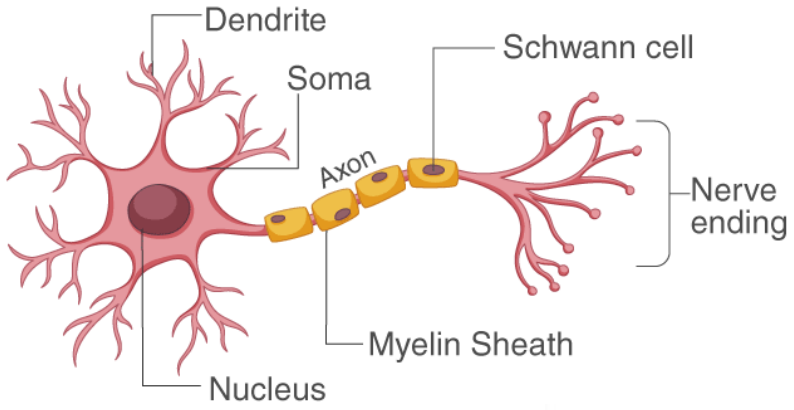
Go to the "Slide Show" shade above

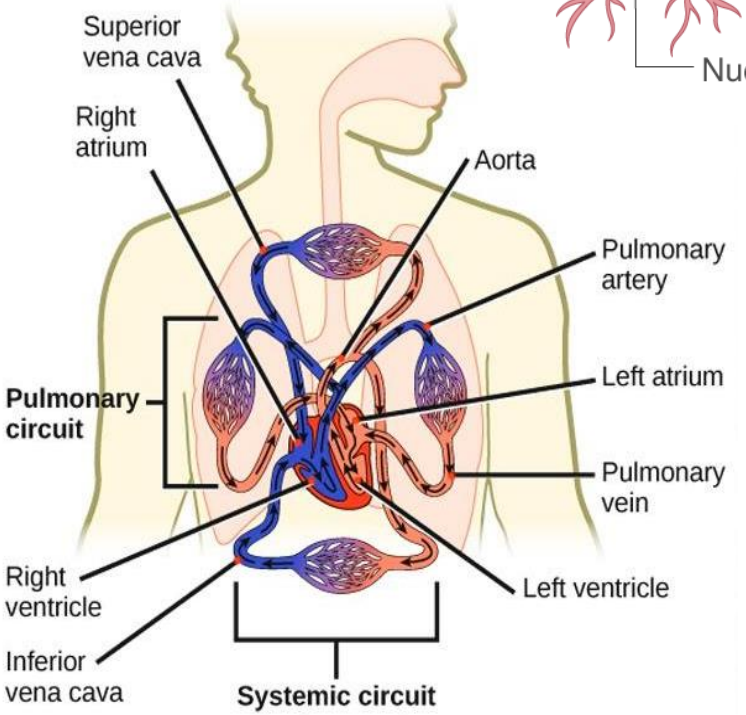
Click on "Play from Beginning"

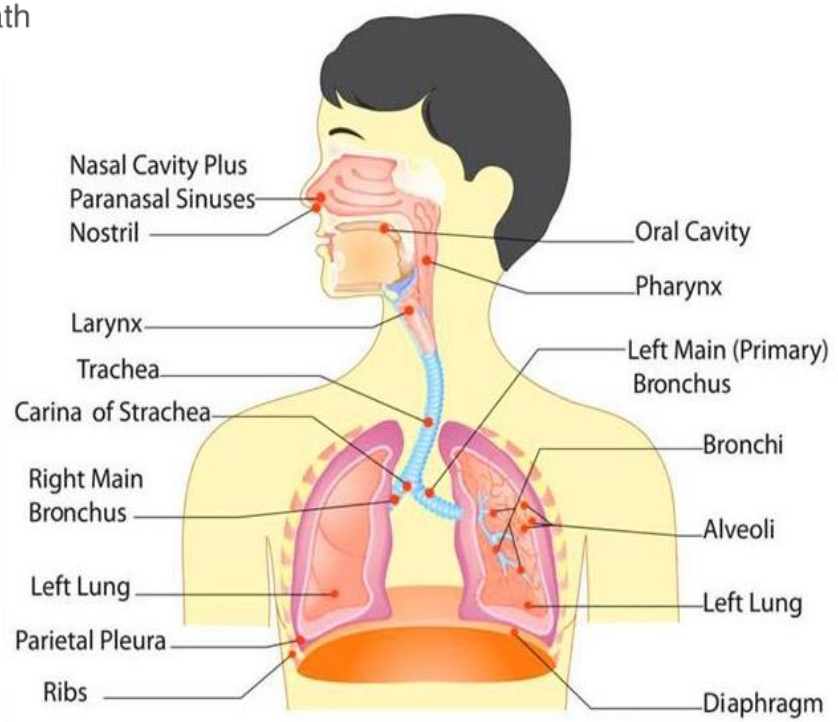
Human Anatomy & Physiology

Nerves, Circulation, Respiration

Chapter 32







WARM-UP

Regulating the internal environment (pH, water, temperature) involves ____.

Protecting the body from infection and cancer involves the ____ and ____ systems.

List four main types of tissue in the body and their function.

What are "skeletal, smooth, and cardiac"?

WARM-UP

Regulating the internal environment (pH, water, temperature) involves homeostasis.

Protecting the body from infection & cancer involves the lymphatic & immune systems.

List four main types of tissue in the body and their function.

epithelial (cover, protect), connective (bind, support), muscle (movement), nerves (communication)

What are "skeletal, smooth, & cardiac"?

muscle tissues

Lesson Objectives

By the end of this lesson, you should be able to:

- Recognize, identify, and define the anatomy and function of the human nervous system.
  - Central vs. Peripheral Nervous System
  - Neurons, Synapses
  - Membrane Potential
- Recognize, identify, and define the anatomy and function of the human circulatory system.
  - Blood Vessels
  - The Heart
  - Types of Blood
- Recognize, identify, and define the anatomy and function of the human respiratory system.
  - Inhalation vs. Exhalation
  - Transport and exchange of Gases

- **Science Practice: Circulation Rest & Exercise Lab**

The Nervous System

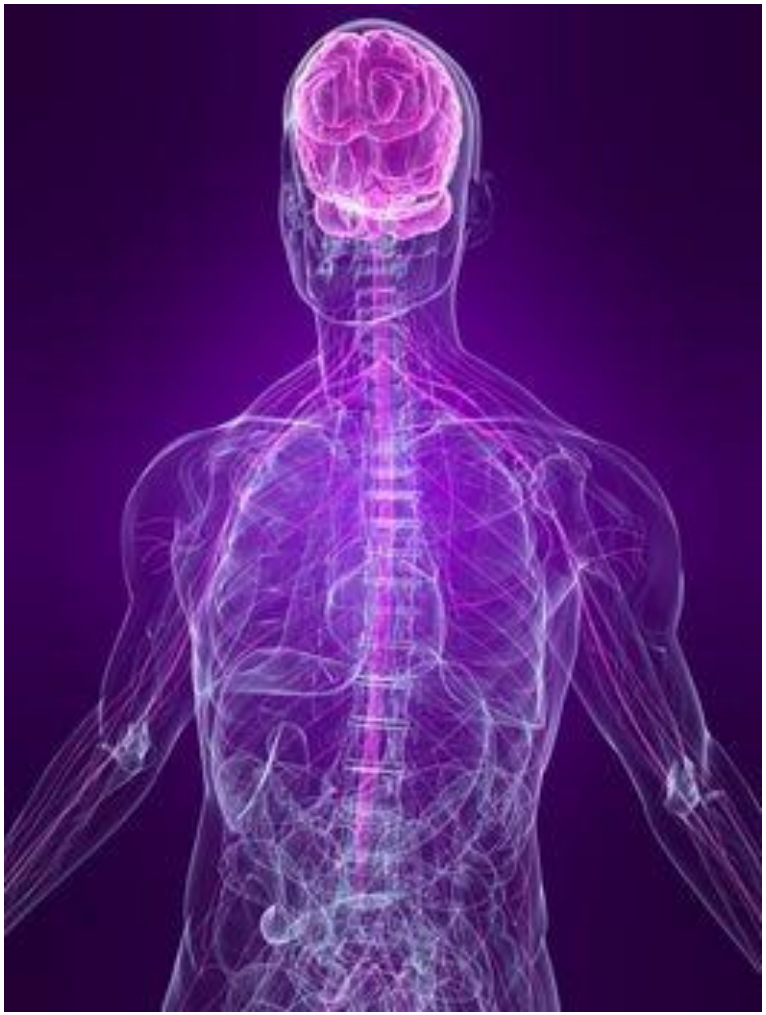
Nervous and Endocrine systems work together to coordinate body functions.

COMMUNICATION within this system relies on **NEURONS**.

Neurons are nerve cells that transmit information via electrical and chemical signals.

