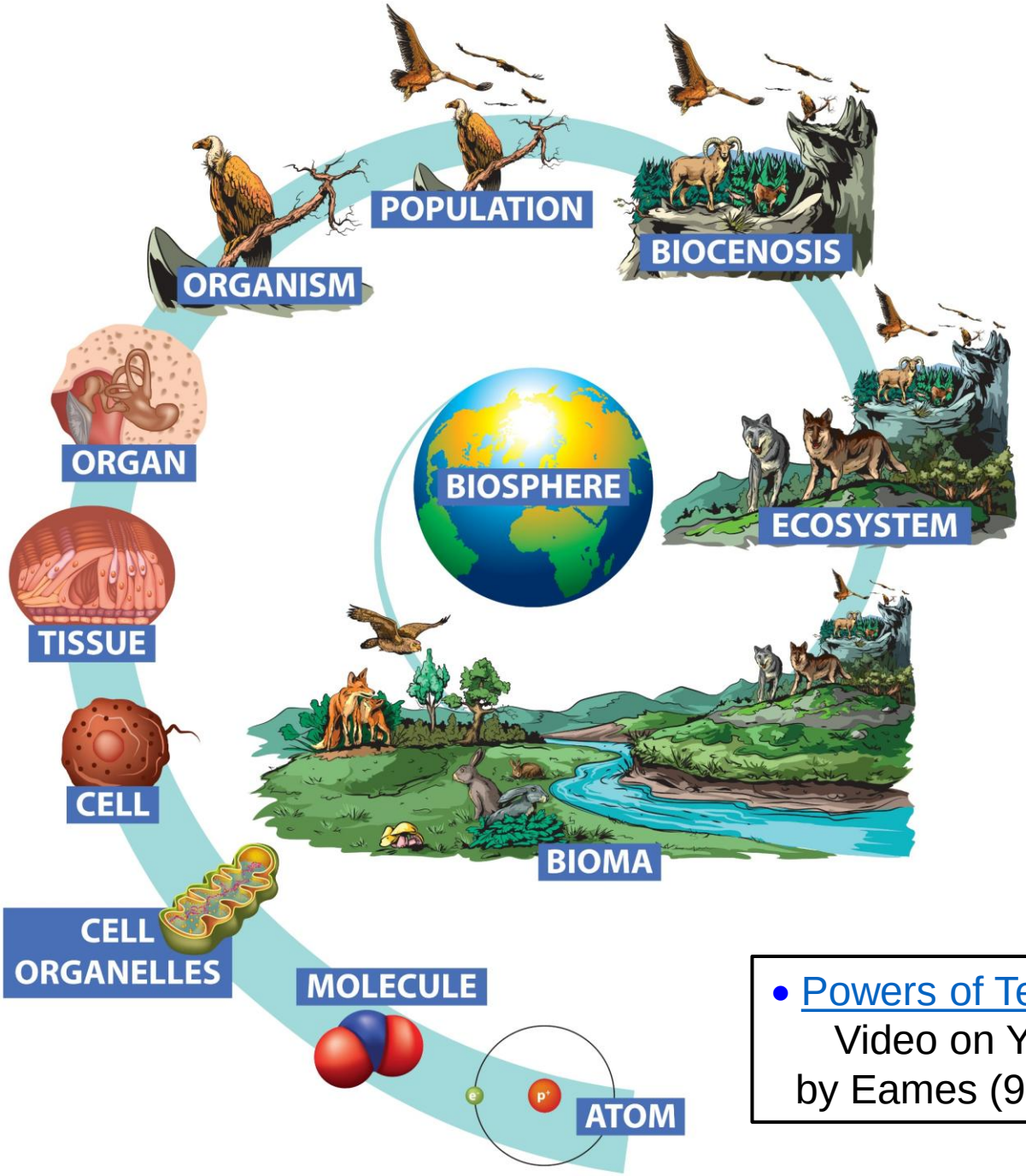
Do you think the organism is an animal cell or a plant cell? Suggest reasons for your answer.

Answer

- The organism is neither an animal cell nor a plant cell.
- It has parts that can only be found in plant cells such as chloroplast and a single large (contractile) vacuole.
- However, it does not have a cell wall. Hence, it cannot be classified as a plant cell.
- The organism shown is a Euglena.

- The organism shown is a Euglena.

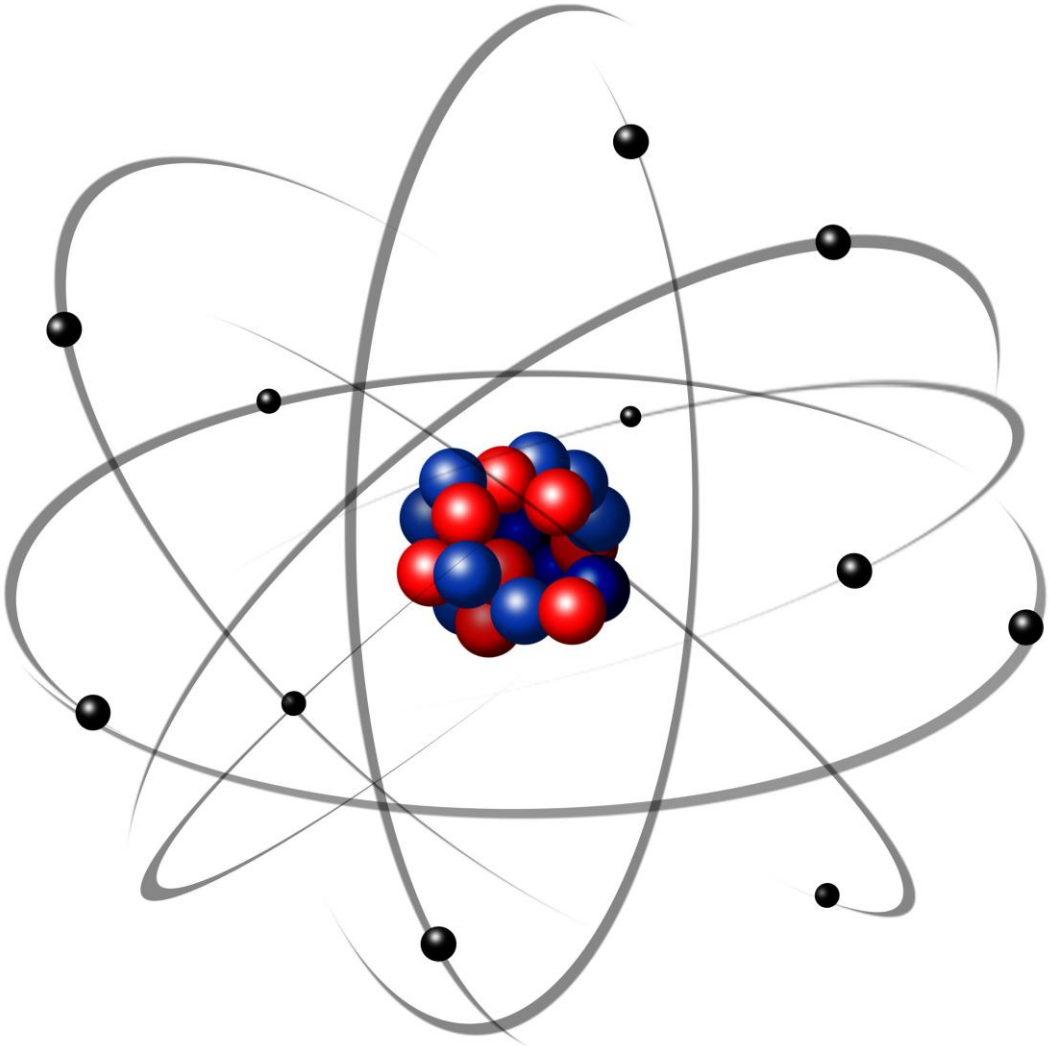
- How are cells organised to form organisms?



- Powers of Ten™ (1977) Video on YouTube by Eames (9 minutes).

- Atoms

- Atoms

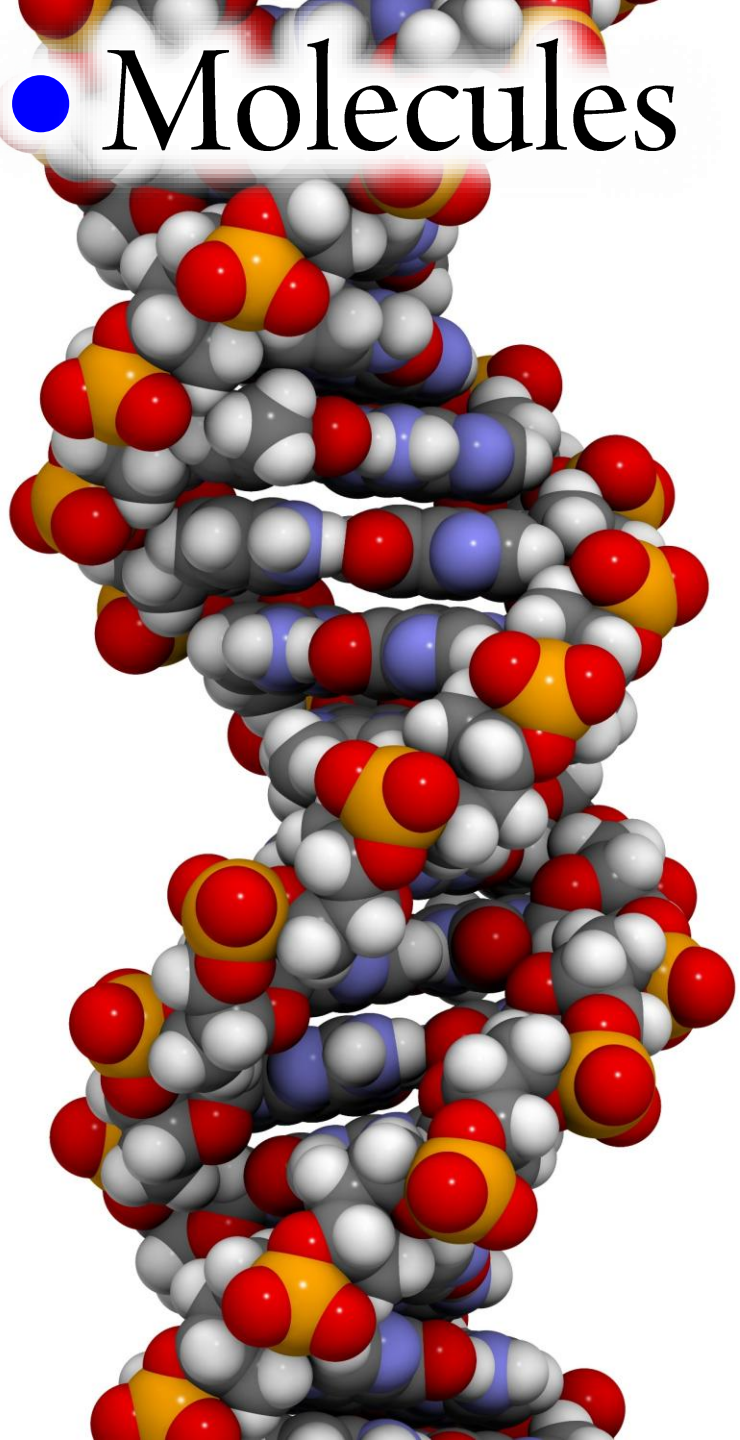


Atoms

- An atom is the smallest part of a chemical element that demonstrates all of the typical properties of that element. They are the fundamental building blocks of the natural world. Atoms are composed of smaller particles called protons, neutrons and electrons.

- Molecules

- Molecules

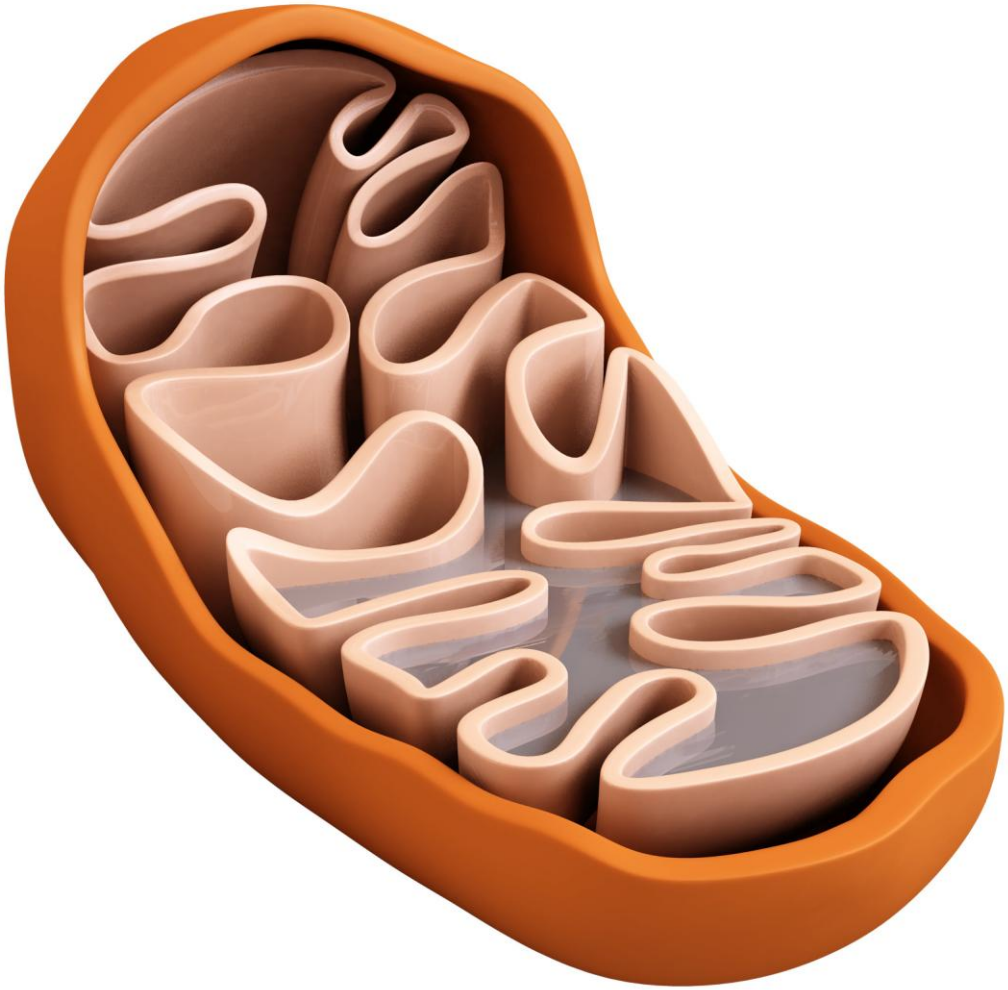


Molecules

- A molecule is a group of two or more atoms that are chemically bonded together. Simple molecules include molecules of water, H_2O, and molecules of carbon dioxide, CO_2. Molecules that are much more complex include deoxyribonucleic acid – DNA (shown).

- Organelles

- Organelles



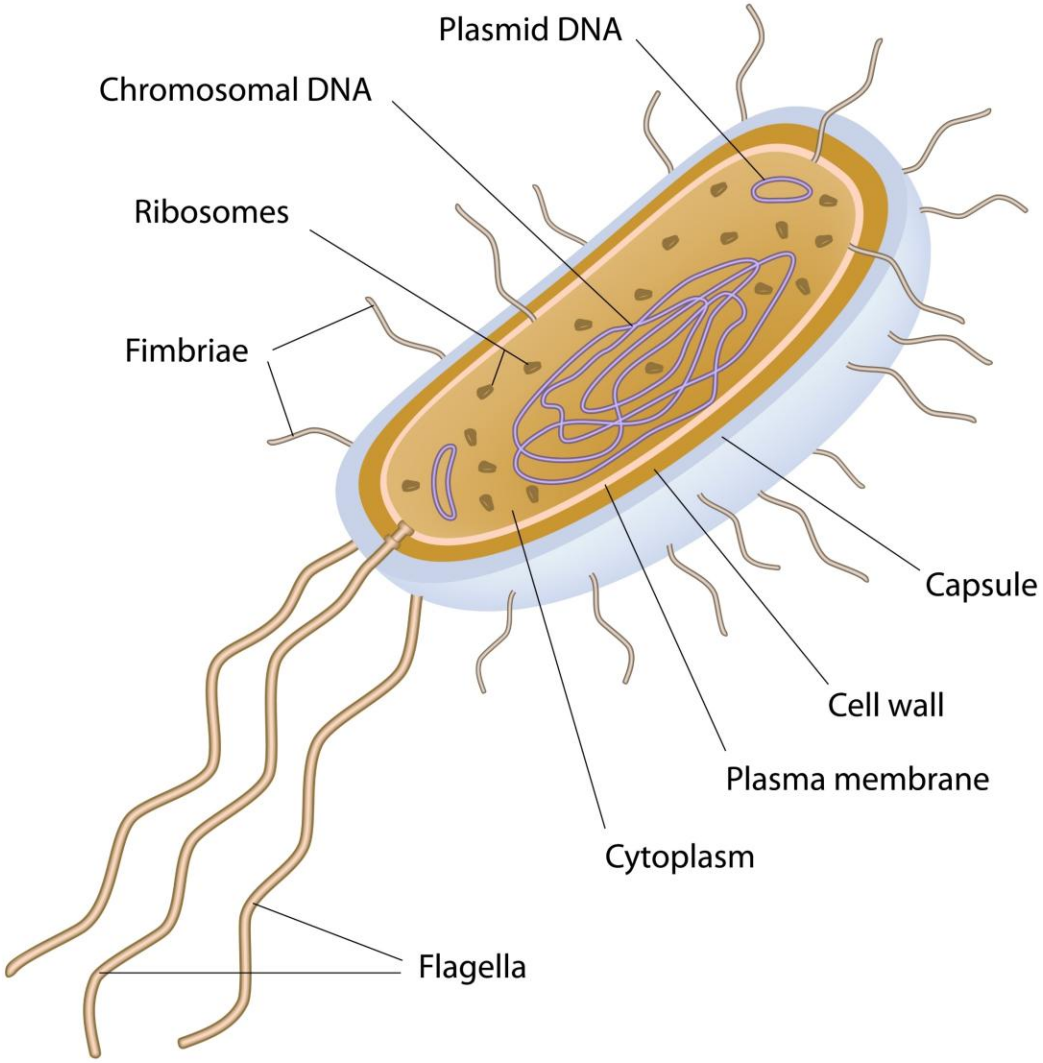
Organelles

- Complex molecules, such as proteins and fatty acids, are arranged together to form organelles. Organelles are tiny cellular structures that are embedded within the cytoplasm of the cell. Organelles perform specific functions within the cell. For example, mitochondria (shown) release energy.

- Cells

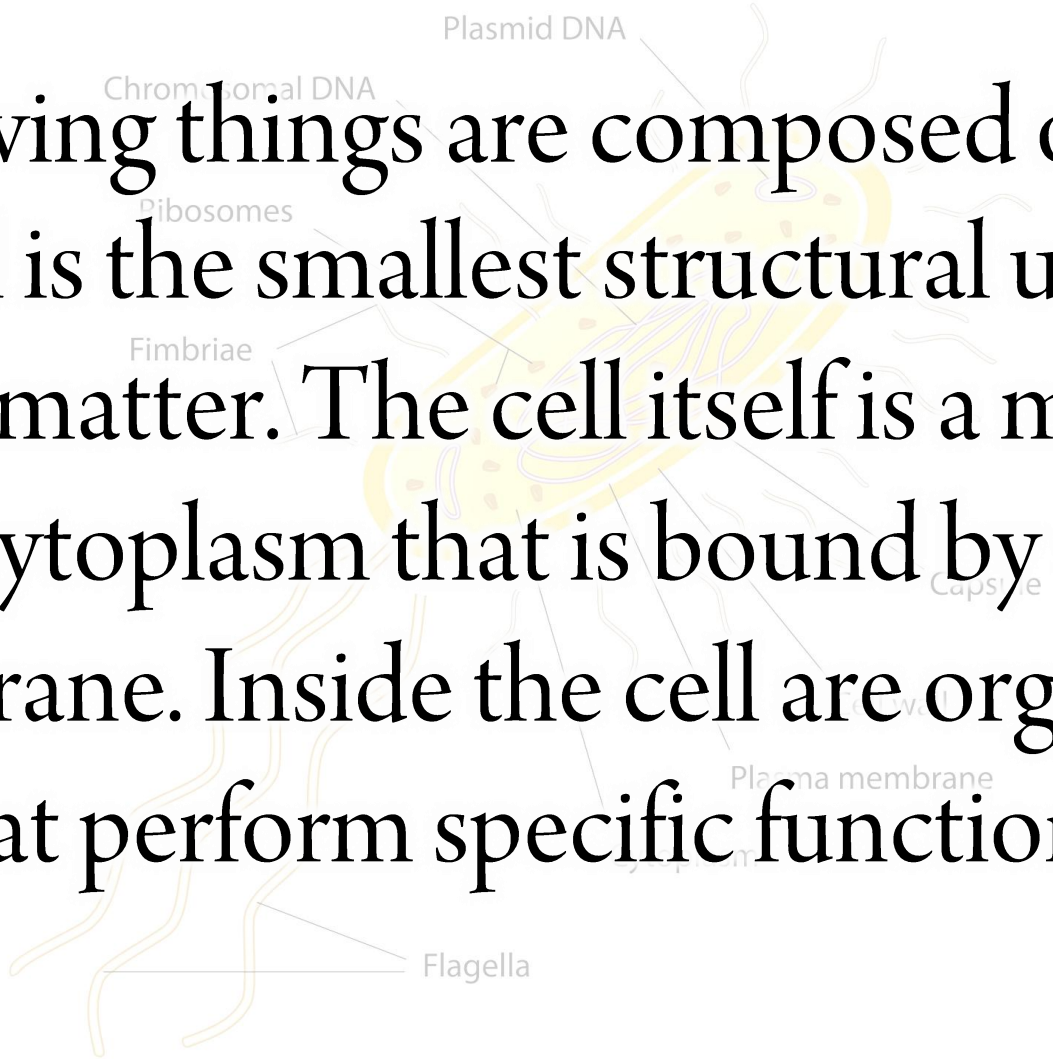
• Cells

Bacteria – Unicellular – Prokaryotic



Cells

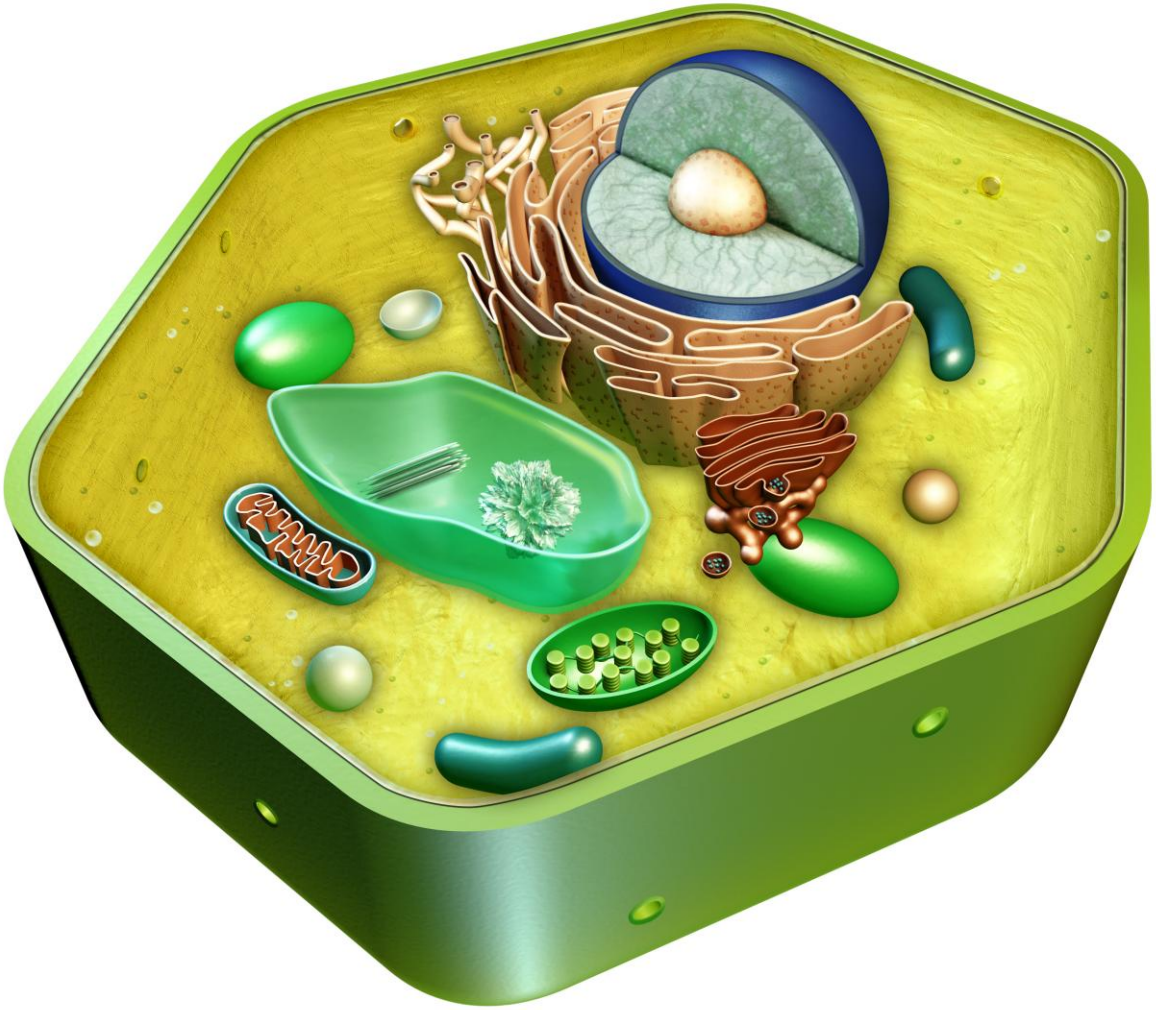
Bacteria – Unicellular – Prokaryotic



- All living things are composed of cells. A cell is the smallest structural unit of living matter. The cell itself is a mass of cytoplasm that is bound by a membrane. Inside the cell are organelles that perform specific functions.

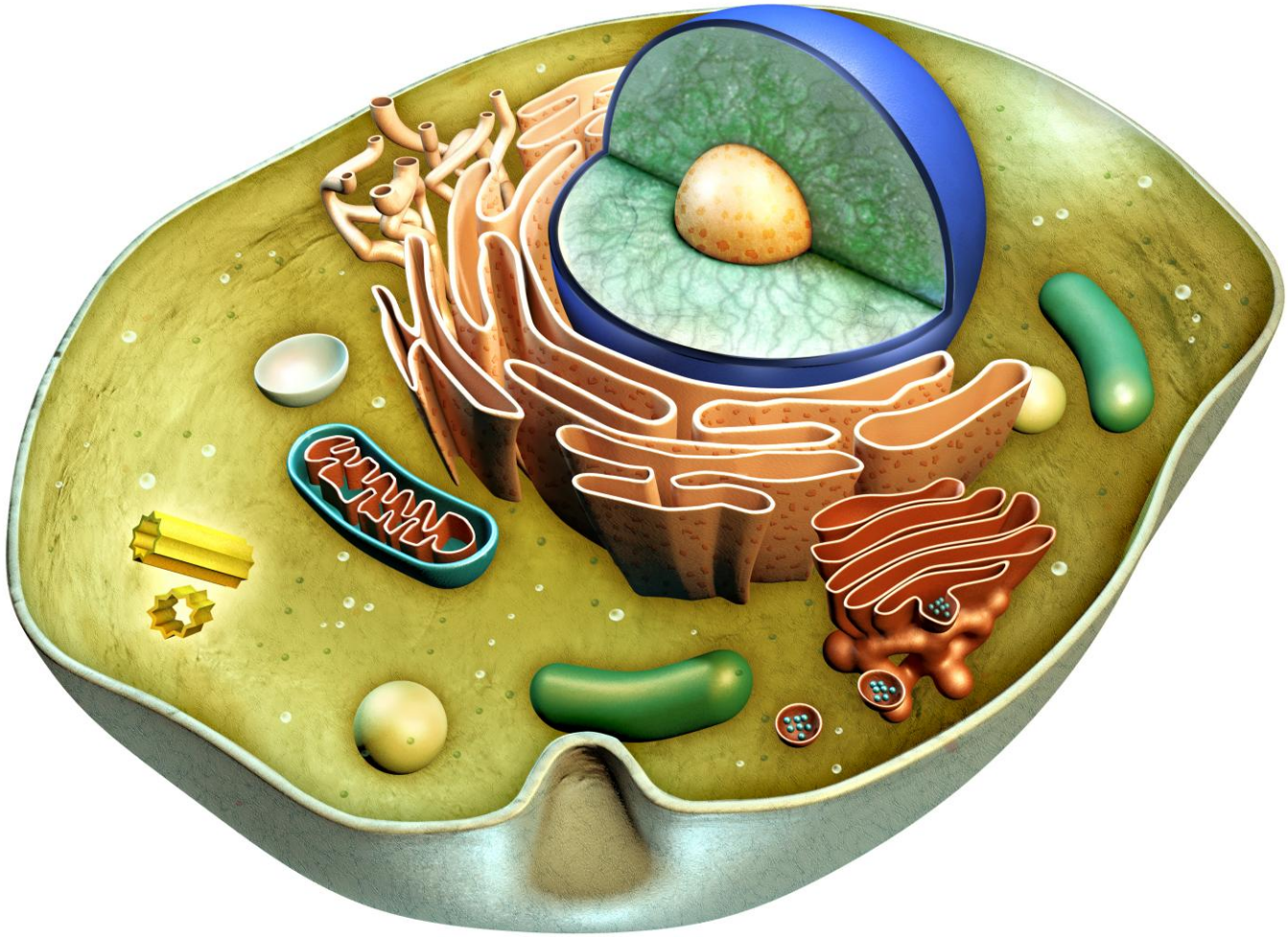
- Cells

Plants – Multicellular – Eukaryotic



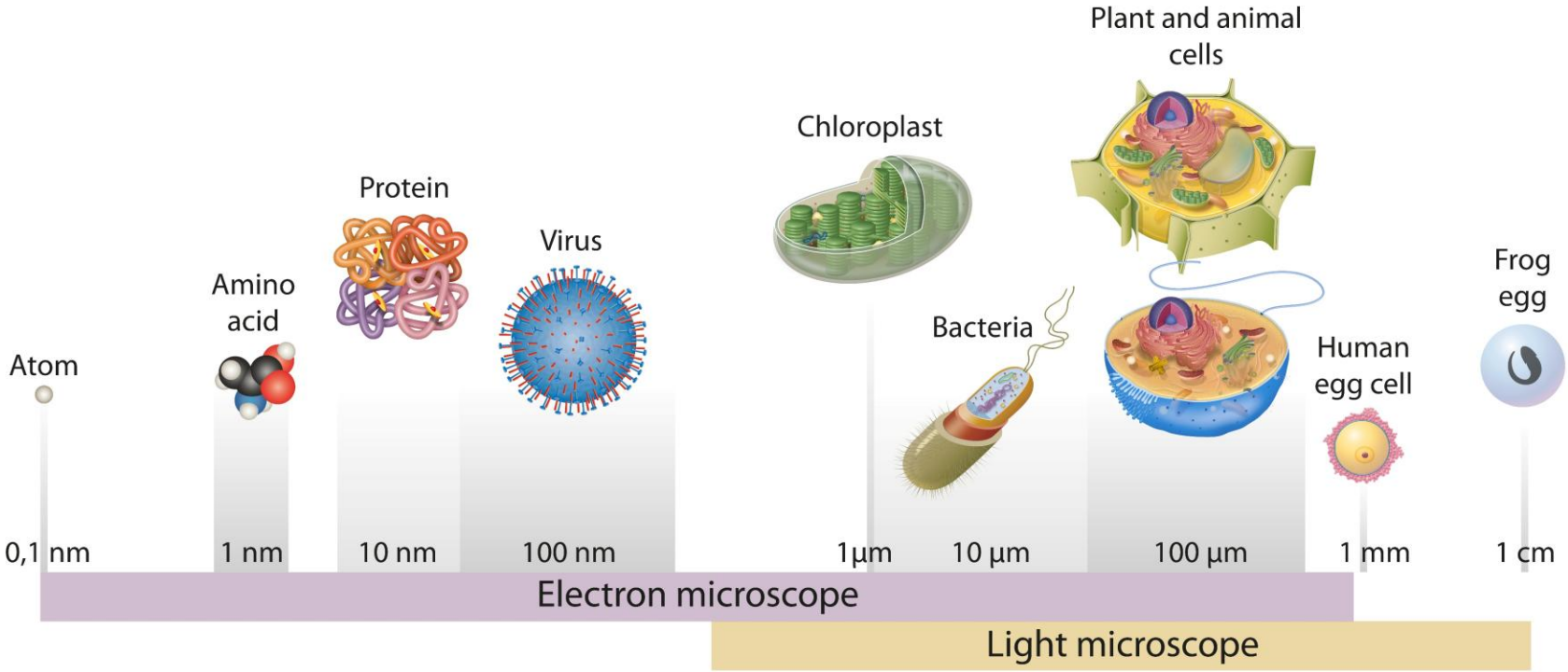
- Cells

Animals – Multicellular – Eukaryotic



• Concept of Scale

→ from single atoms to single cells →



- Tissue


Tissue

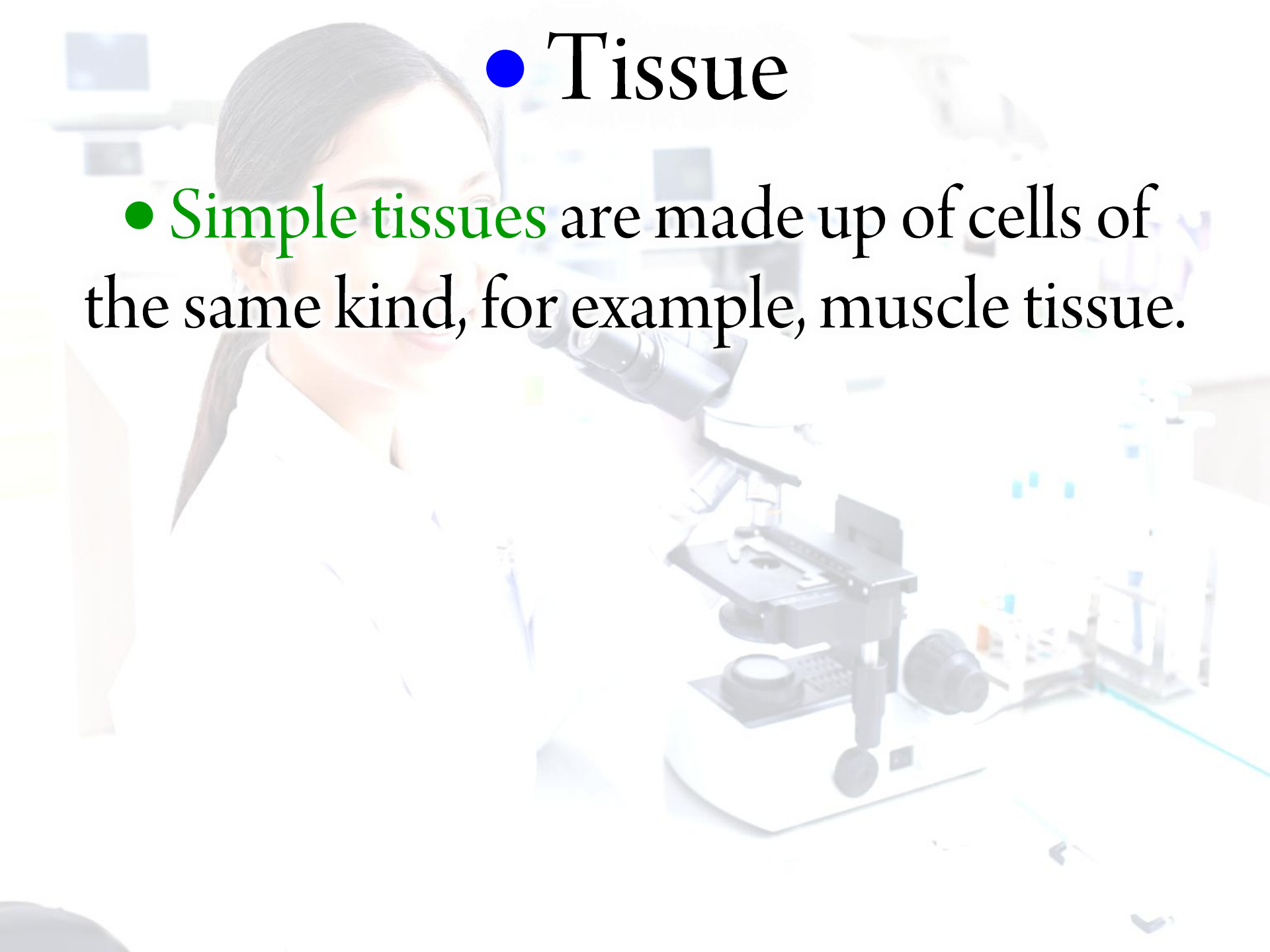
Tissue

- A collection of cells with similar structures that are grouped together to perform a shared function is called a tissue.