MAIN FUNCTIONS:

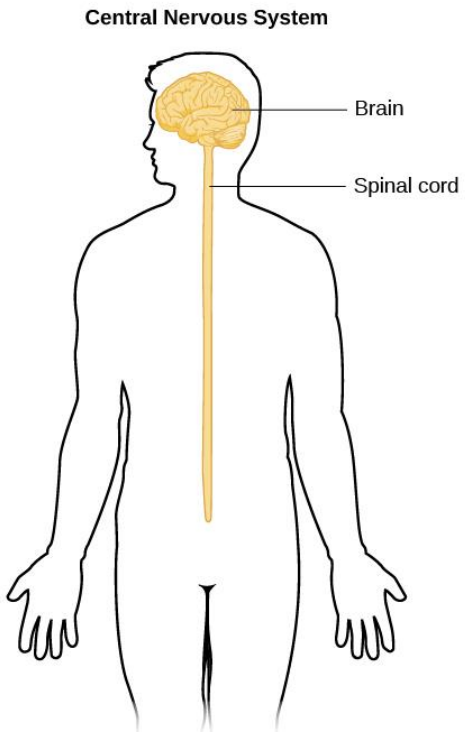
- Receive Sensory Information
- Integrate the information
- Coordinate a Response

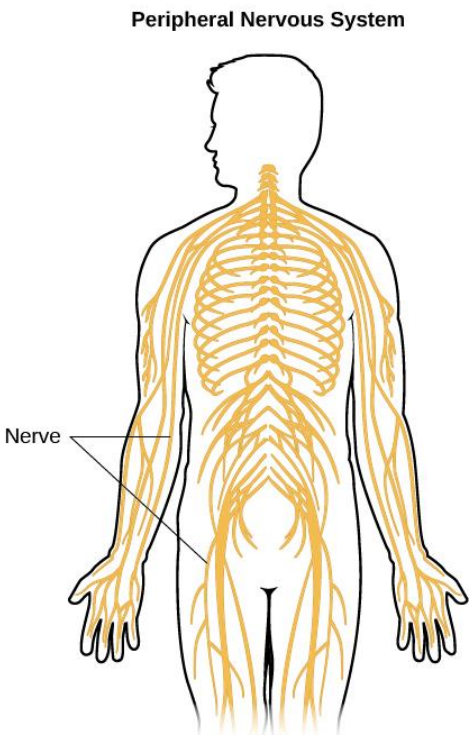


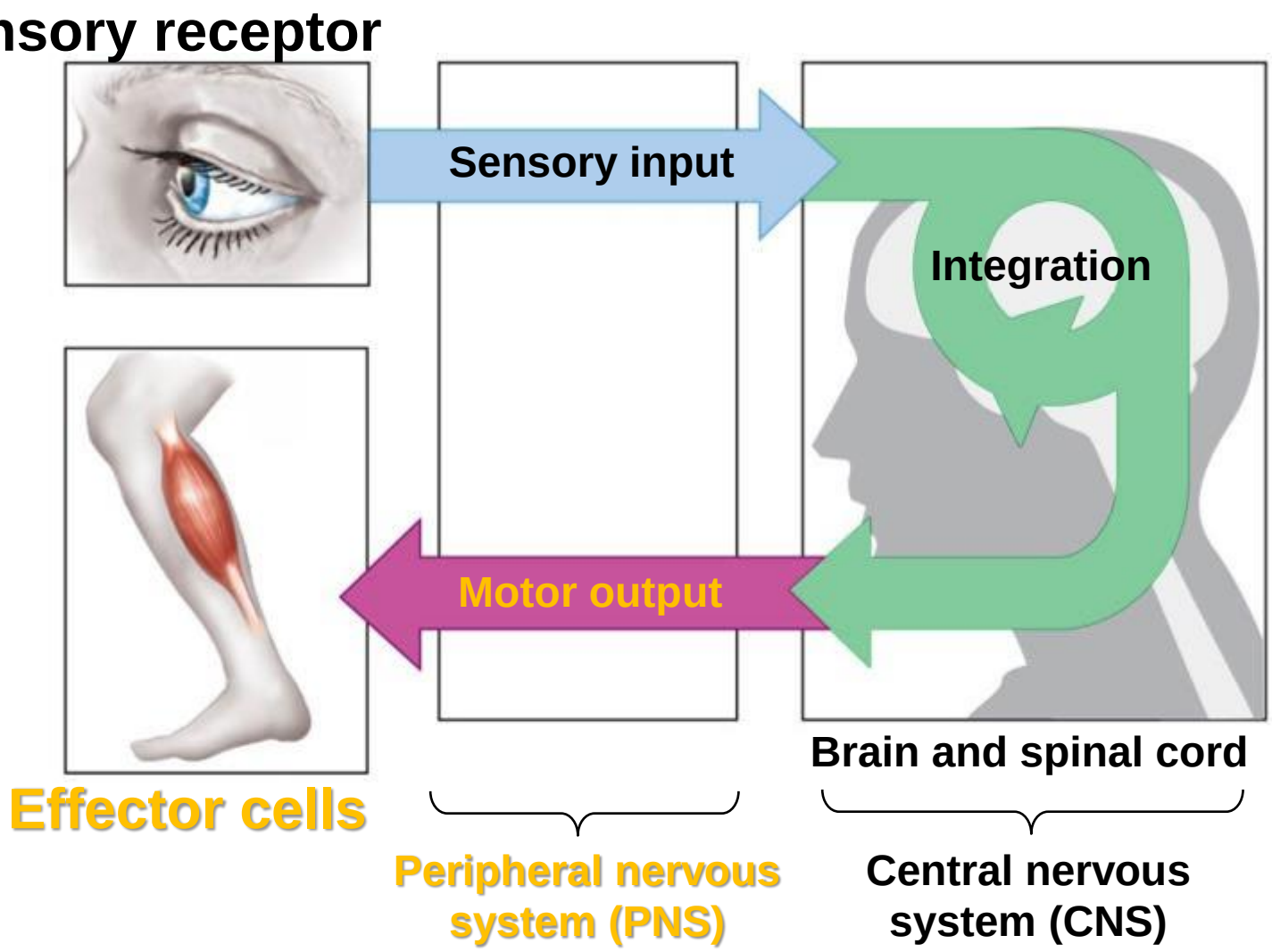
The Nervous System

Two Main Divisions:

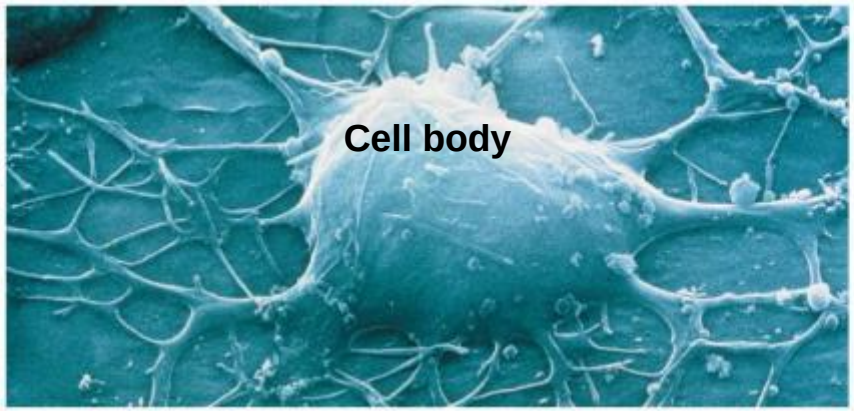
- Central Nervous System (CNS)
  - Brain
  - Spinal Cord
- Peripheral Nervous System (PNS)
  - Nerves which convey information between the CNS and the rest of the body.






Sensory receptor
Sensory input
Integration
Motor output
Effector cells
Brain and spinal cord
Peripheral nervous system (PNS)
Central nervous system (CNS)

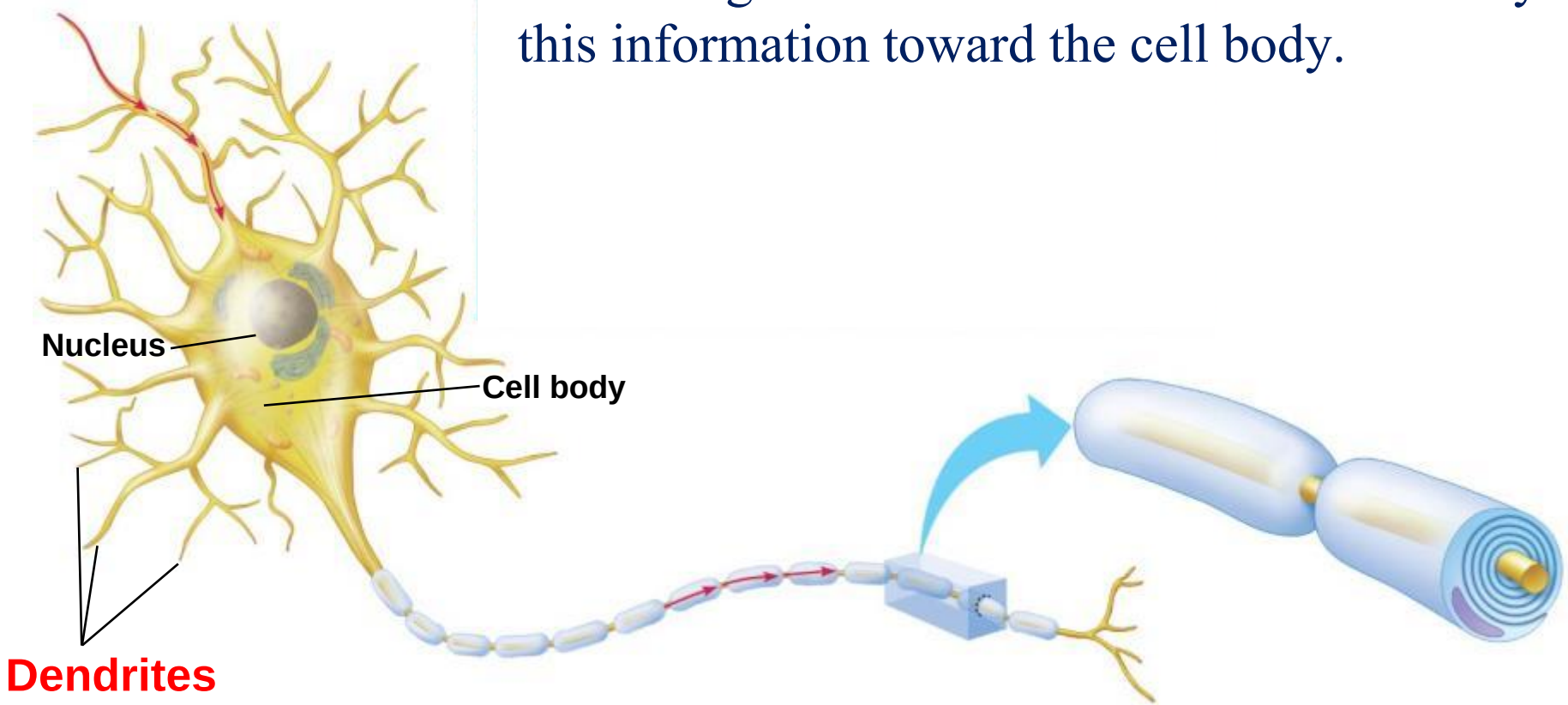
Neurons



CELL BODY: contains the **nucleus** and other **cell organelles**.