- Tissue

Tissue

- Simple tissues are made up of cells of the same kind, for example, muscle tissue.



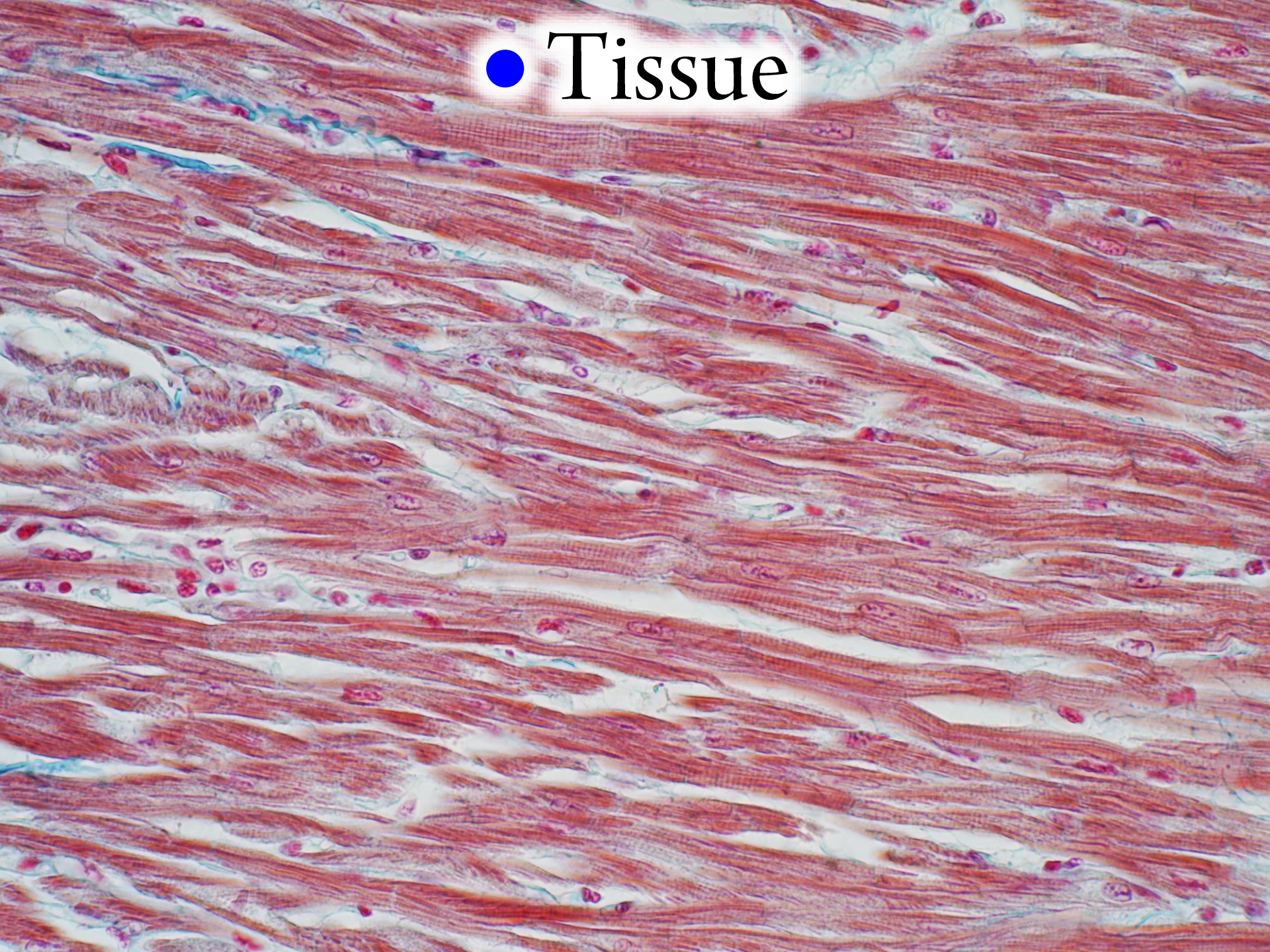
• Tissue

• Simple tissues are made up of cells of the same kind, for example, muscle tissue.

• Complex tissues are made-up of more than one type of cell, for example, blood consists of red blood cells (erythrocytes), white blood cells (leucocytes) and platelets.

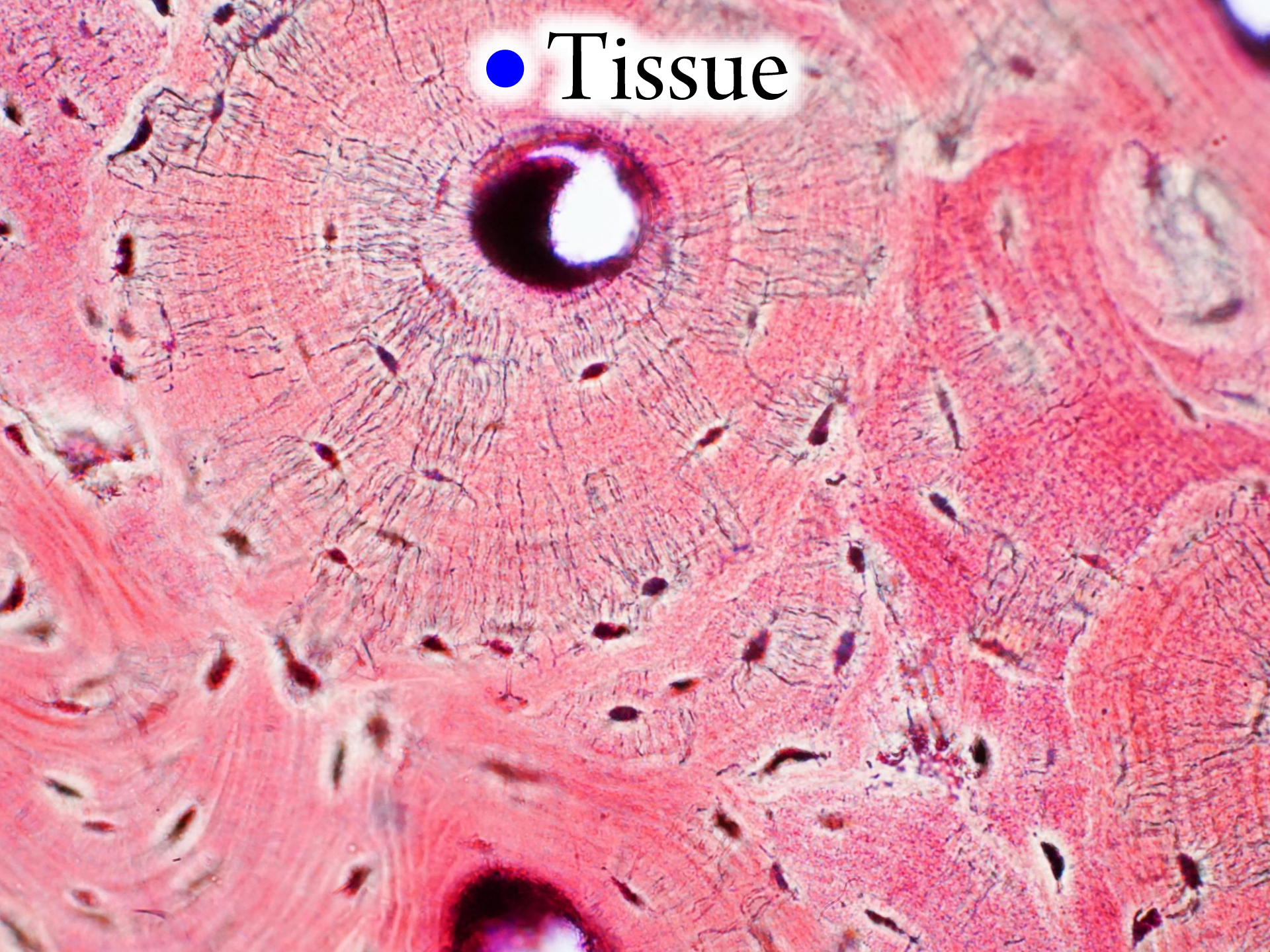
- Tissue

- Heart Muscle Tissue


Tissue

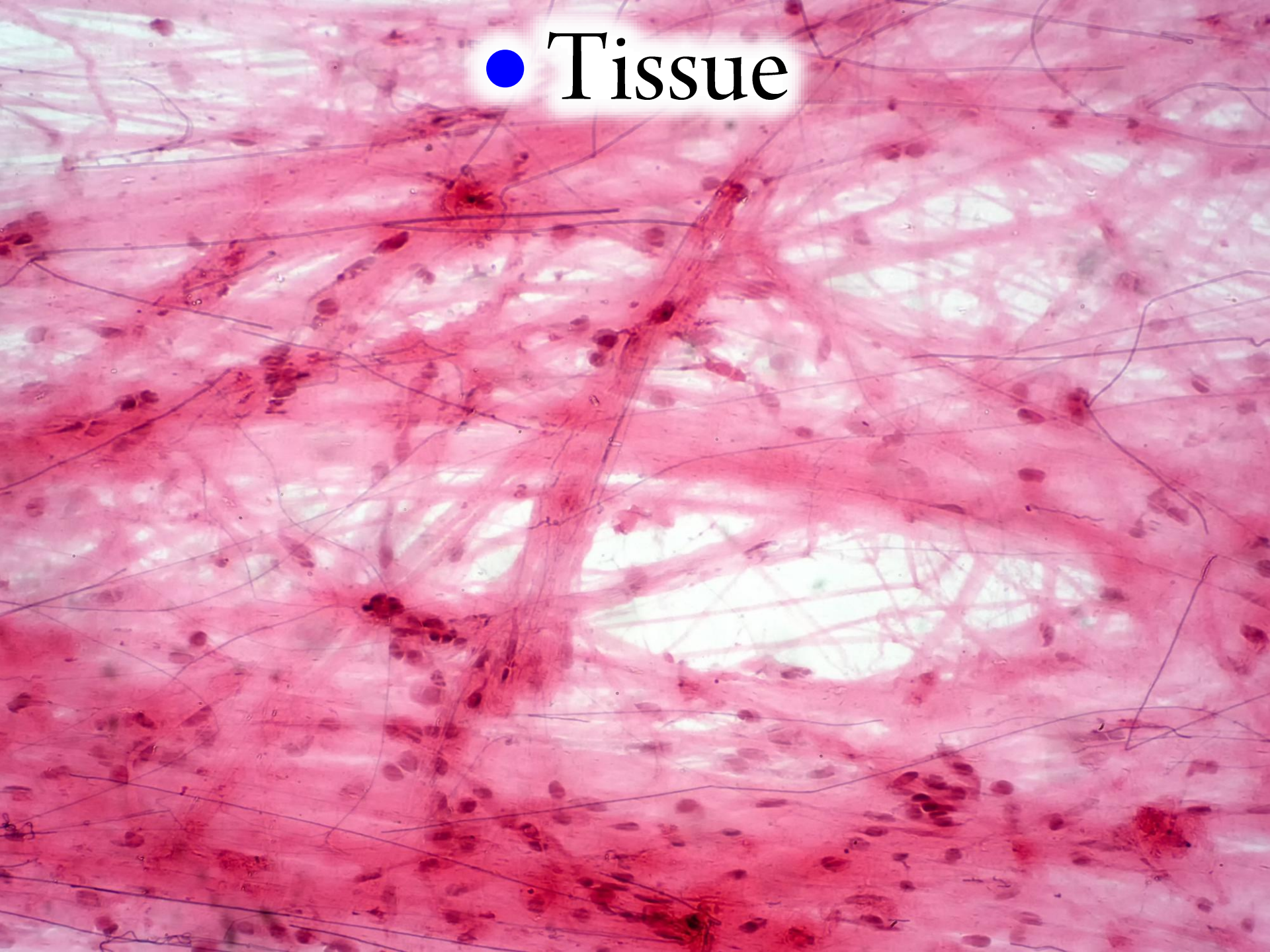
- Tissue

- Bone Tissue


Tissue

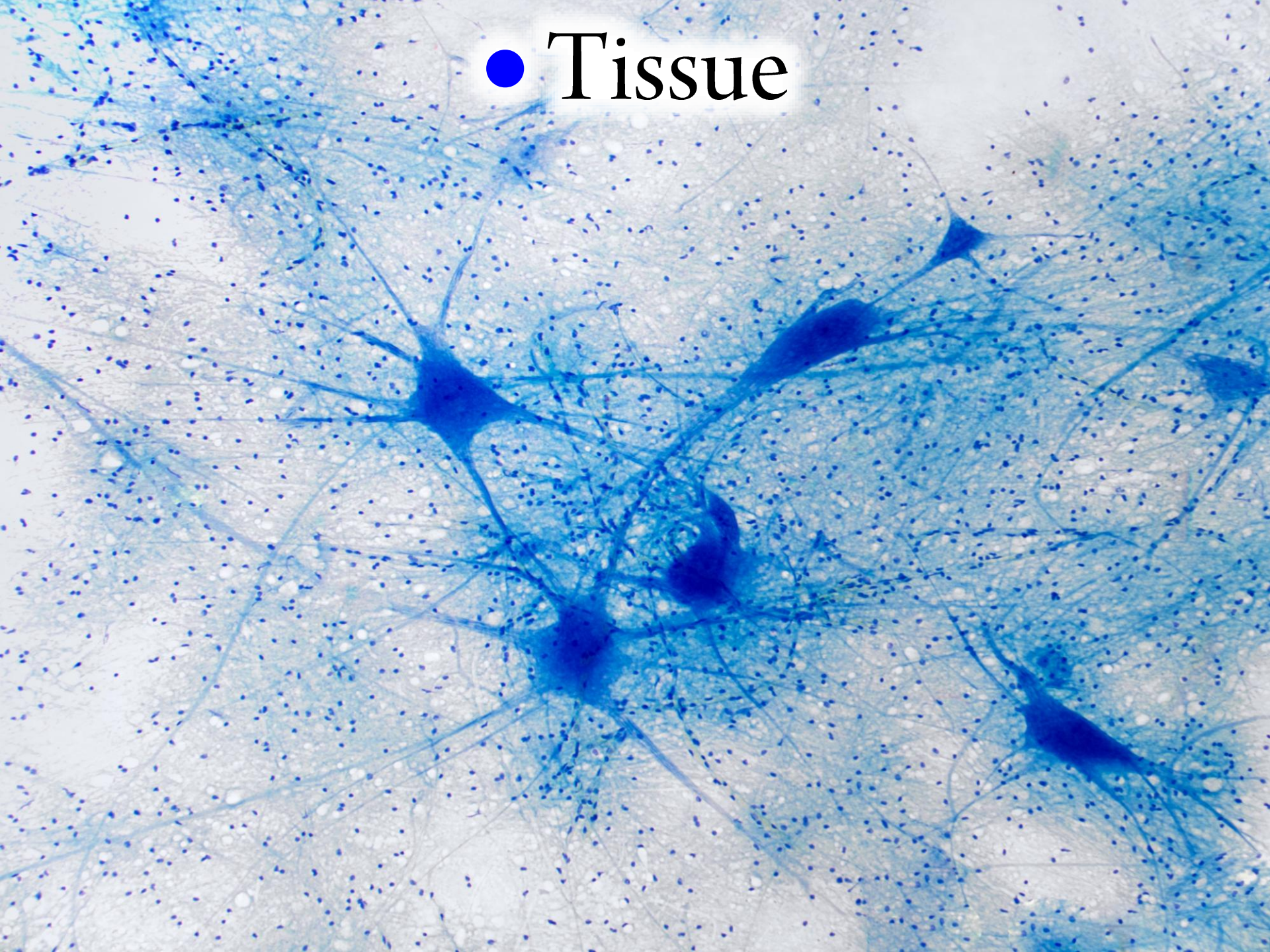
- Tissue

- Connective Tissue


• Tissue

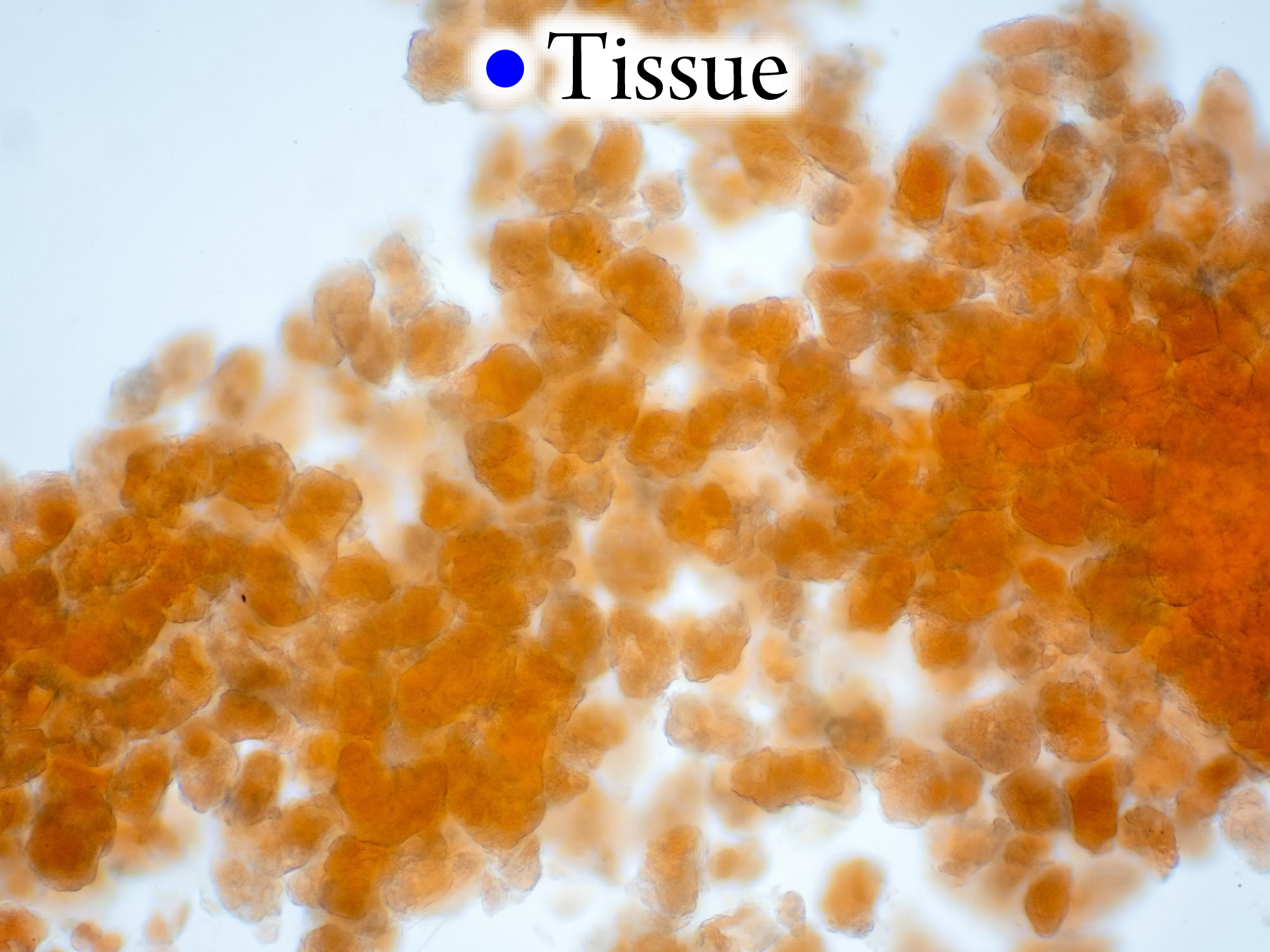
- Tissue

- Neural Tissue


Tissue

- Tissue

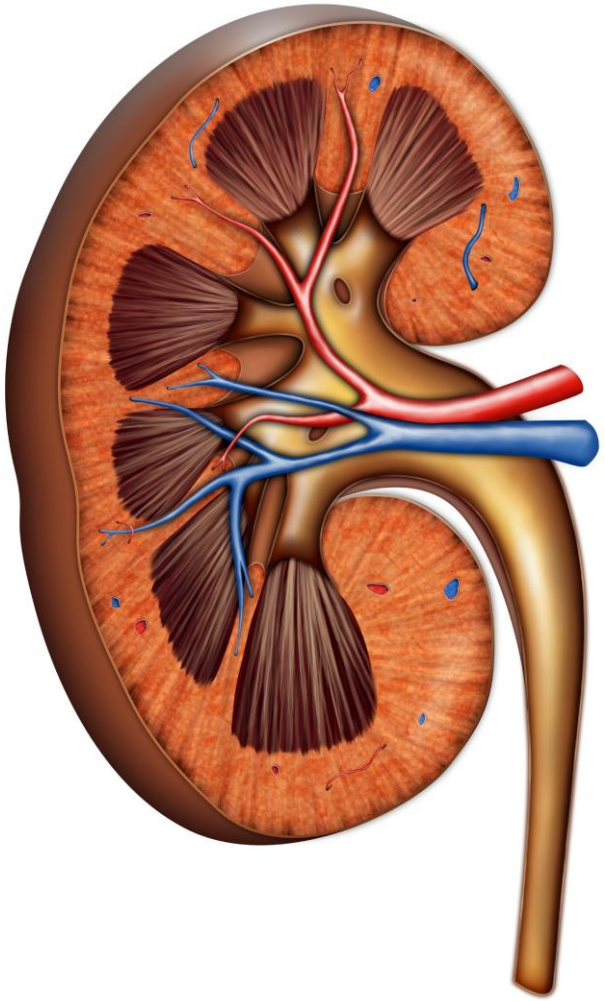
- Adipose Tissue


Tissue

- Organs

- Organs

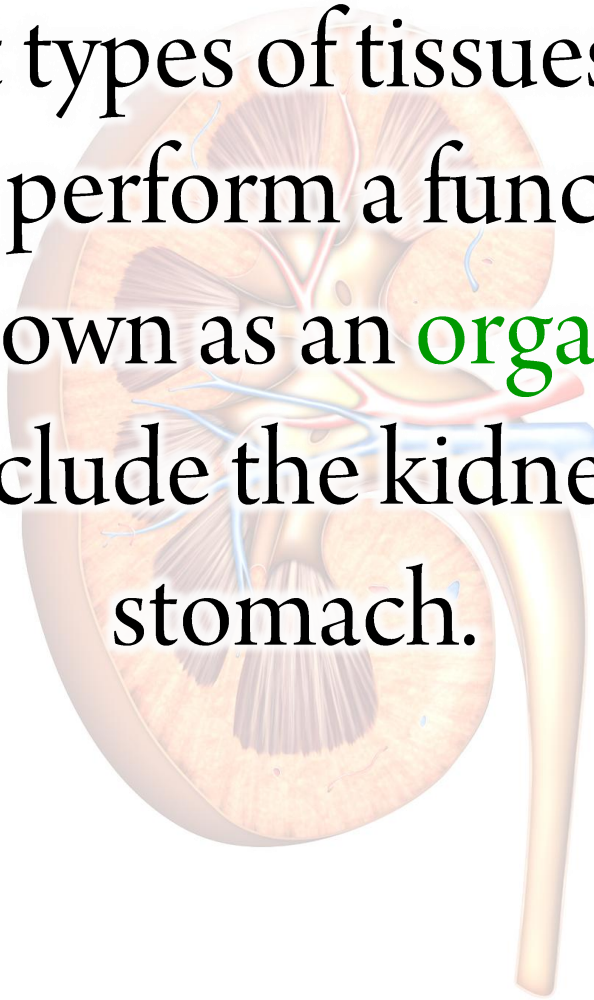
Kidney



Organs

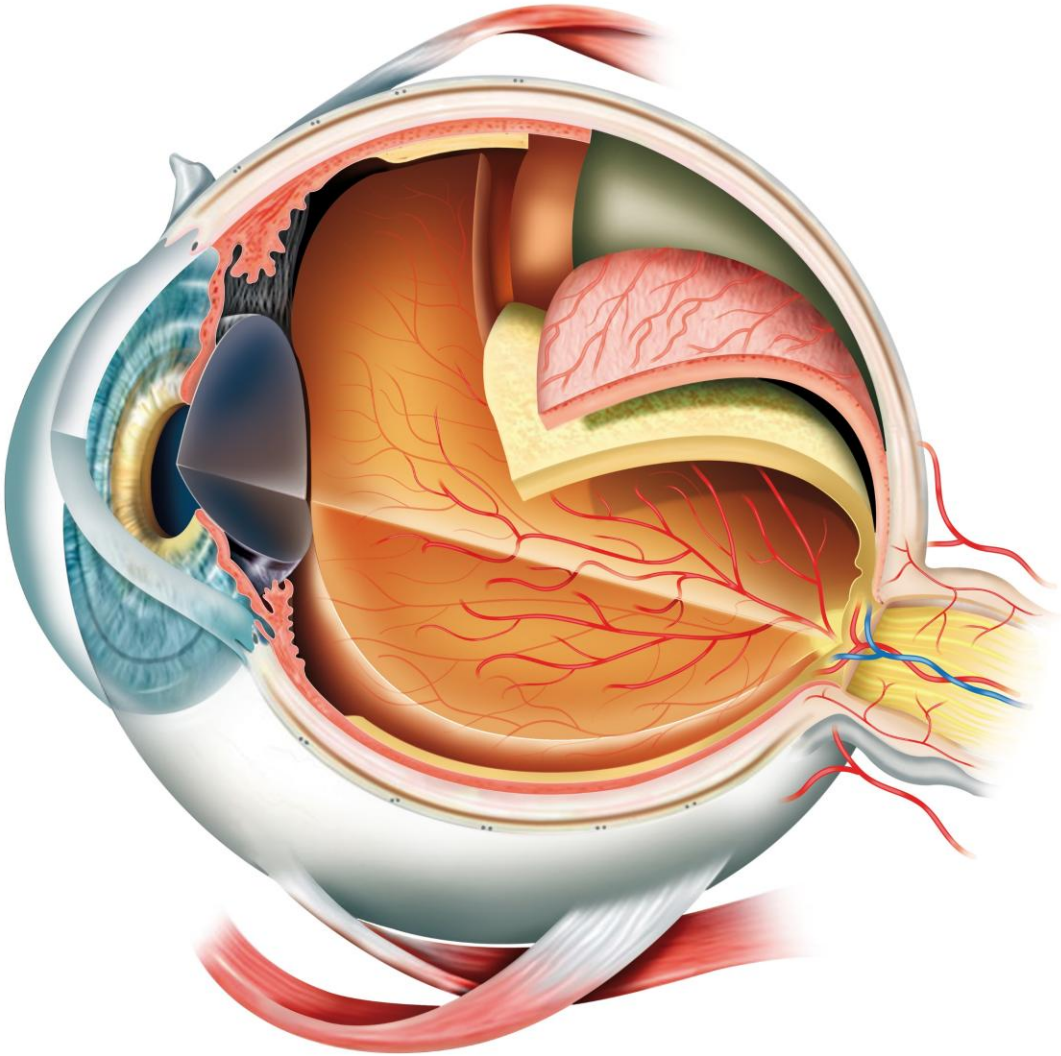
Kidney

- Different types of tissues that work together to perform a function form a structure known as an organ. Examples of organs include the kidney, heart and stomach.