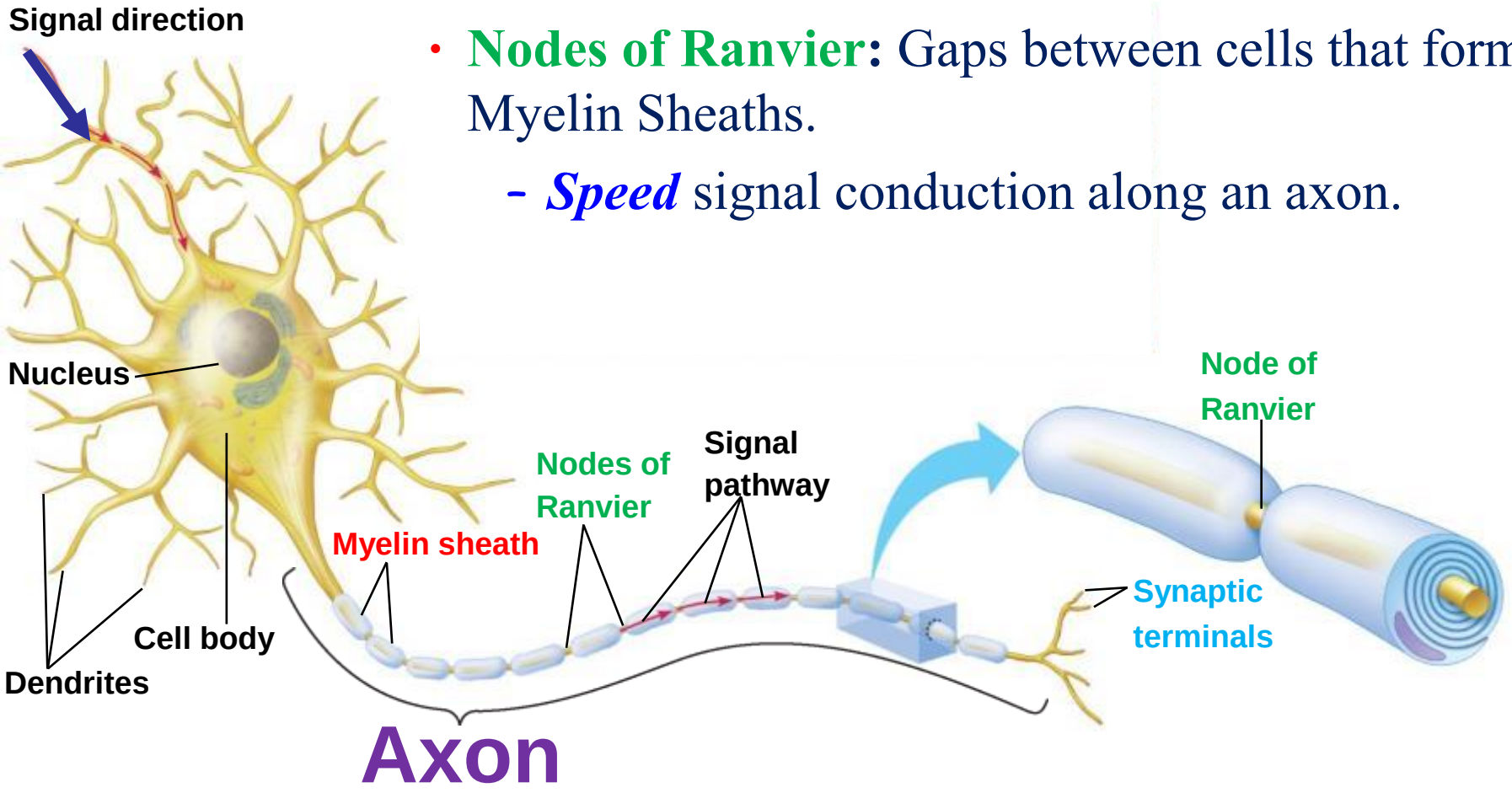
DENDRITES

receive signals from other neurons and convey this information toward the cell body.



AXON: ***transmit*** signals to other cells.

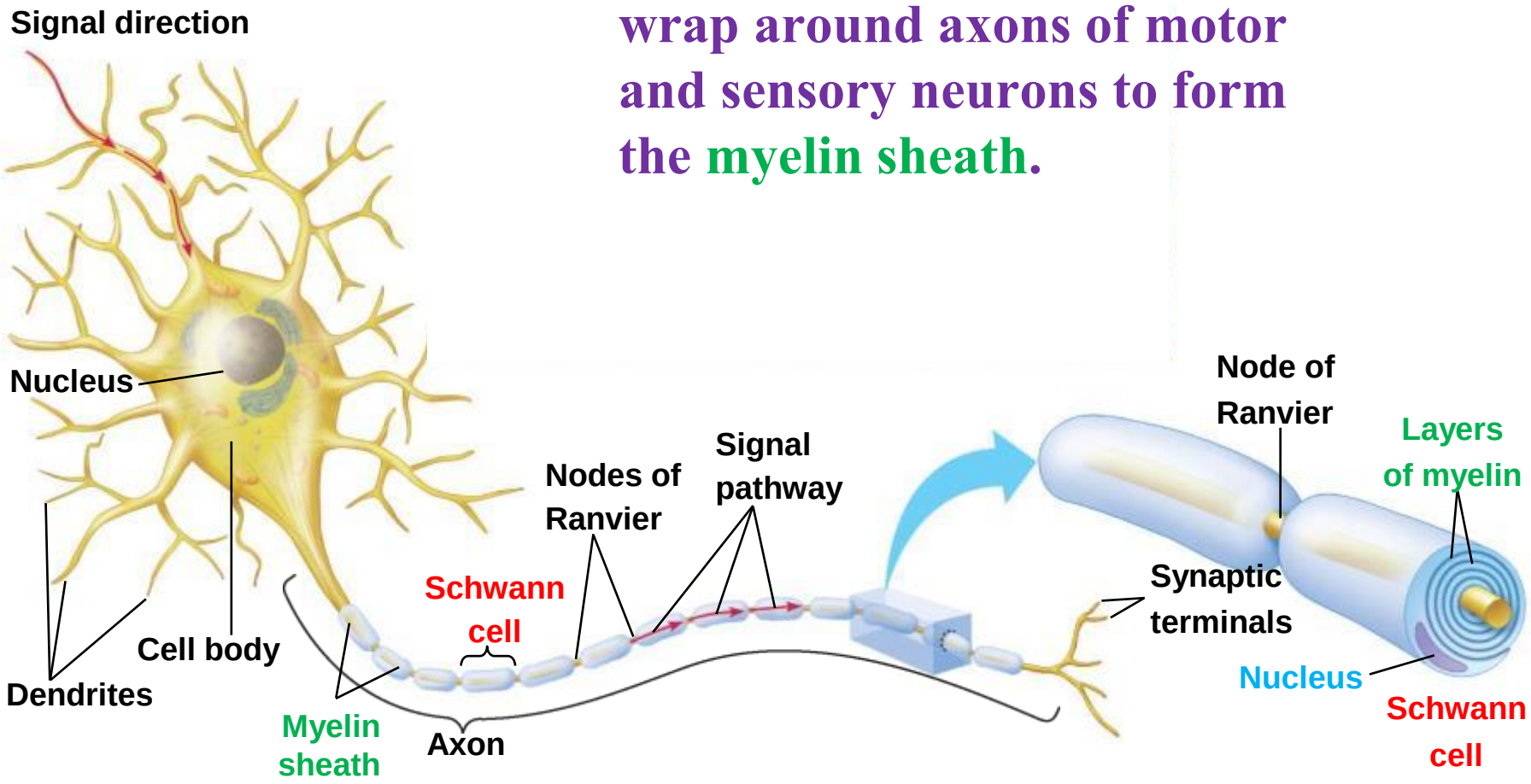
- Wrapped in fatty **Myelin Sheaths.**
- **Nodes of Ranvier:** Gaps between cells that form Myelin Sheaths.
  - ***Speed*** signal conduction along an axon.



A typical axon has hundreds of branches, each with a **Synaptic Terminal** at the very end.

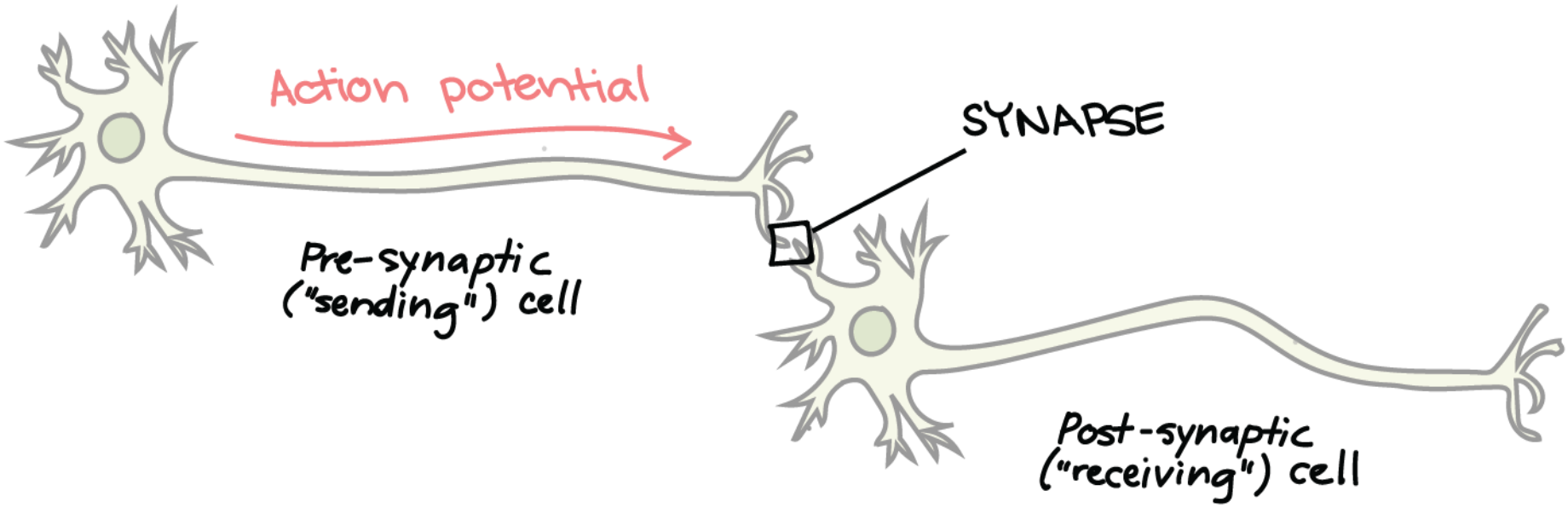
SCHWANN CELLS

wrap around axons of motor and sensory neurons to form the myelin sheath.



SYNAPSE

The junction between a synaptic terminal and another cell is called a **Synapse**, or relay point.

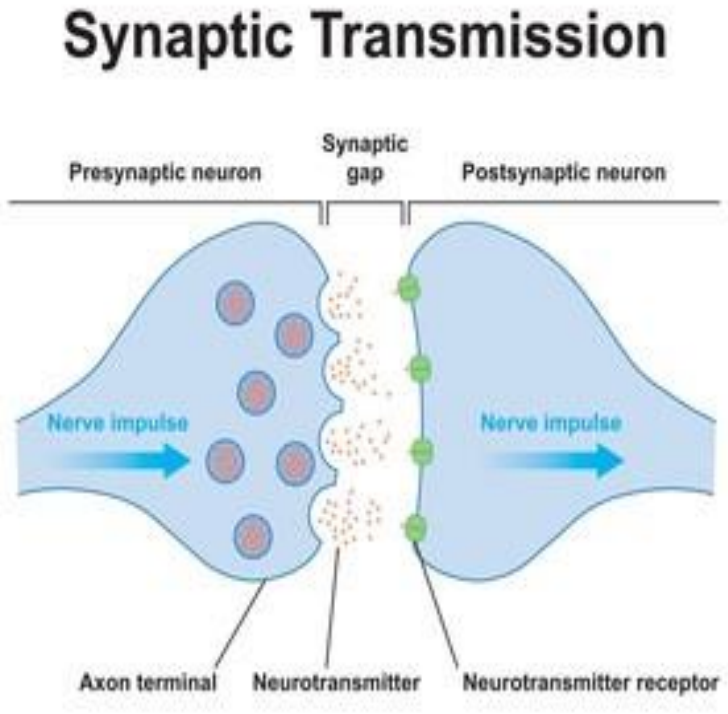


At a synapse, electrical or chemical signals are transmitted to other neurons or effector cells.

Neurons communicate at Synapses

Synapses are relay points between a synaptic terminal of a sending neuron and a receiving cell, which could be another neuron.

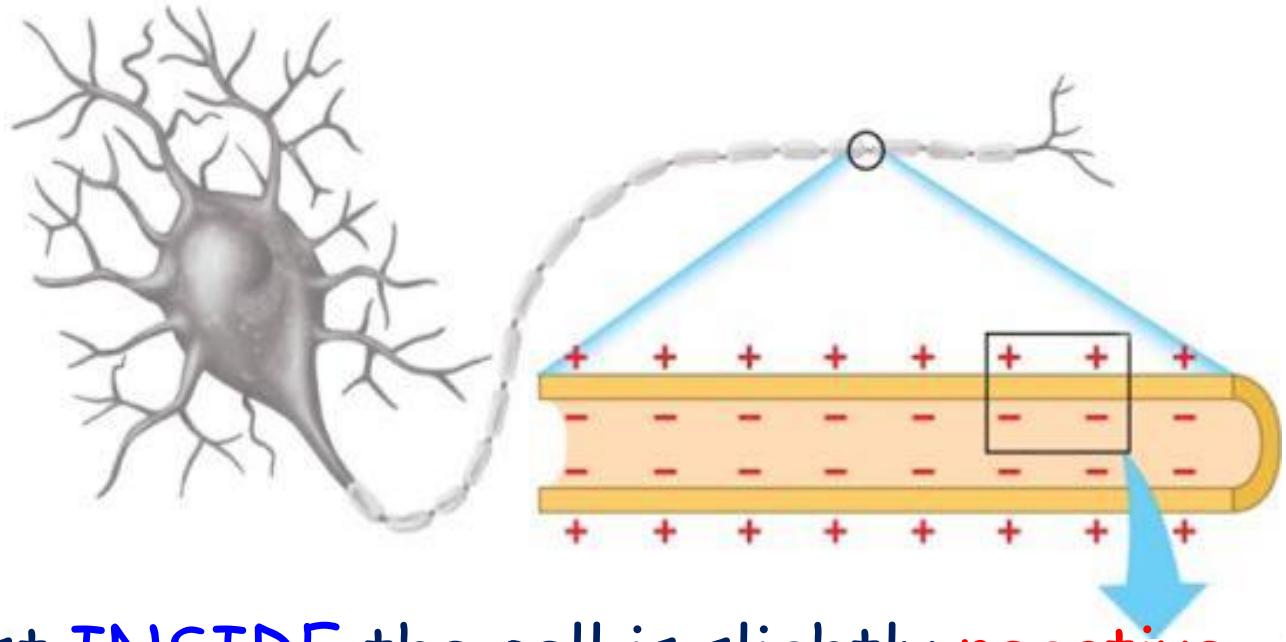
The **sending (presynaptic) cell** secretes a ***chemical signal***, a **Neurotransmitter**, which crosses the **Synaptic Cleft.**



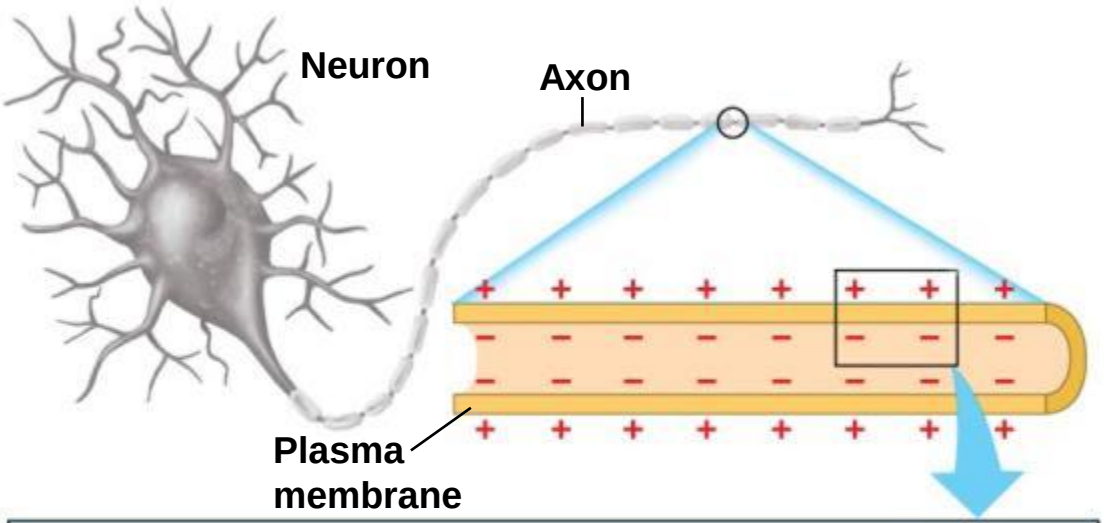
The neurotransmitter binds to a ***specific receptor*** on the surface of the **receiving (postsynaptic) cell.**

Nerve function depends on charge differences across neuron membranes.