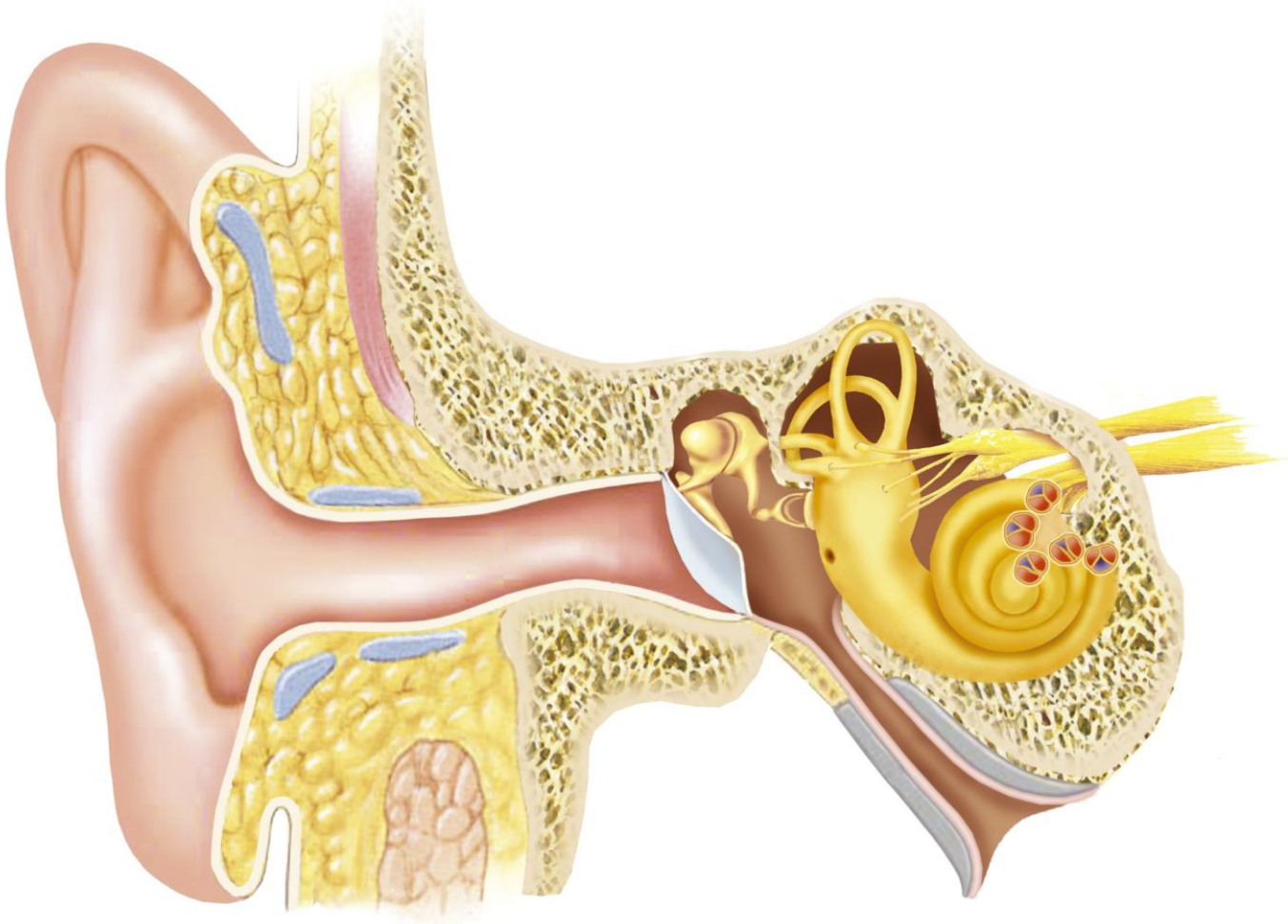
- Organs

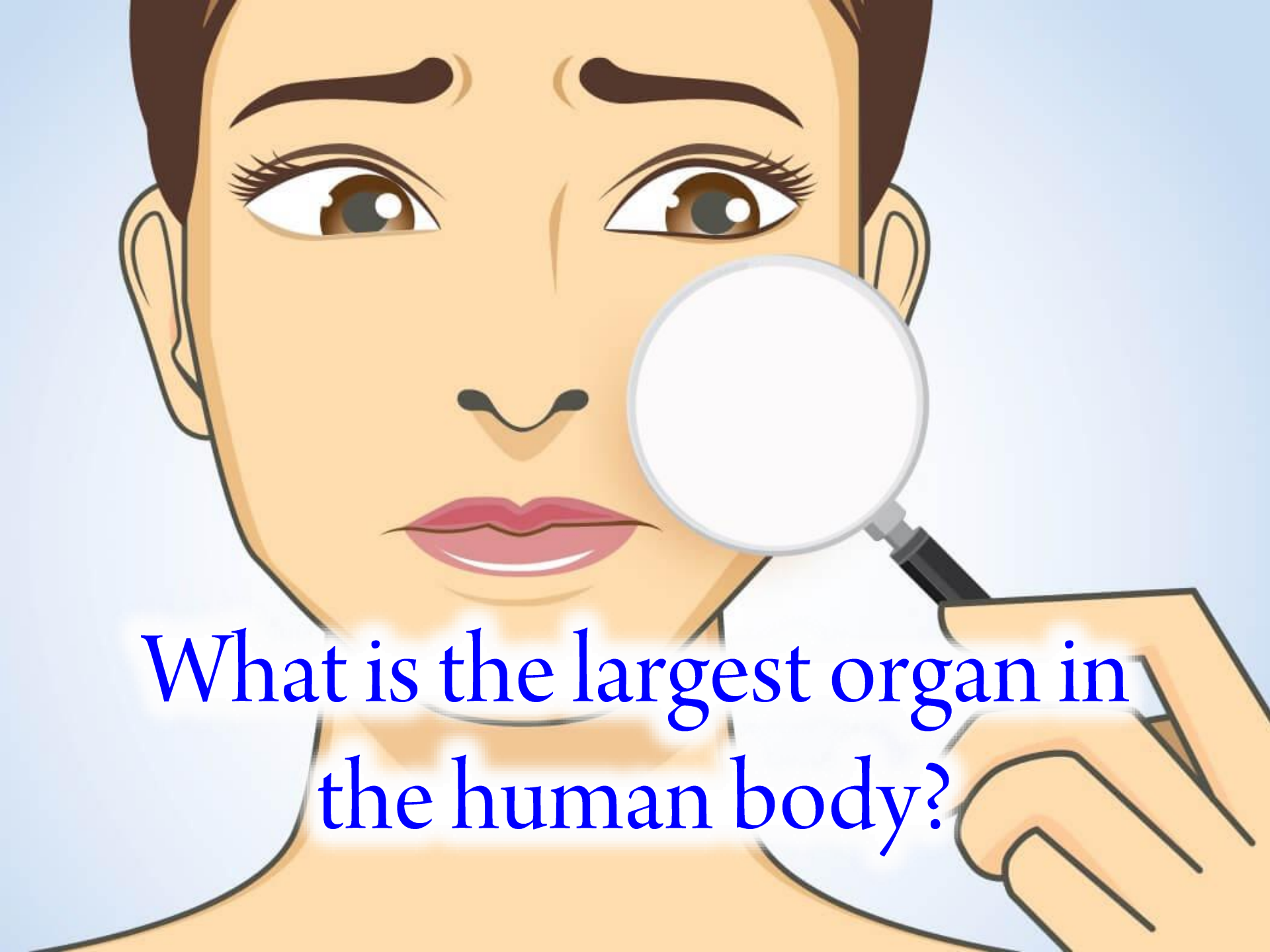
Eye

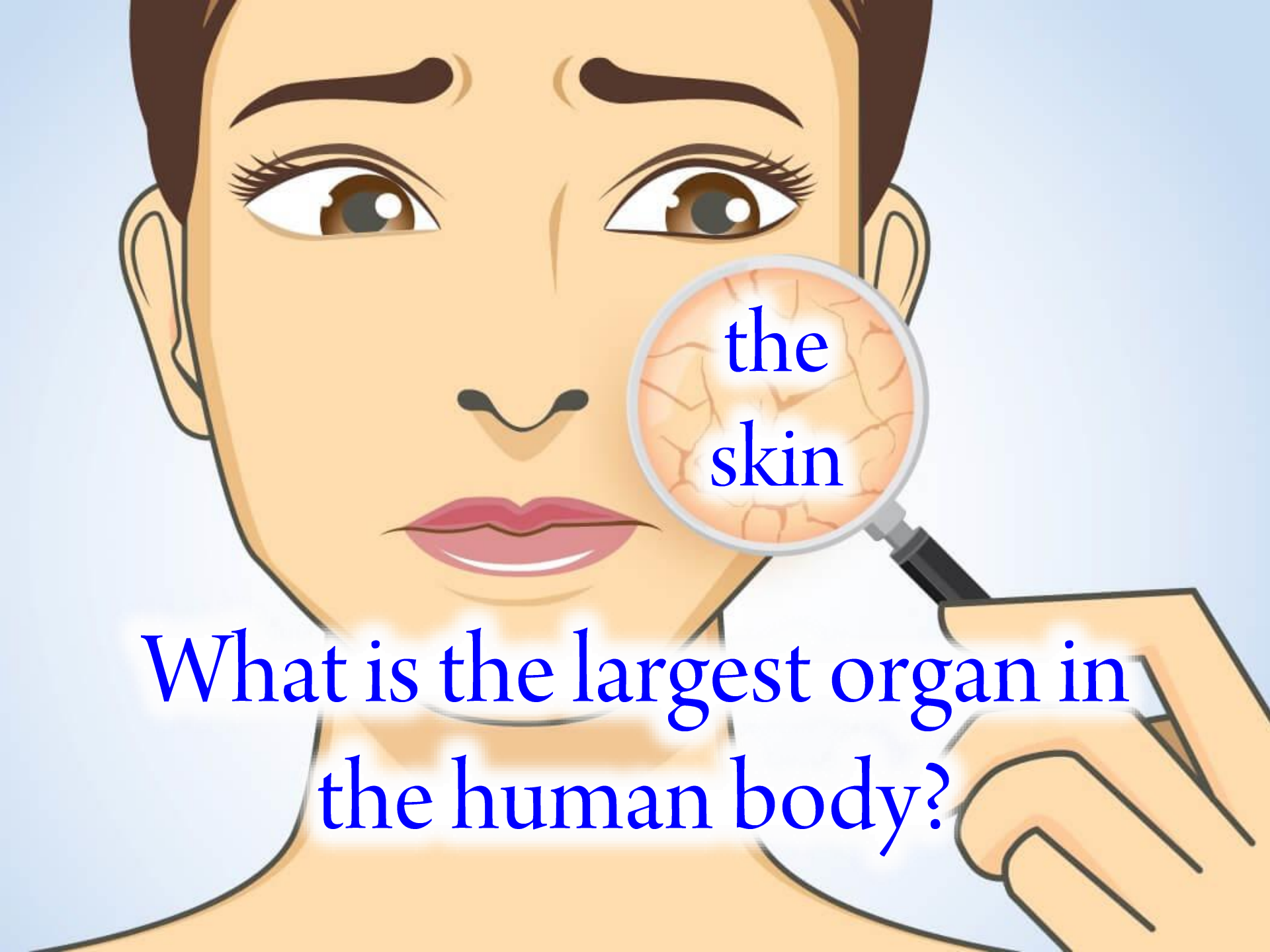


- Organs

Ear



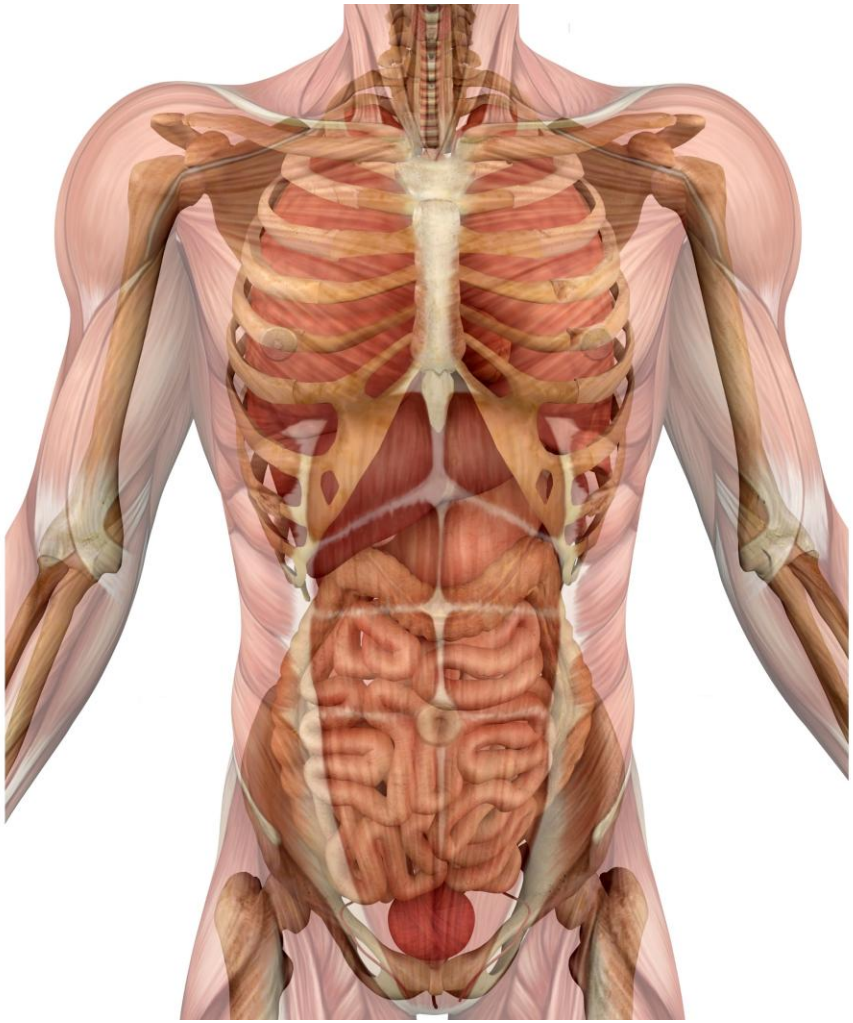

What is the largest organ in the human body?



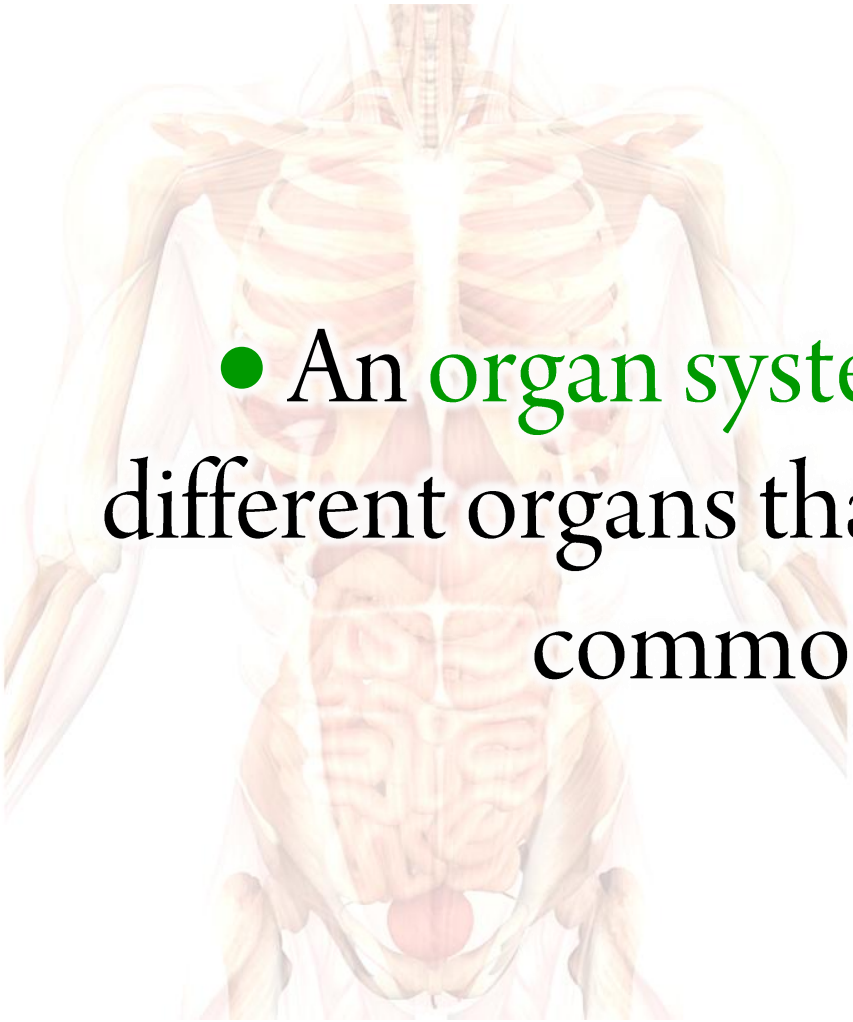
What is the largest organ in the human body?

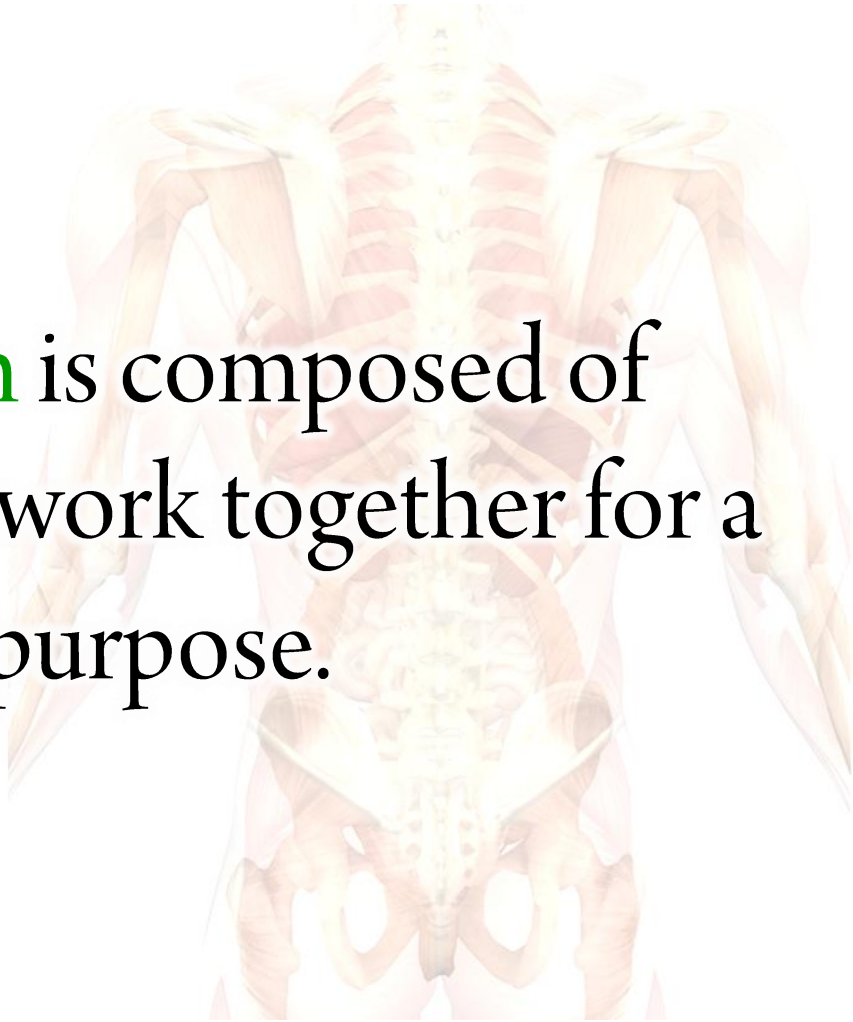
- Organ Systems

- Organ Systems in the Human Body



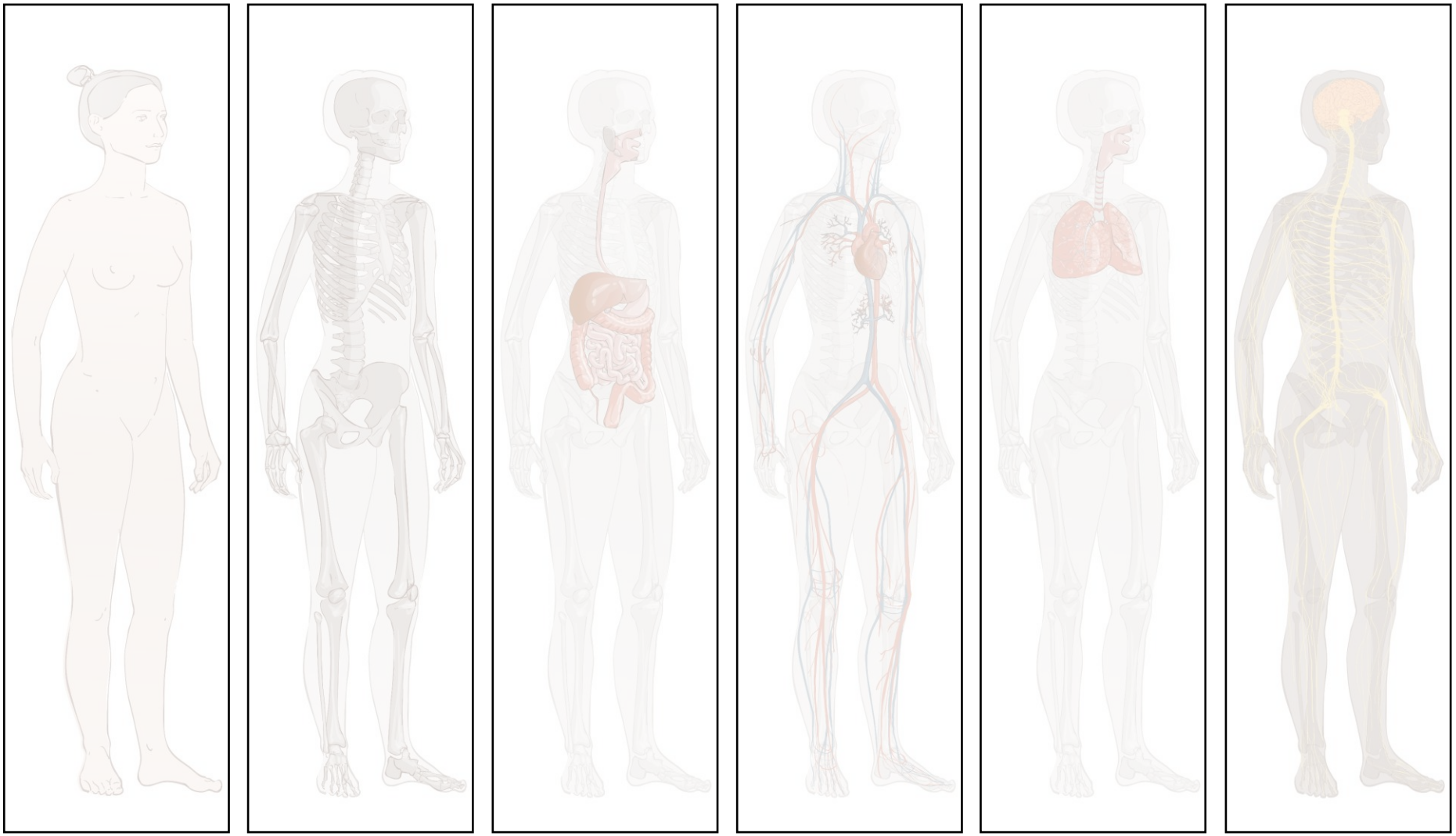
Organ Systems in the Human Body



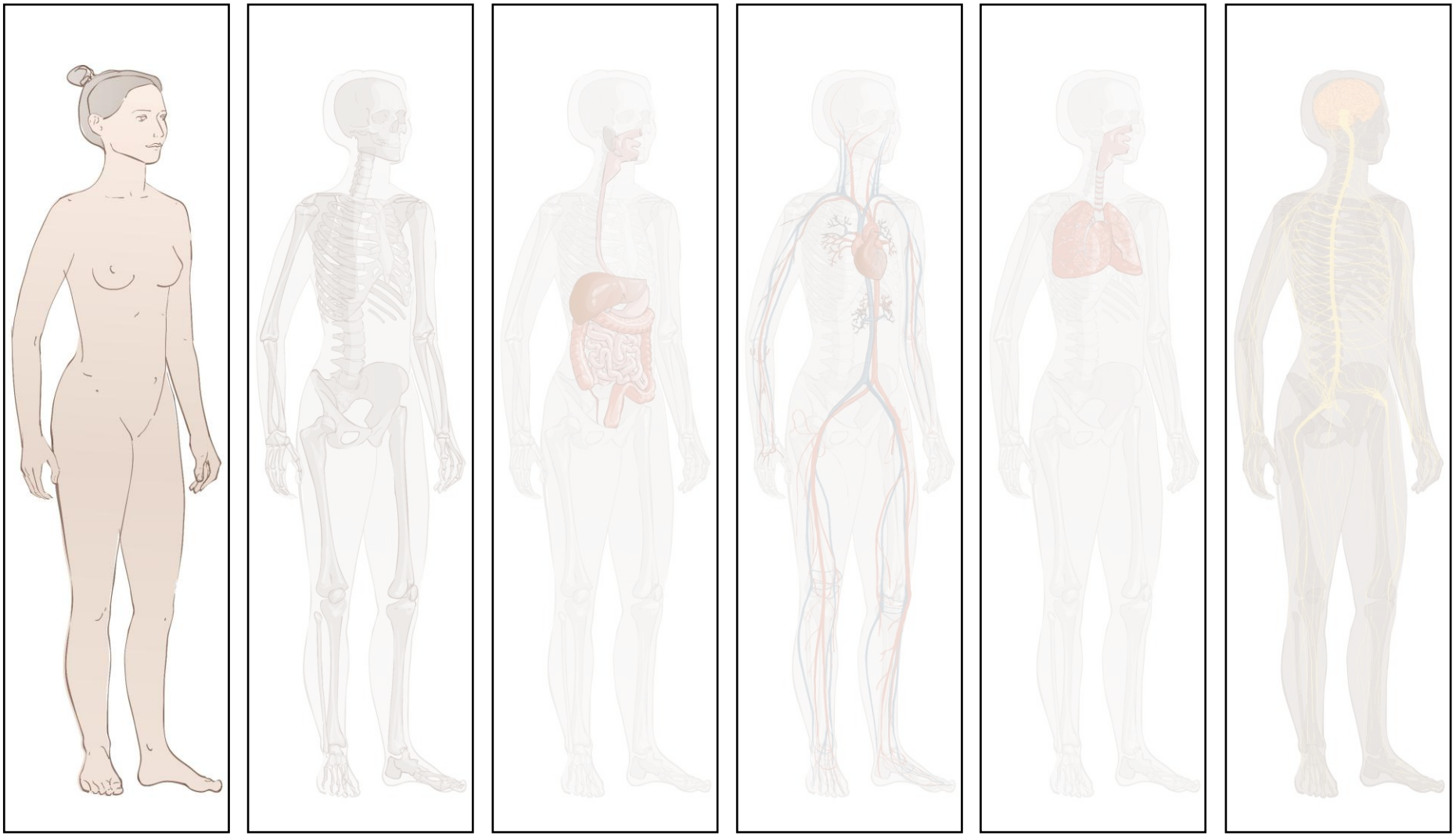


- An organ system is composed of different organs that work together for a common purpose.