At REST, when a neuron is not transmitting a signal, a neuron's plasma membrane has potential energy—the **MEMBRANE POTENTIAL**, in which

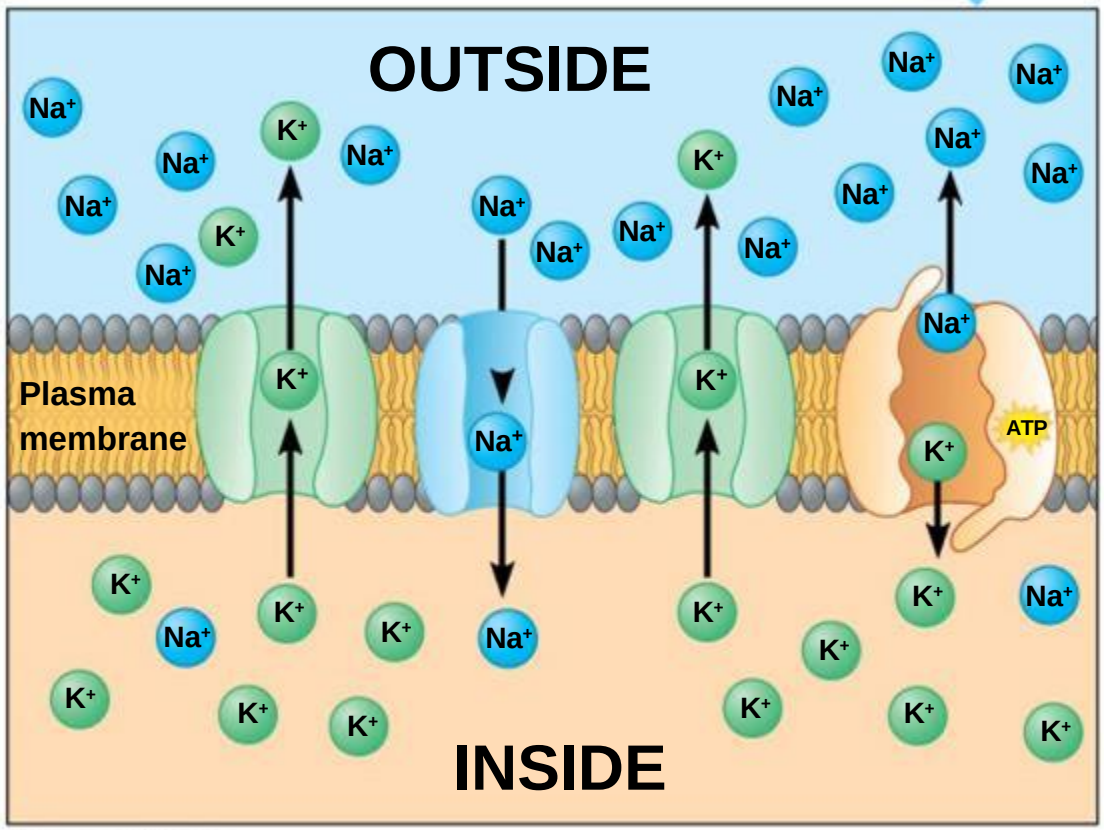


- just INSIDE the cell is slightly negative.
- just OUTSIDE the cell is slightly positive.



Outside

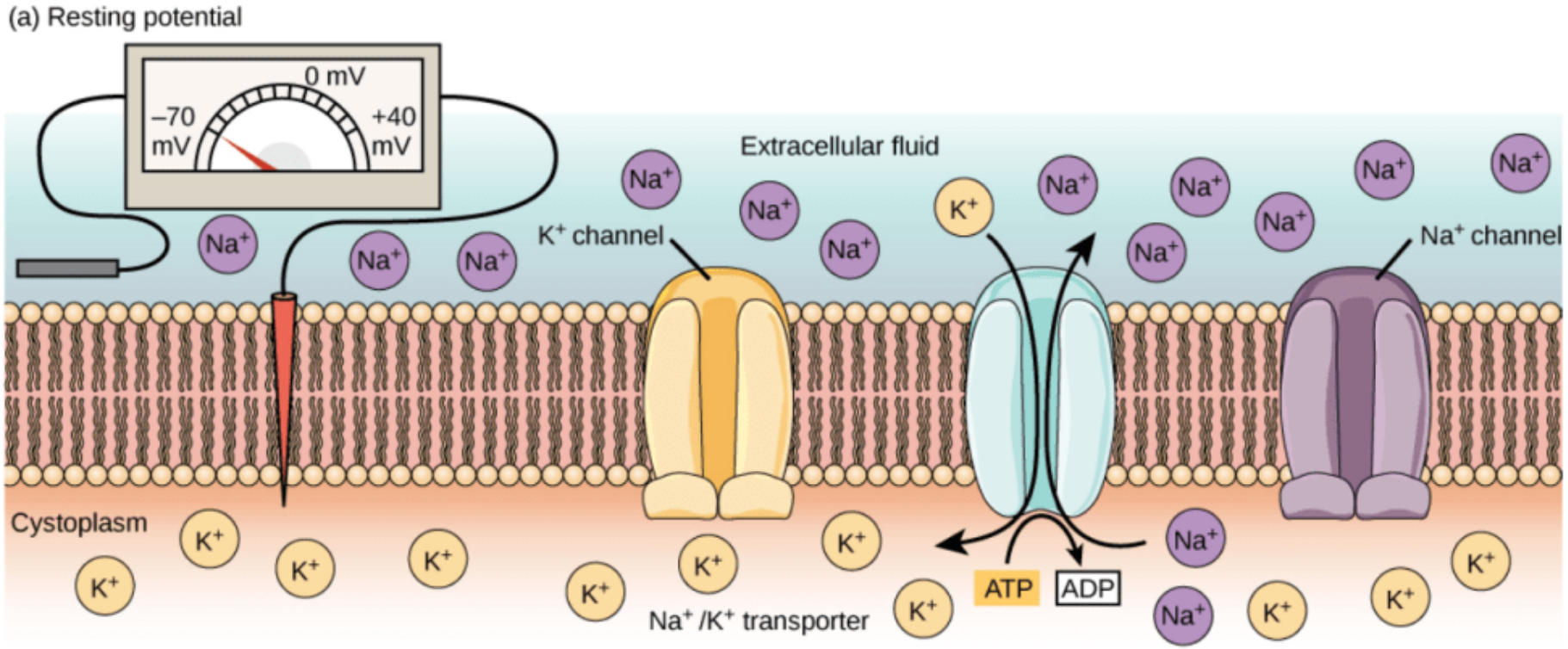
of neuron: more POSITIVE charges.



INSIDE of neuron: fewer positive charges .. more NEGATIVE.

Nerve function depends on charge differences across neuron membranes.

The **Resting Potential** is the voltage across the plasma membrane of a resting neuron.



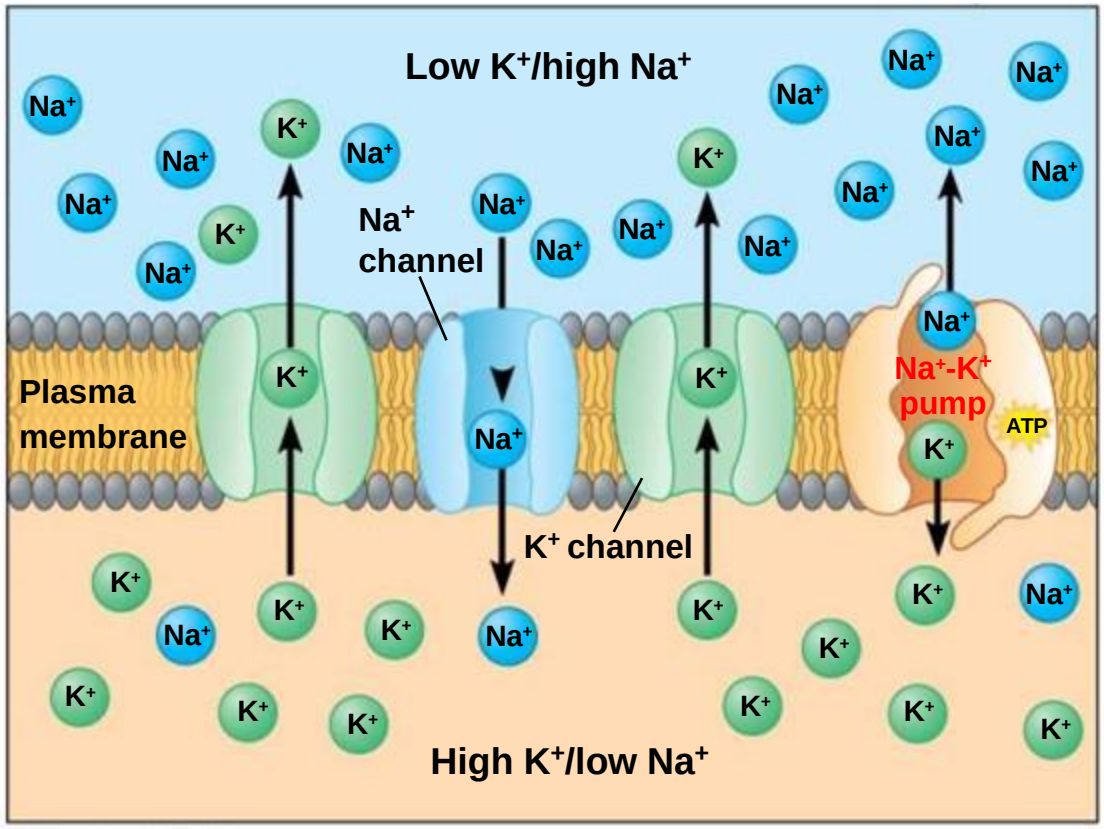
All voltage-gated Na+ channels and most voltage-gated K+ channels are closed.