- Organ Systems in the Human Body

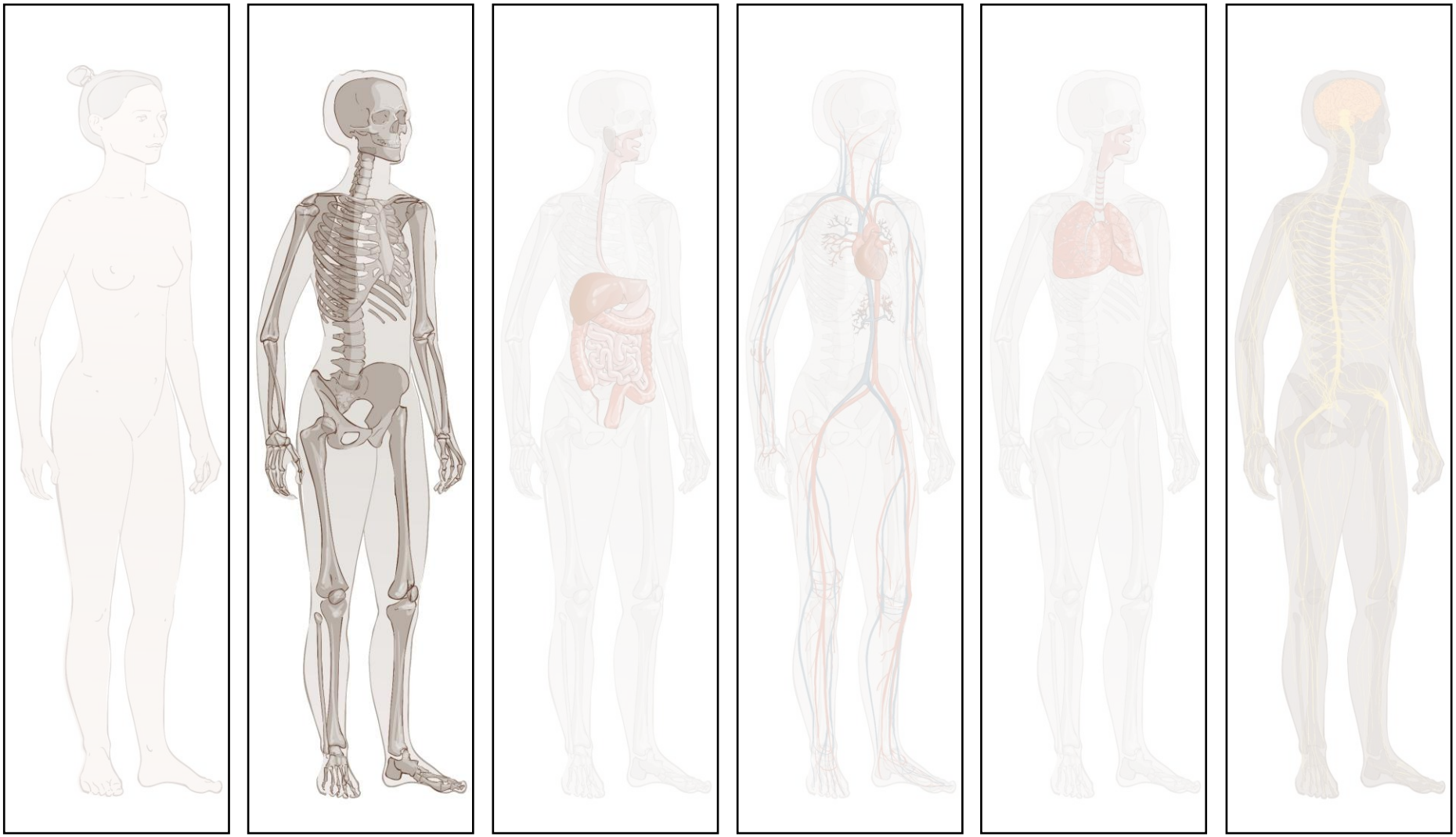


Organ Systems in the Human Body



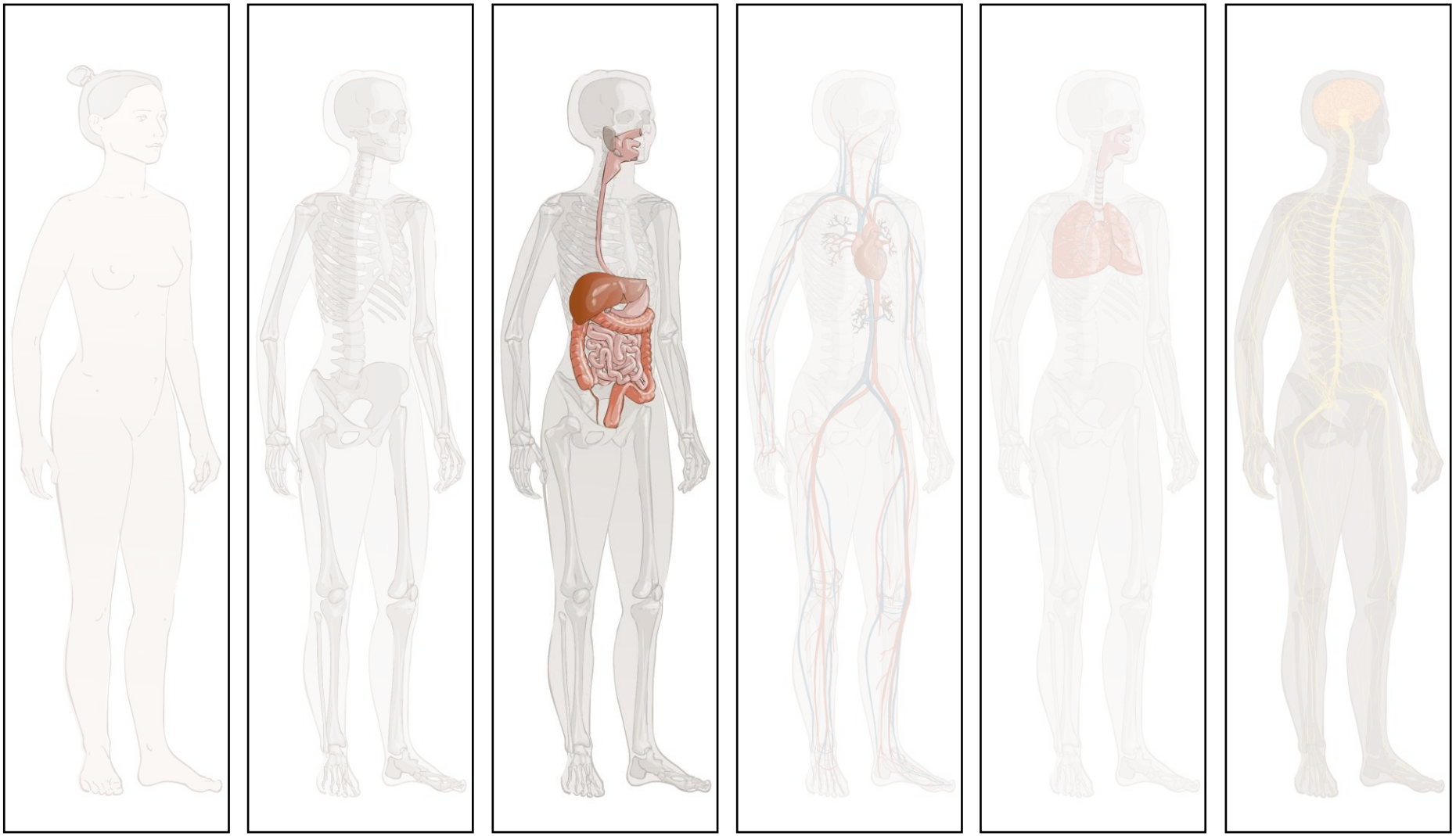
- Human Body

Organ Systems in the Human Body



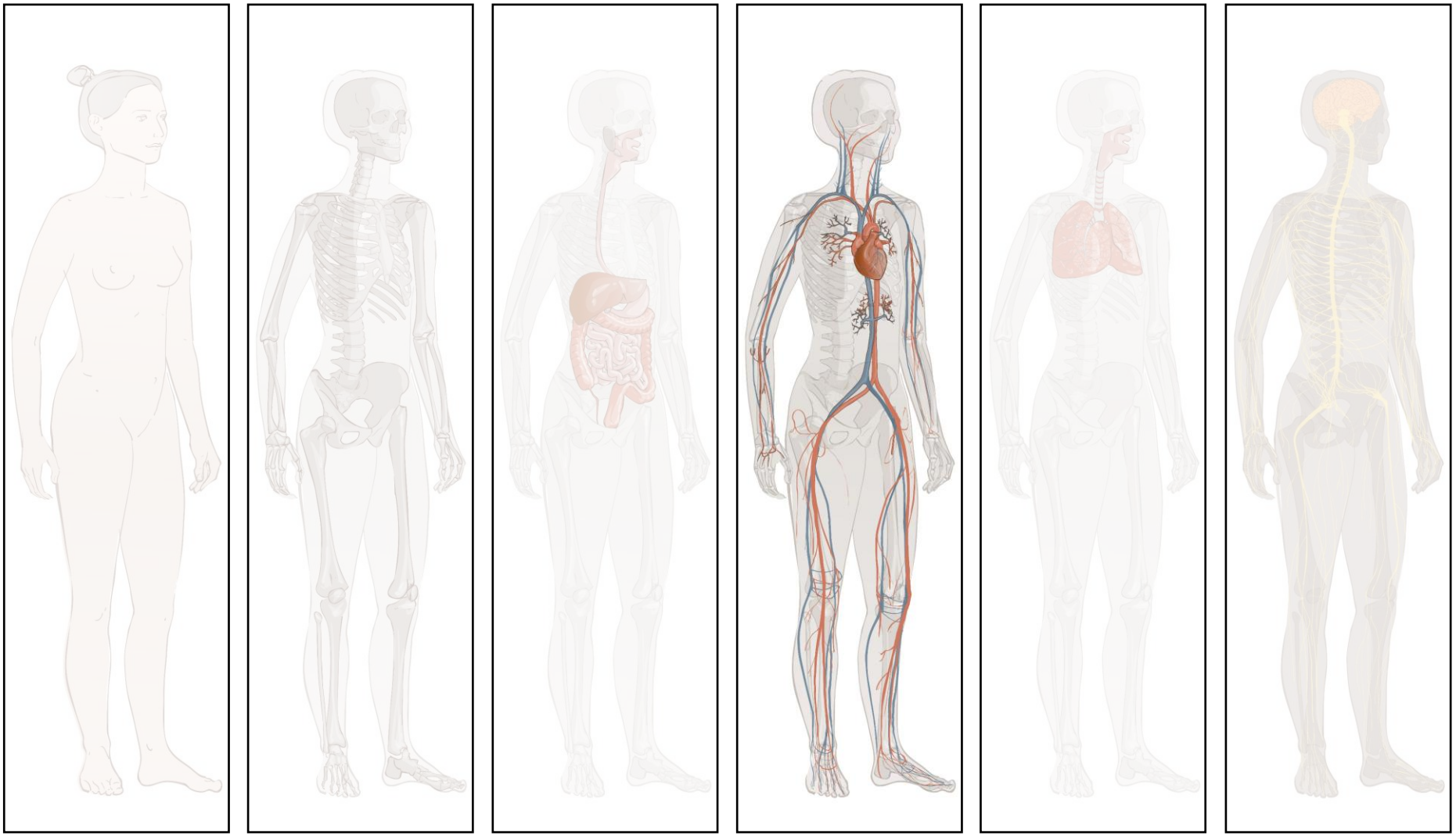
- Skeletal System

Organ Systems in the Human Body



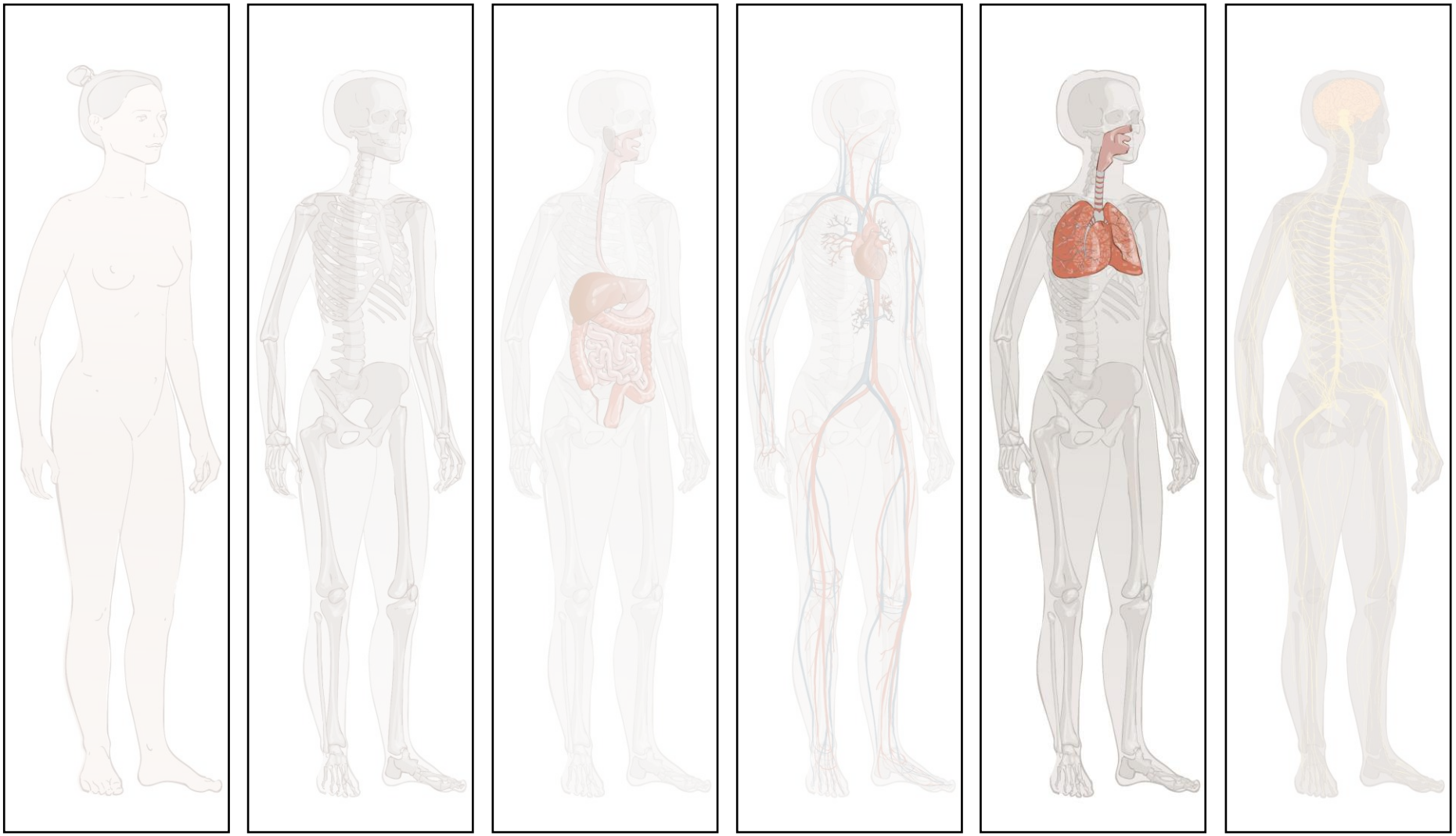
- Digestive System

Organ Systems in the Human Body



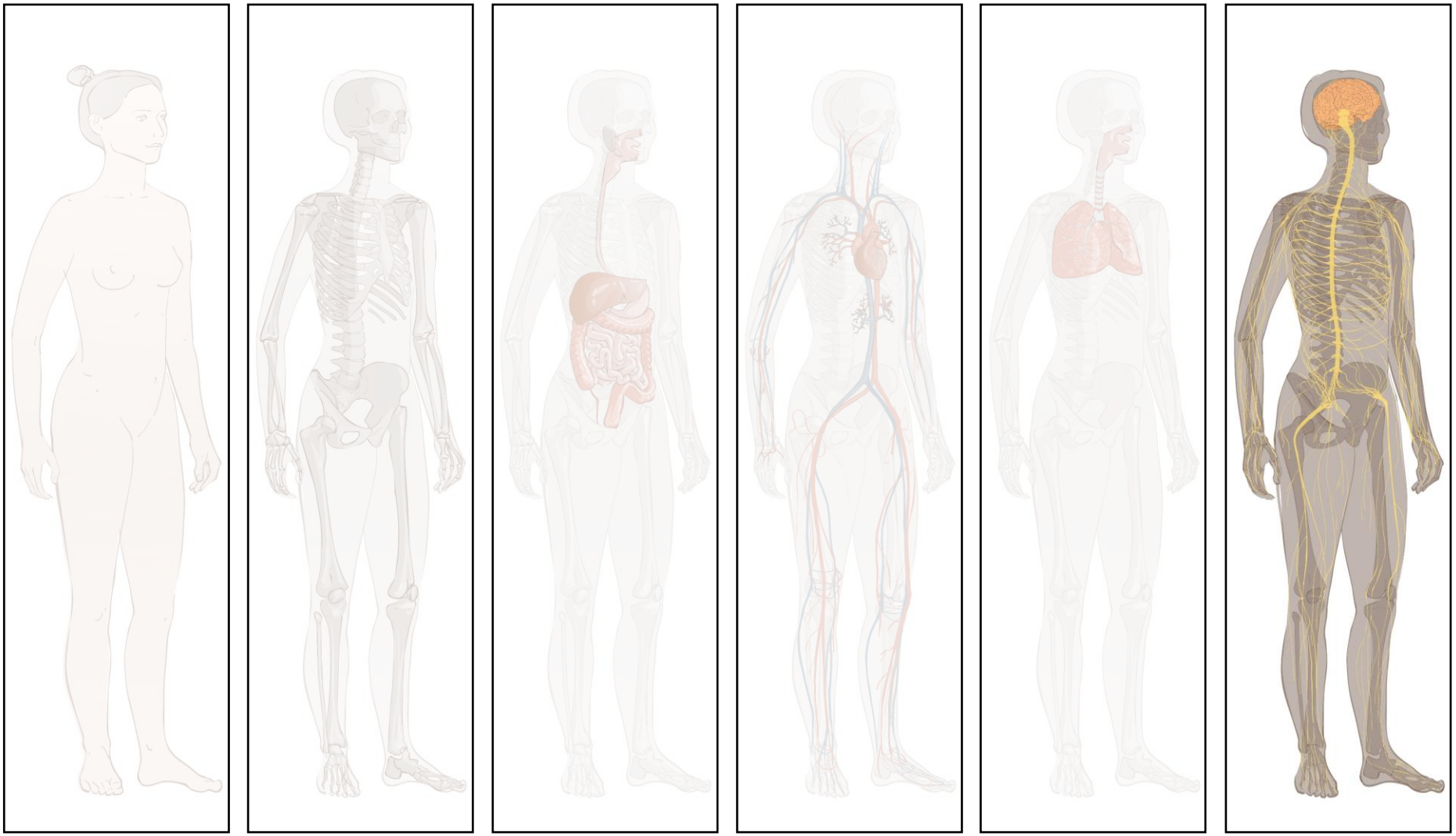
- Circulatory System

Organ Systems in the Human Body



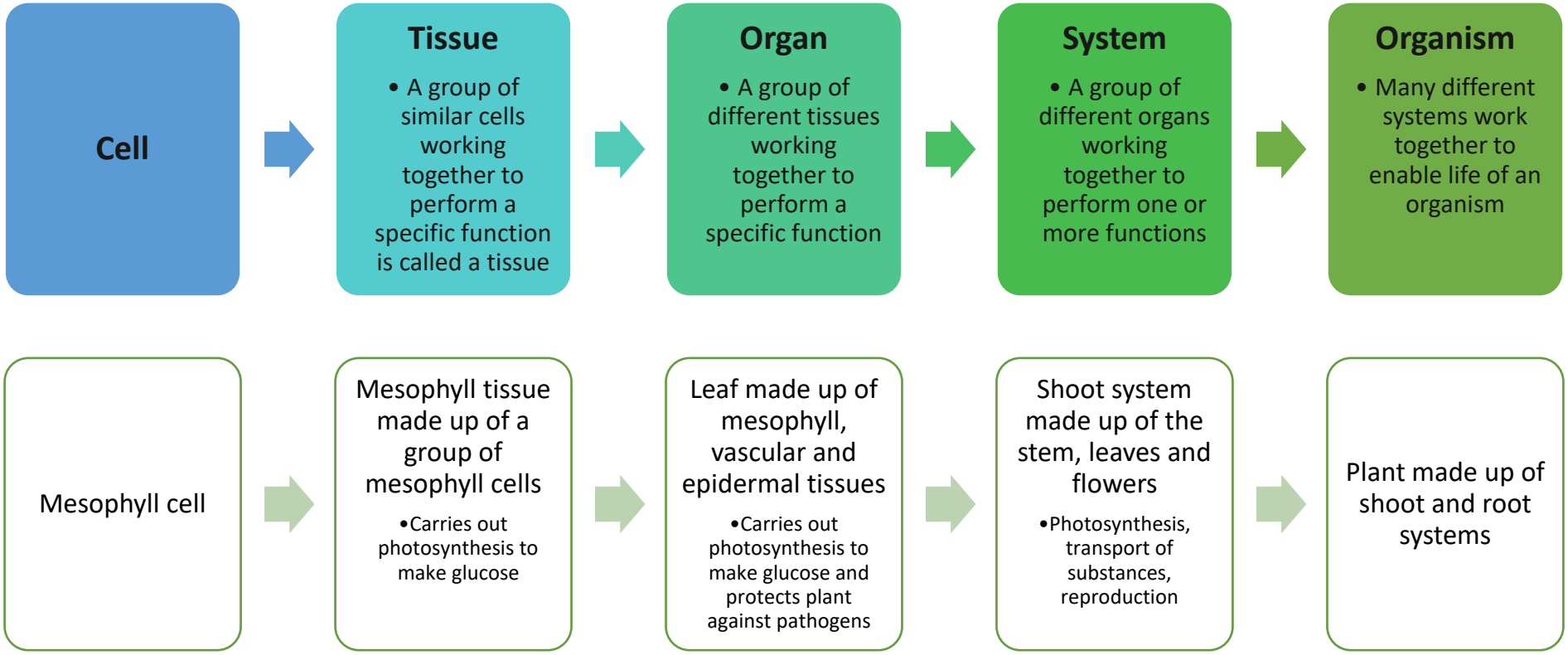
- Respiratory System

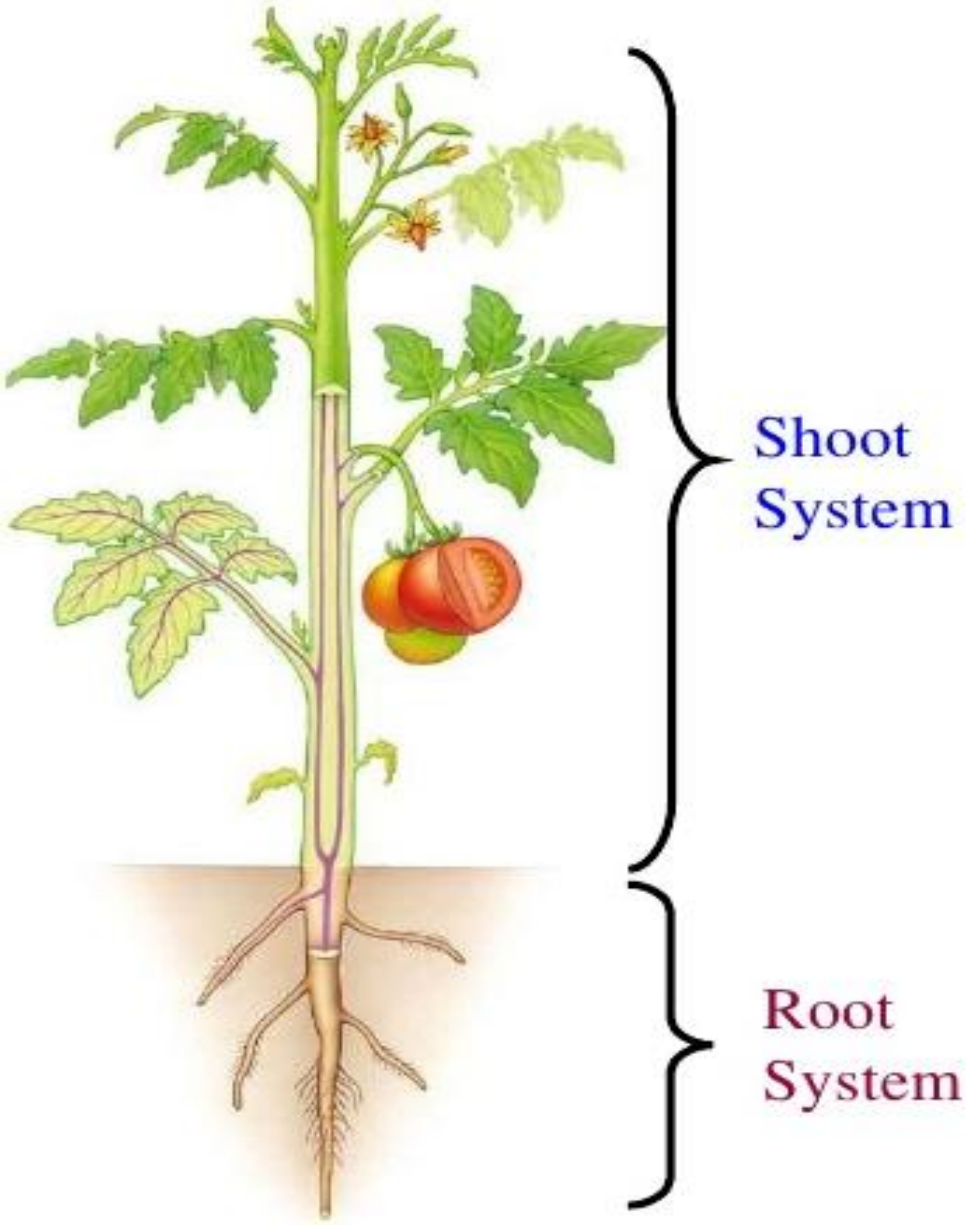
• Organ Systems in the Human Body



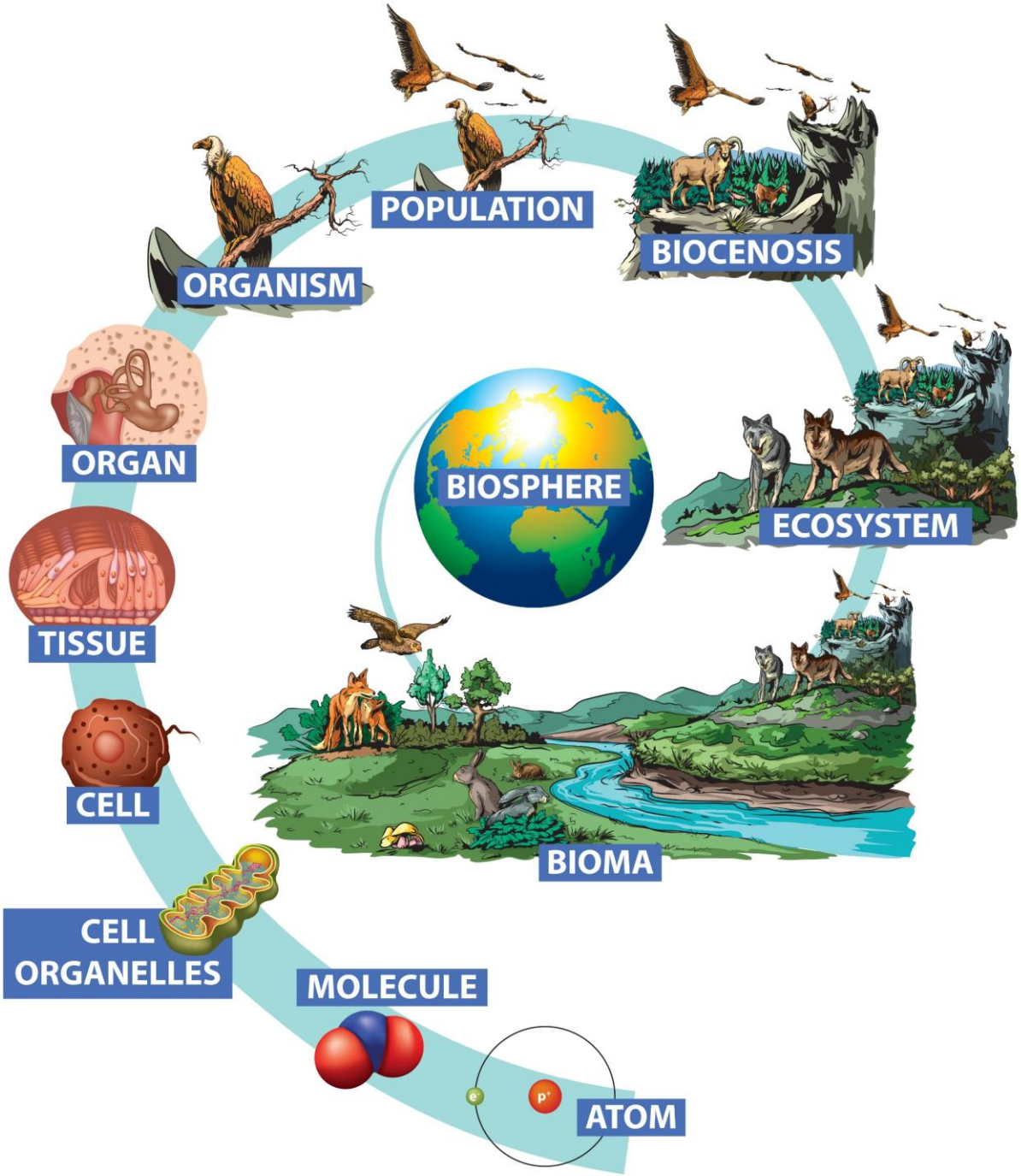
• Nervous System

From Cells to Systems in Plants



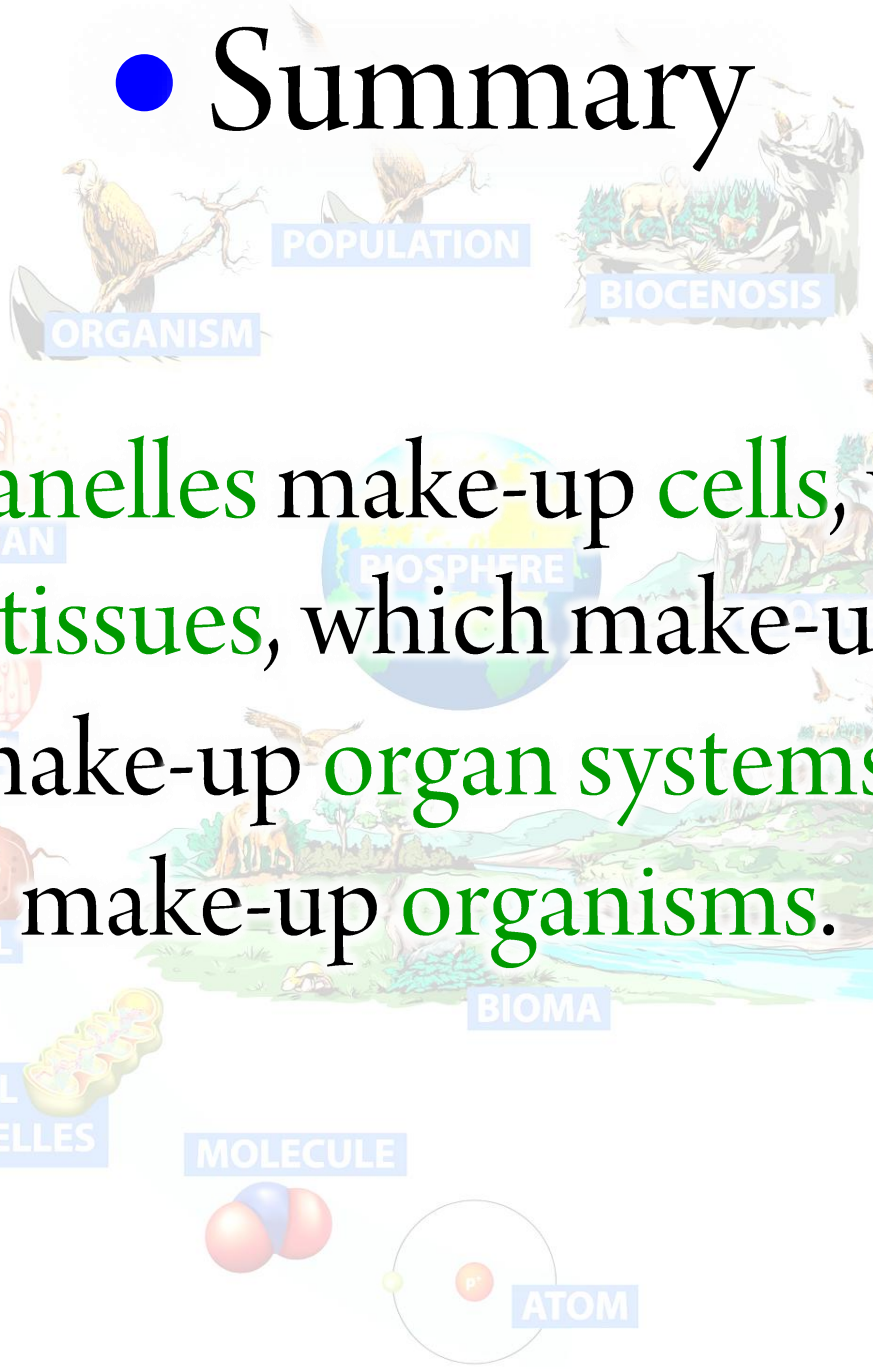

Shoot
System
Root
System

- Summary


POPULATION
BIOCENOSIS
ORGANISM
ORGAN
BIOSPHERE
ECOSYSTEM
TISSUE
CELL
BIOMA
CELL ORGANELLES
MOLECULE
ATOM

• Summary

• Organelles make-up cells, which make-up tissues, which make-up organs, which make-up organ systems, which make-up organisms.



Summary

- The Division of Labour:

In multicellular organisms, although different cells / tissues / organs / systems perform different functions, they all work together to ensure that the whole organism functions efficiently and effectively.

- Questions

• Question:

a) Arrange these structures in order of size, beginning with the smallest first:
stomach, mitochondrion, nucleus, muscle cell.

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stomach, mitochondrion, nucleus, muscle cell.

• Answer:

mitochondrion → nucleus → muscle cell → stomach

• Question:

b) For each of the following, state whether it is an organelle, cell, tissue, organ, organ system or organism: heart, bacterium, chloroplast, xylem, nucleus, blood, onion plant, kidney.

• **Question:**

b) For each of the following, state whether it is an organelle, cell, tissue, organ, organ system or organism: heart, bacterium, chloroplast, xylem, nucleus, blood, onion plant, kidney.

• Answer:

heart	→	organ	nucleus	→	organelle
bacterium	→	organism	blood	→	tissue
chloroplast	→	organelle	onion plant	→	organism
xylem	→	tissue	kidney	→	organ

- **Question:**

c) How can the concept of *division of labour* be applied in your everyday life?

- **Question:**

c) How can the concept of *division of labour* be applied in your everyday life?