Sodium-Potassium (Na^+-K^+) Pumps

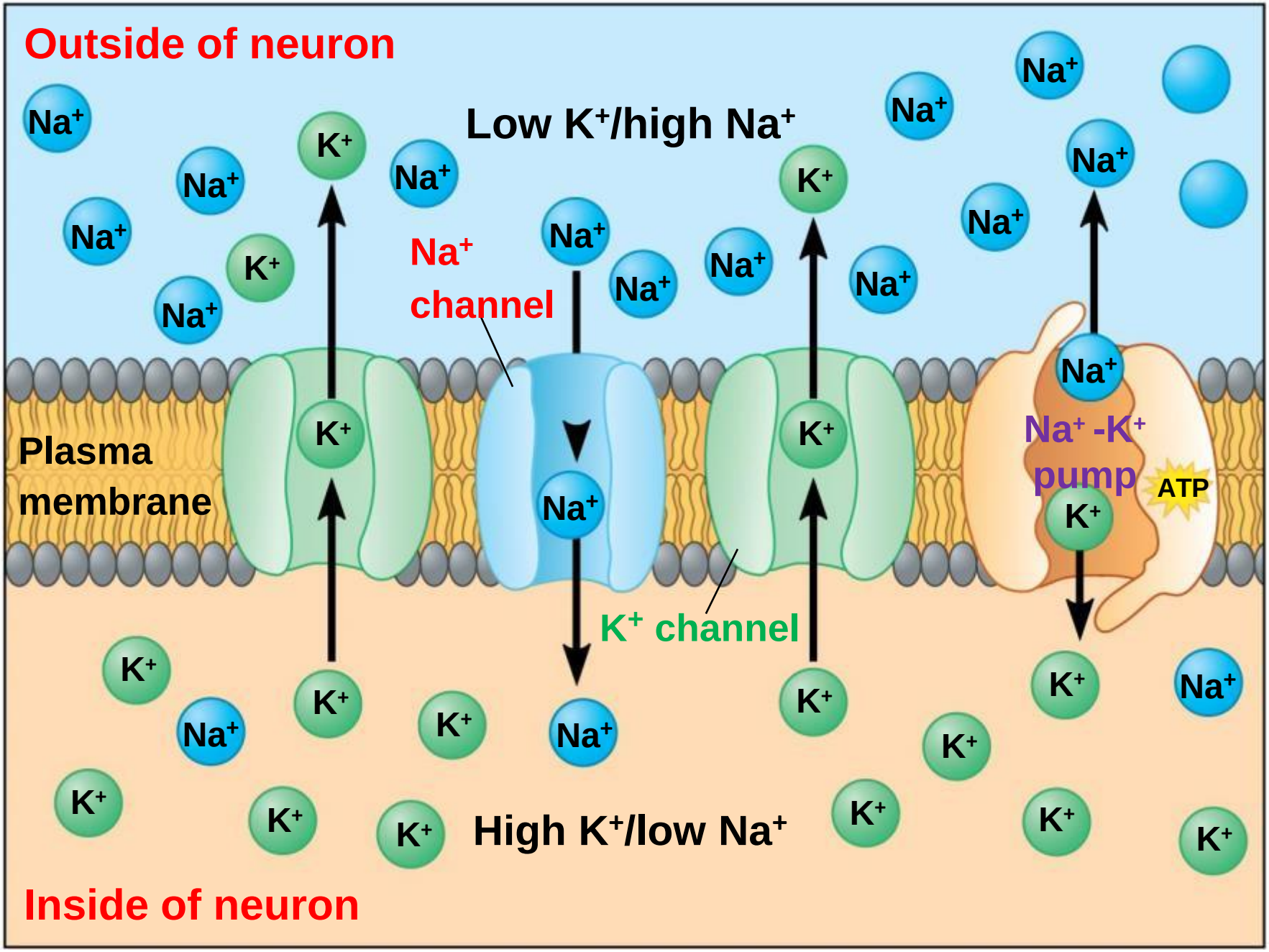
use energy from **ATP** to actively move Na^+ out of the neuron and K^+ into the neuron.

The resting potential exists because of **differences in ion concentration** of the fluids inside and outside the neuron.

OUTSIDE the neuron, K^+ is low and Na^+ is high.



INSIDE the neuron, K^+ is high and Na^+ is low.

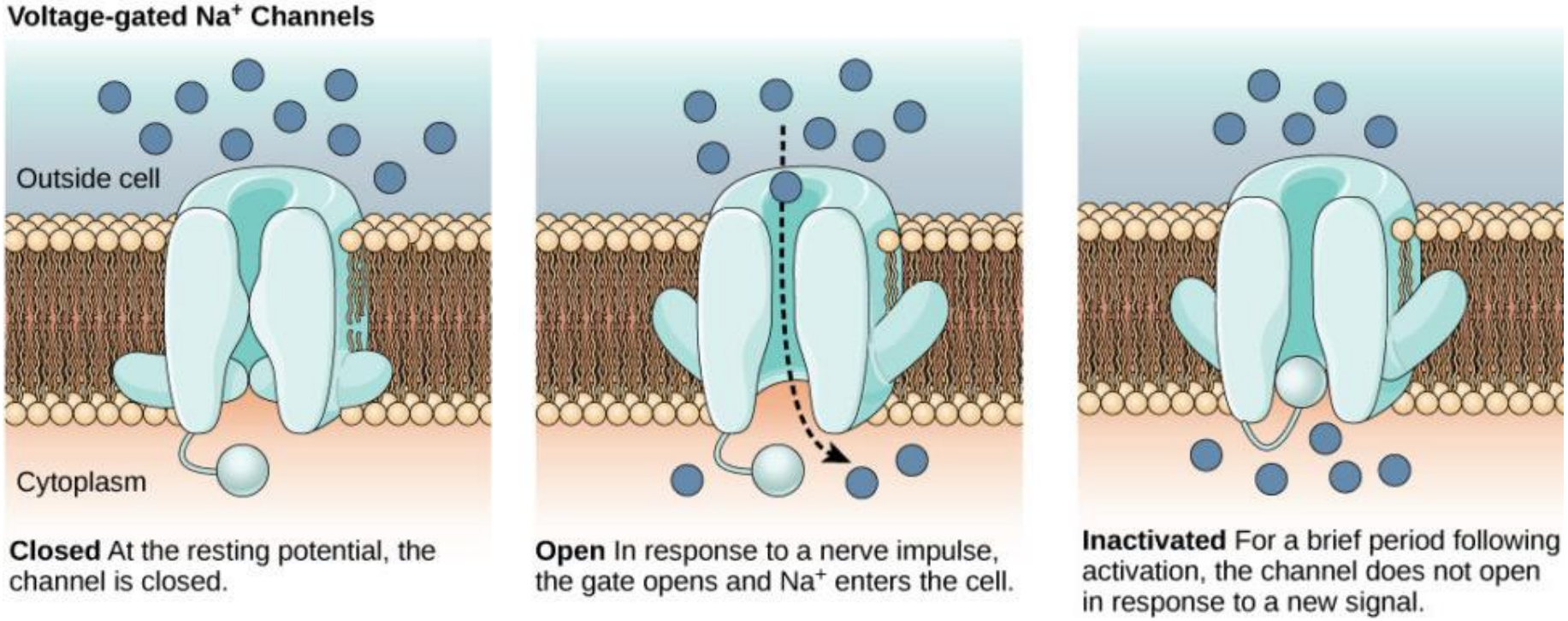

Outside of neuron
Low K+/high Na+
Na+ channel
Plasma membrane
Na+ -K+ pump
ATP
K+ channel
High K+/low Na+
Inside of neuron

Membrane Potential

The lipid bilayer membrane that surrounds a neuron is impermeable to charged molecules or ions.

To enter or exit the neuron, ions must pass through special proteins called ion channels that span the membrane.

Ion channels have different configurations: open, closed, and inactive.



Action Potentials

A nerve signal, called an **Action Potential**,

- is a **change in the membrane voltage.**
- that **transmits a nerve signal along an axon.**

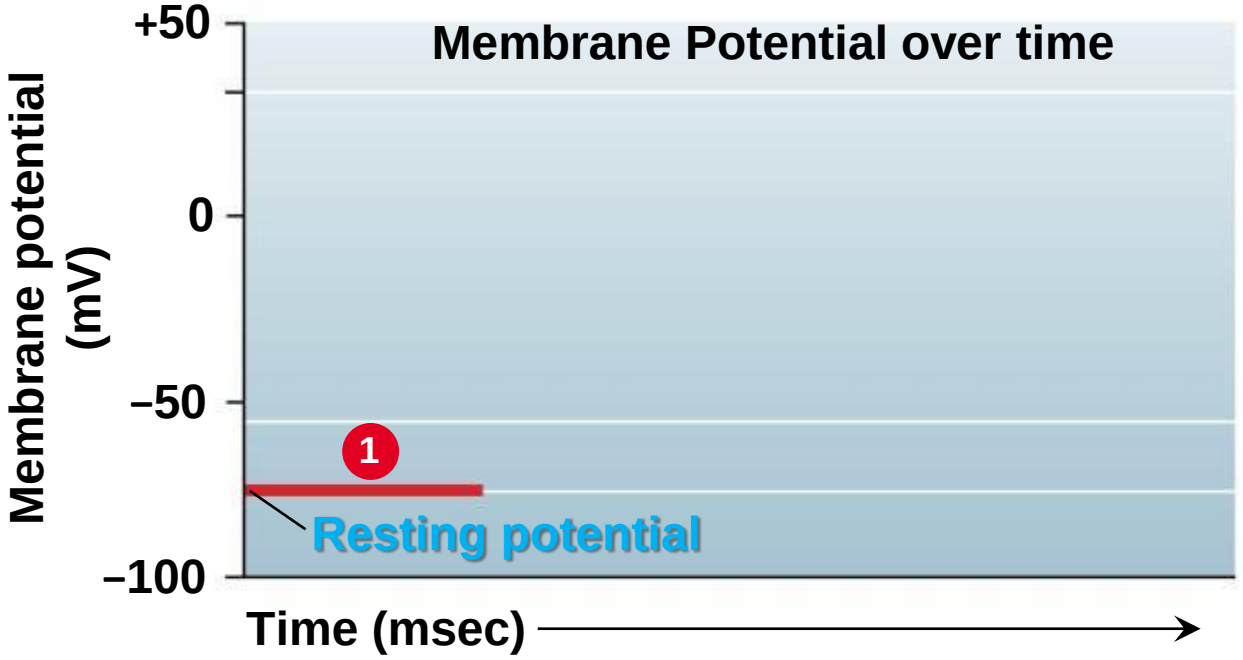
The rapid flip-flop of the membrane potential is

- a result of the rapid movements of ions across the membrane.
- at **Na^+ and K^+ *voltage-gated channels***,
- that **open and close in response to stimuli**.