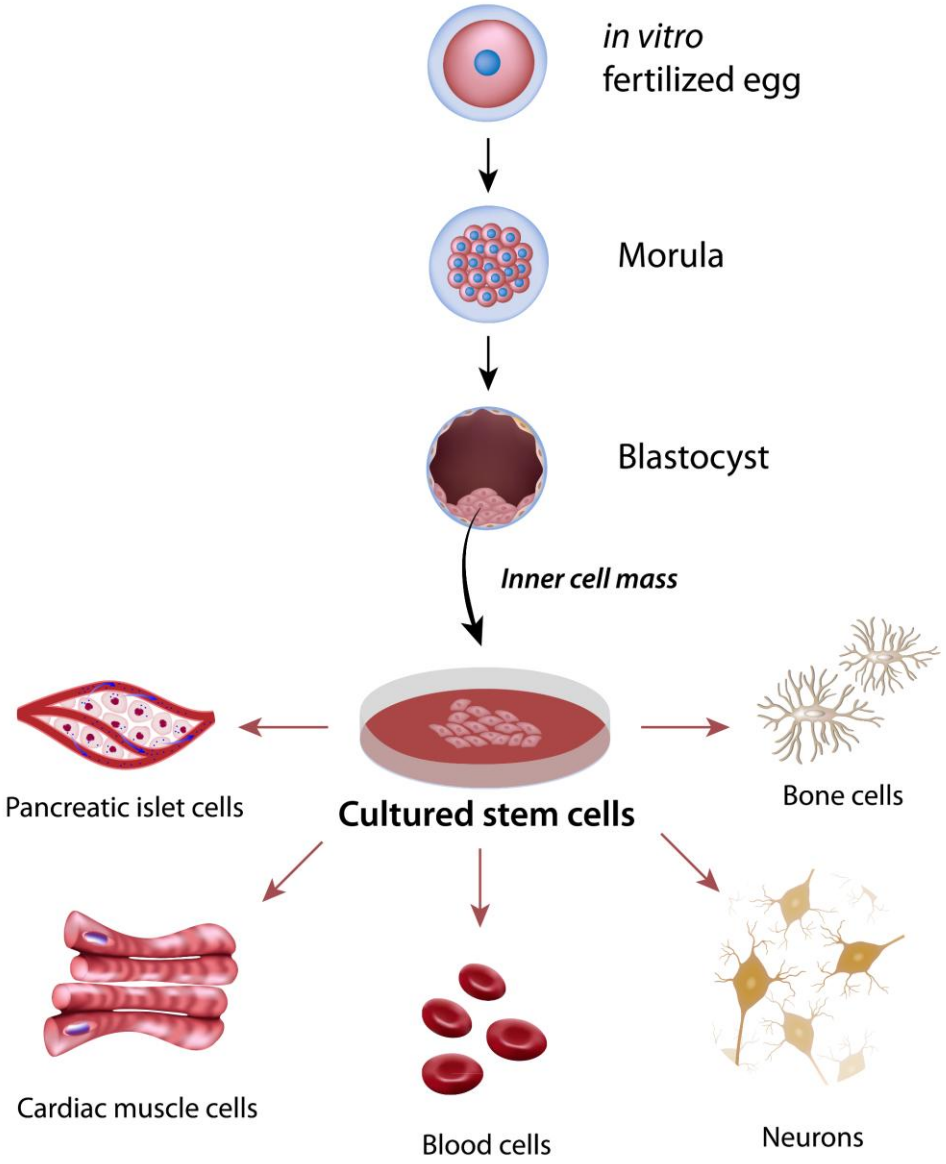
- **Answer:**

An example might be the class committee. There is a division of labour in the tasks that must be completed, such as empty the bin, sweep the floor and clean the whiteboard.

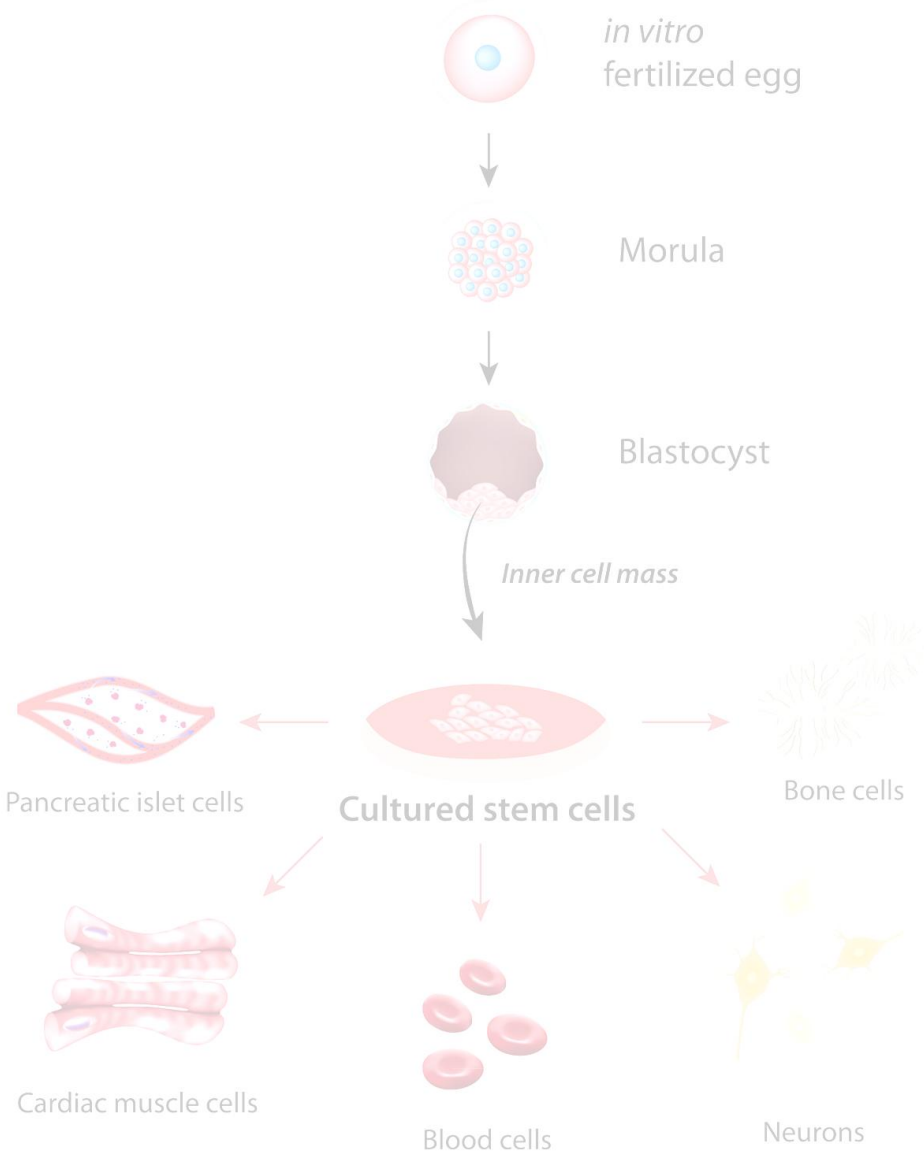
- Stem Cells

- What are stem cells?
- How can research into stem cells help in the treatment of certain medical conditions?

• Stem Cells


in vitro
fertilized egg
Morula
Blastocyst
Inner cell mass
Pancreatic islet cells
Cultured stem cells
Bone cells
Cardiac muscle cells
Blood cells
Neurons

• Stem Cells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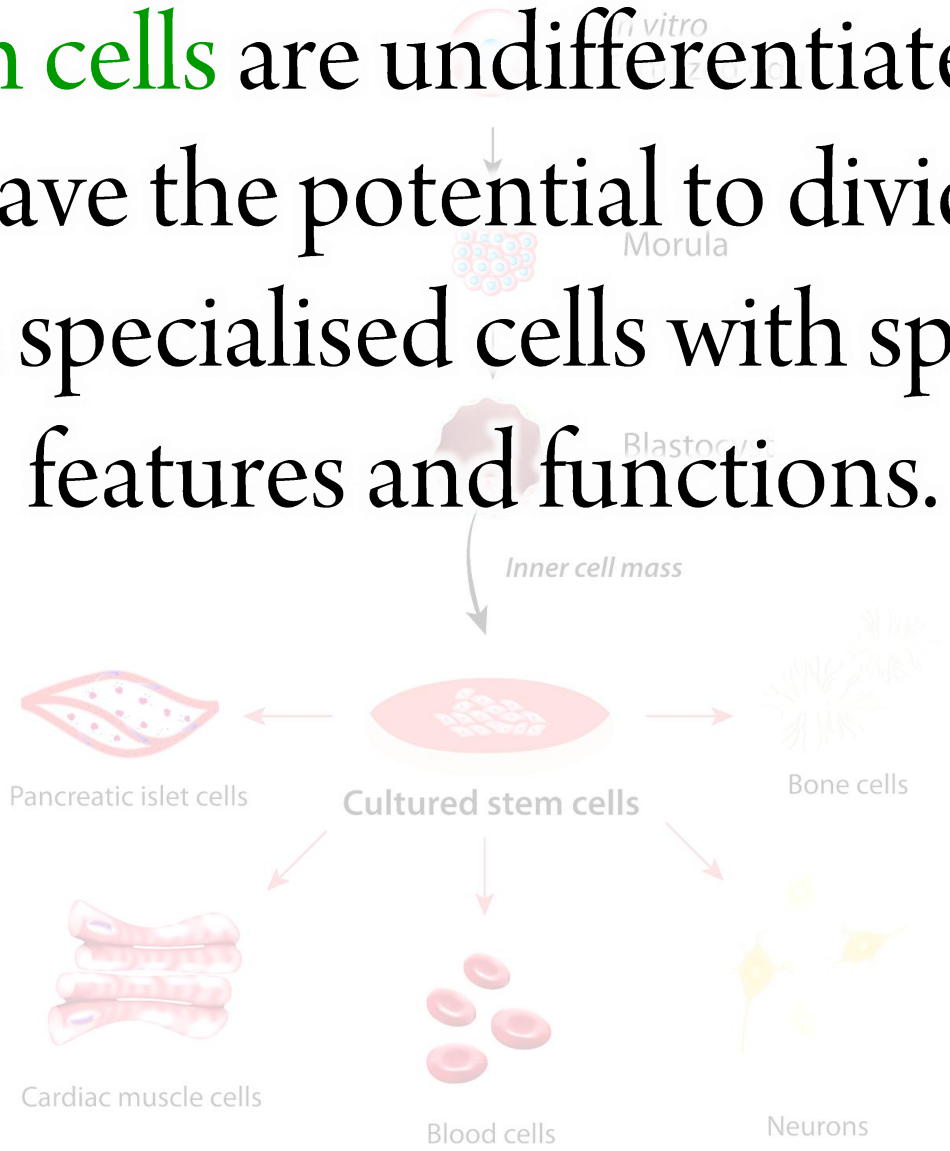
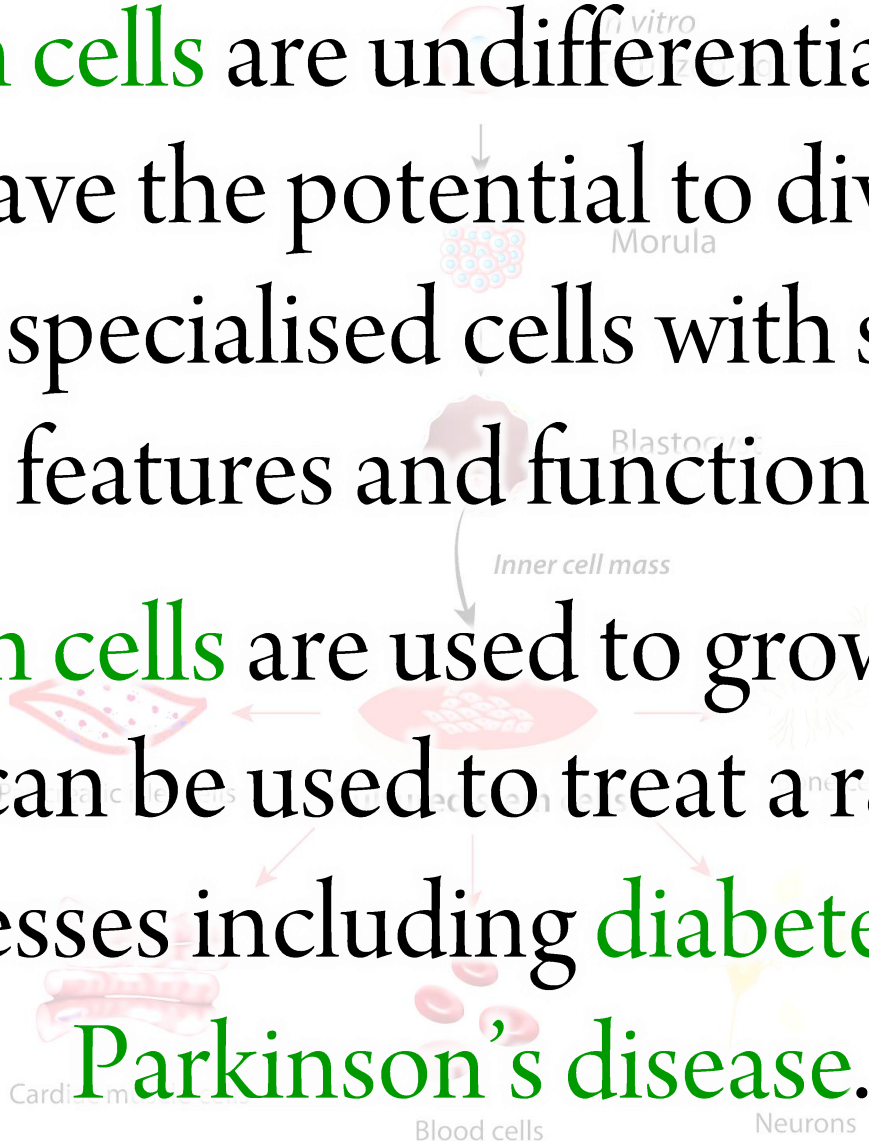
• Stem Cells

• Stem cells are undifferentiated cells that have the potential to divide and form specialised cells with specific features and functions.

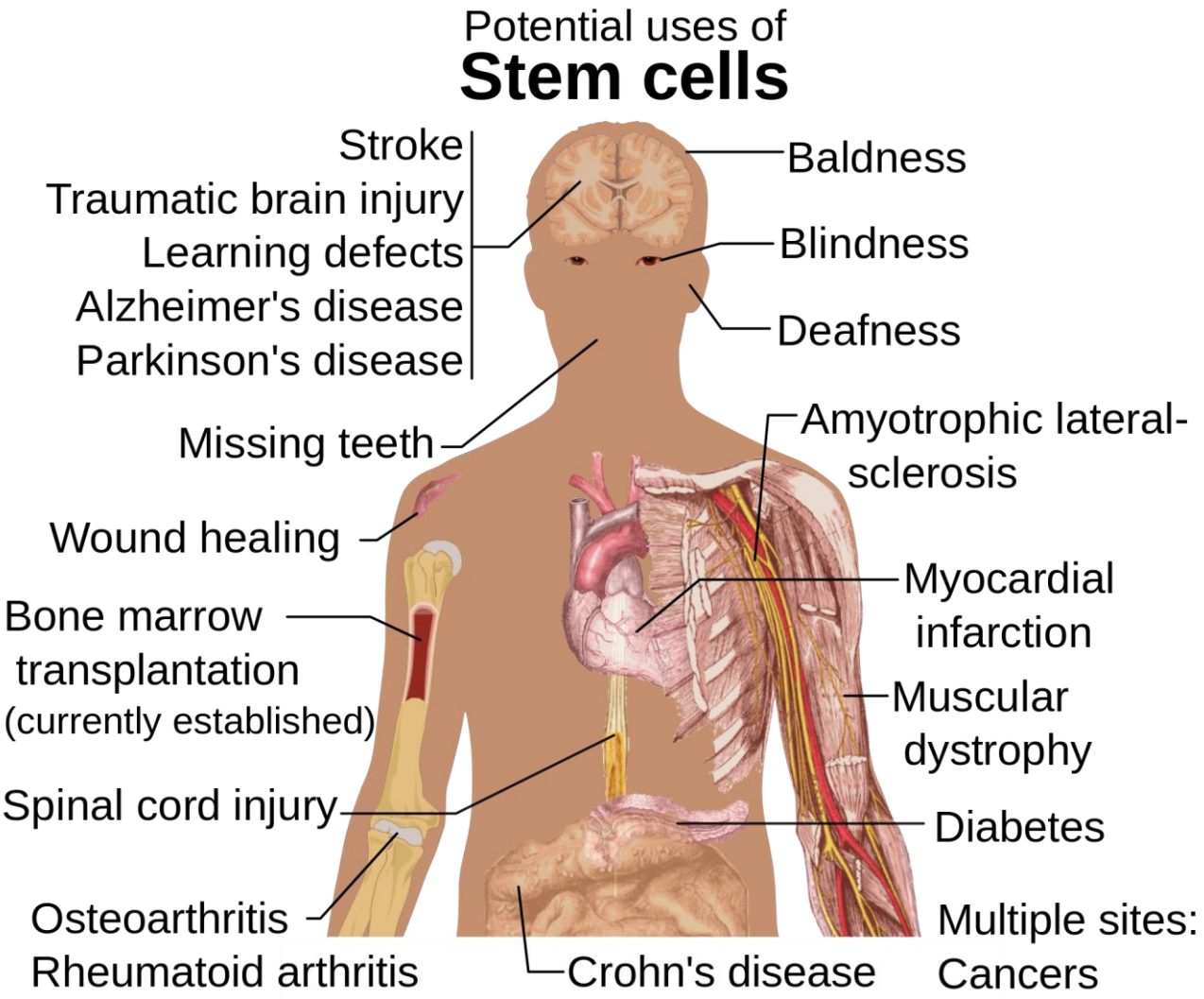


Stem Cells

- Stem cells are undifferentiated cells that have the potential to divide and form specialised cells with specific features and functions.
- Stem cells are used to grow tissues that can be used to treat a range of illnesses including diabetes and Parkinson's disease.



Stem Cells



- Graphic by Mikael Häggström, used with permission.

Presentation on

Cells → Tissues → Organs

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23rd April 2020