They propagate in a **one-way** chain reaction **along a neuron.**

They are **all-or-none** events.

A Nerve Signal begins as a change in the Membrane Potential.

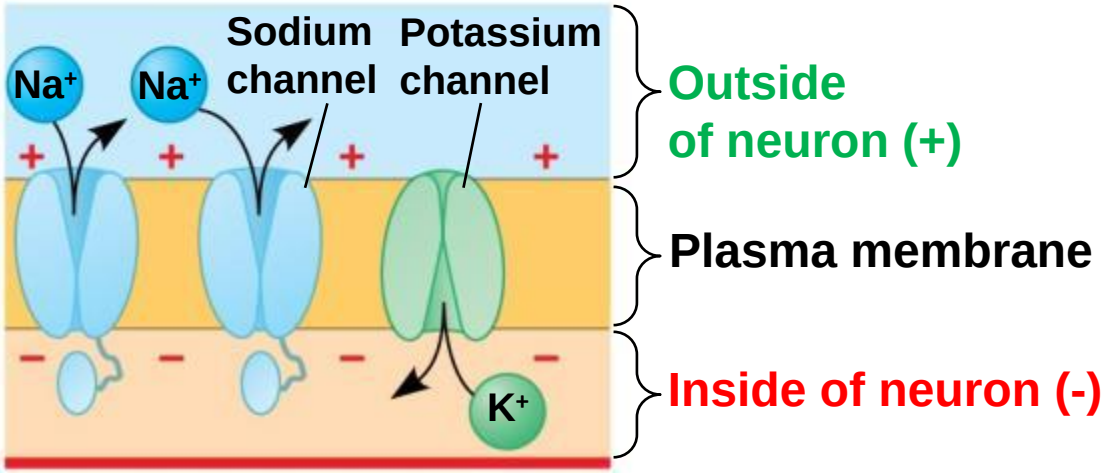


1

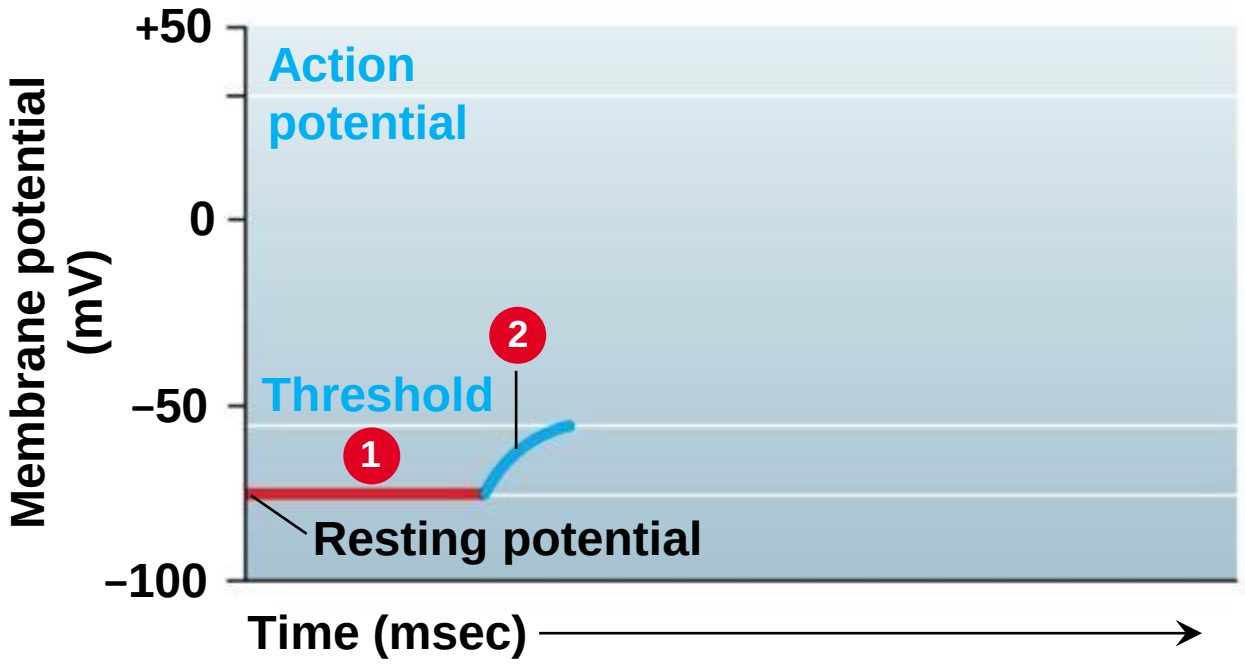
Resting State

Voltage-gated Na^+ & K^+ channels are closed;

Resting potential is maintained by Sodium-Potassium channels (not shown).



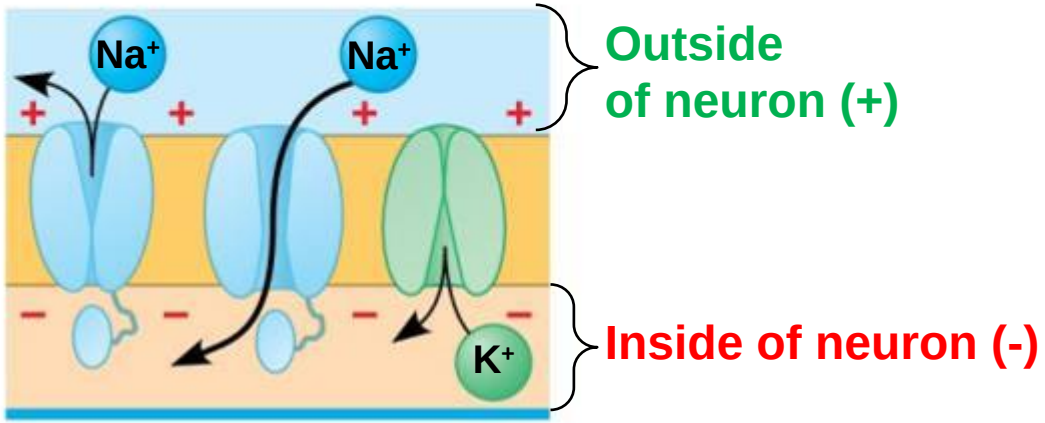
A **Stimulus** is any factor that causes a nerve signal to be generated.



2 DEPOLARIZATION

A stimulus opens some Na^+ channels;

If THRESHOLD is reached, an action potential is triggered.



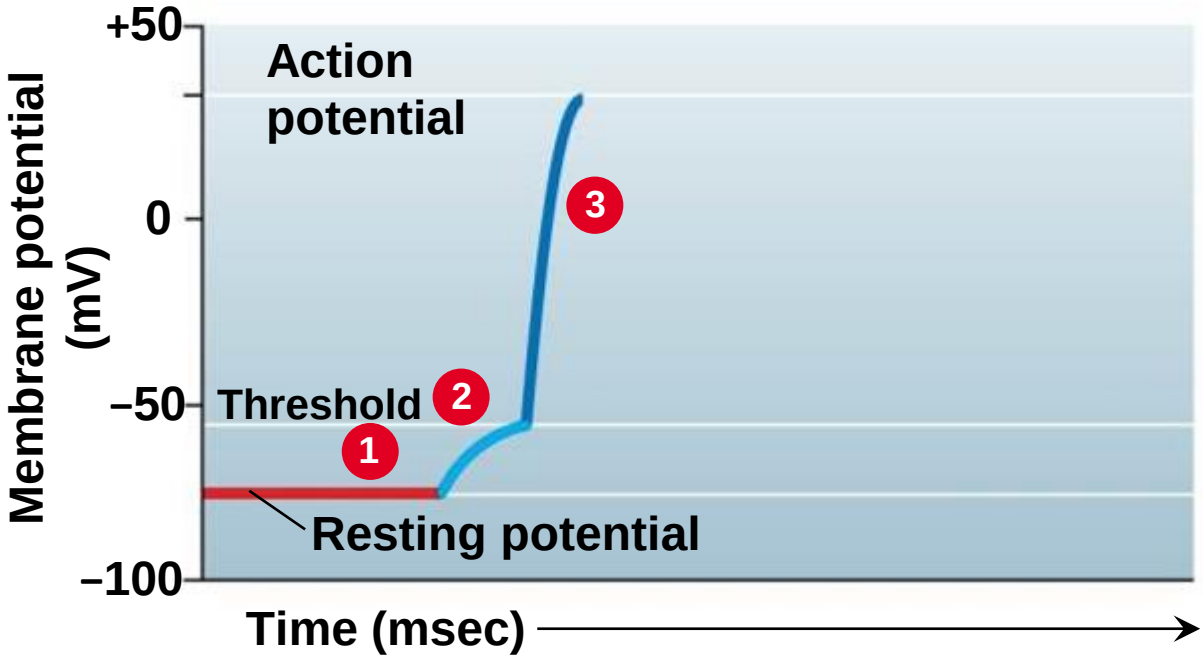
3

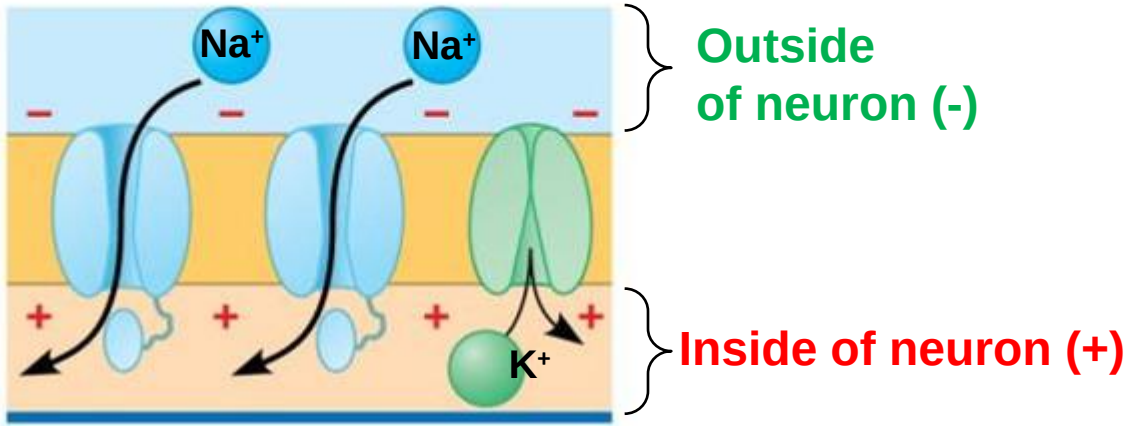
Additional Na^+ channels open.

K^+ channels are closed;

The interior of cell becomes more positive.

Membrane polarity REVERSES from resting state.





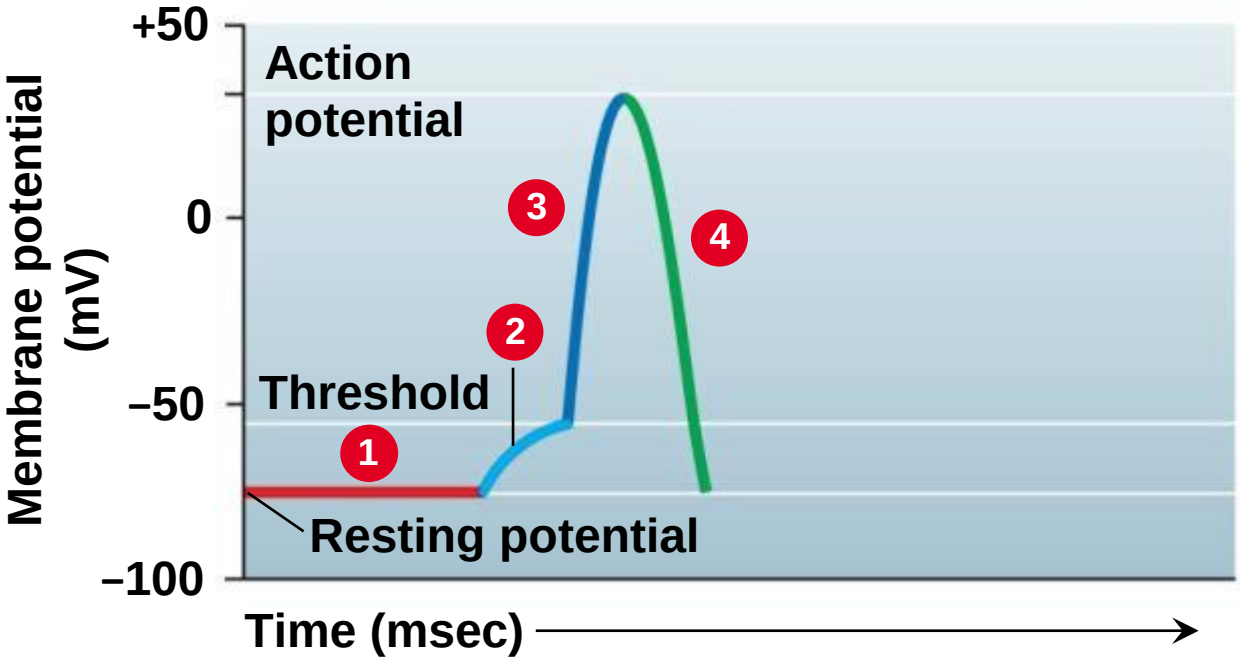
4

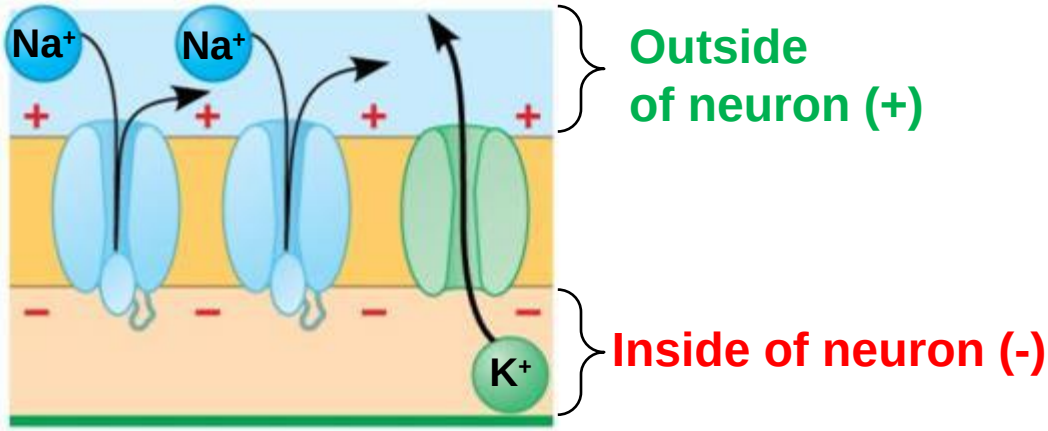
REPOLARIZATION

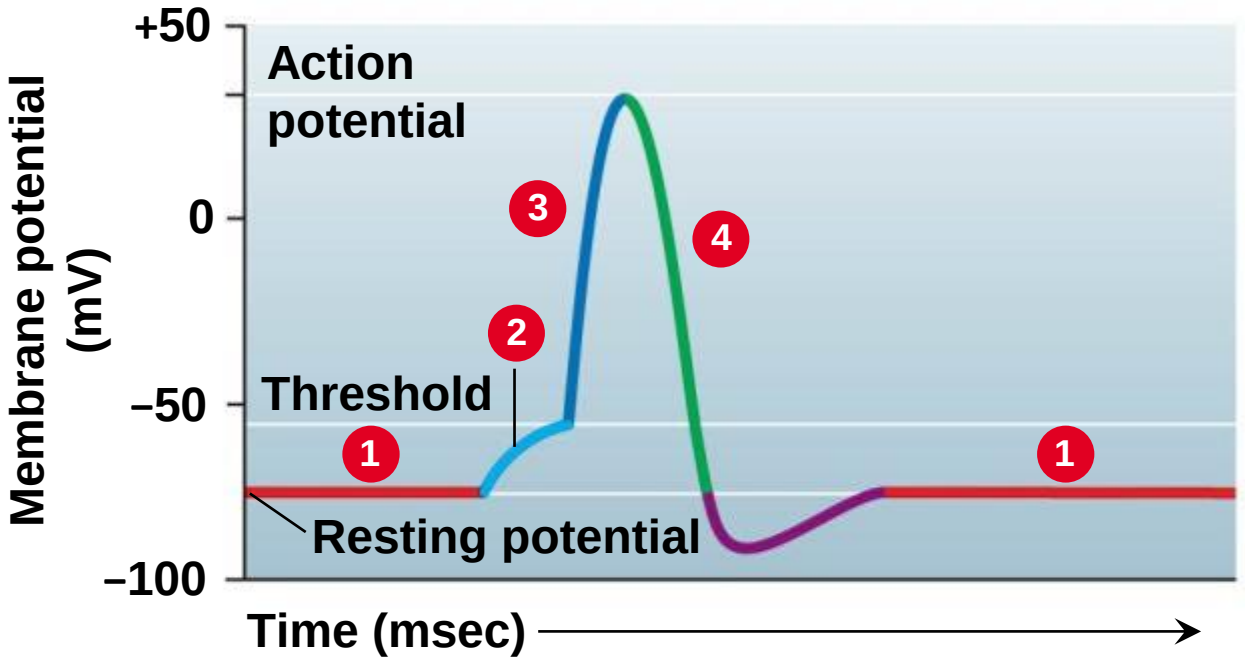
Na^+ channels close and inactivate;

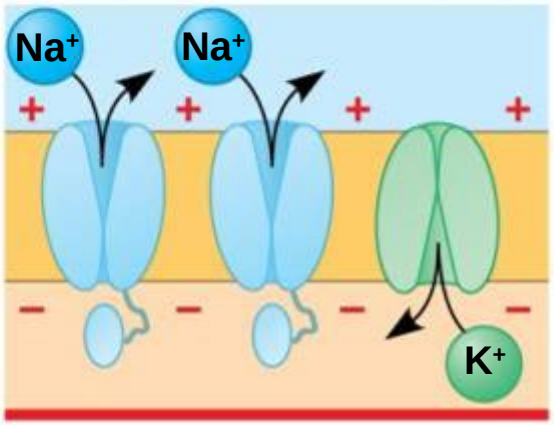
K^+ channels open and K^+ rushes out;

The interior of cell is more negative than outside again.

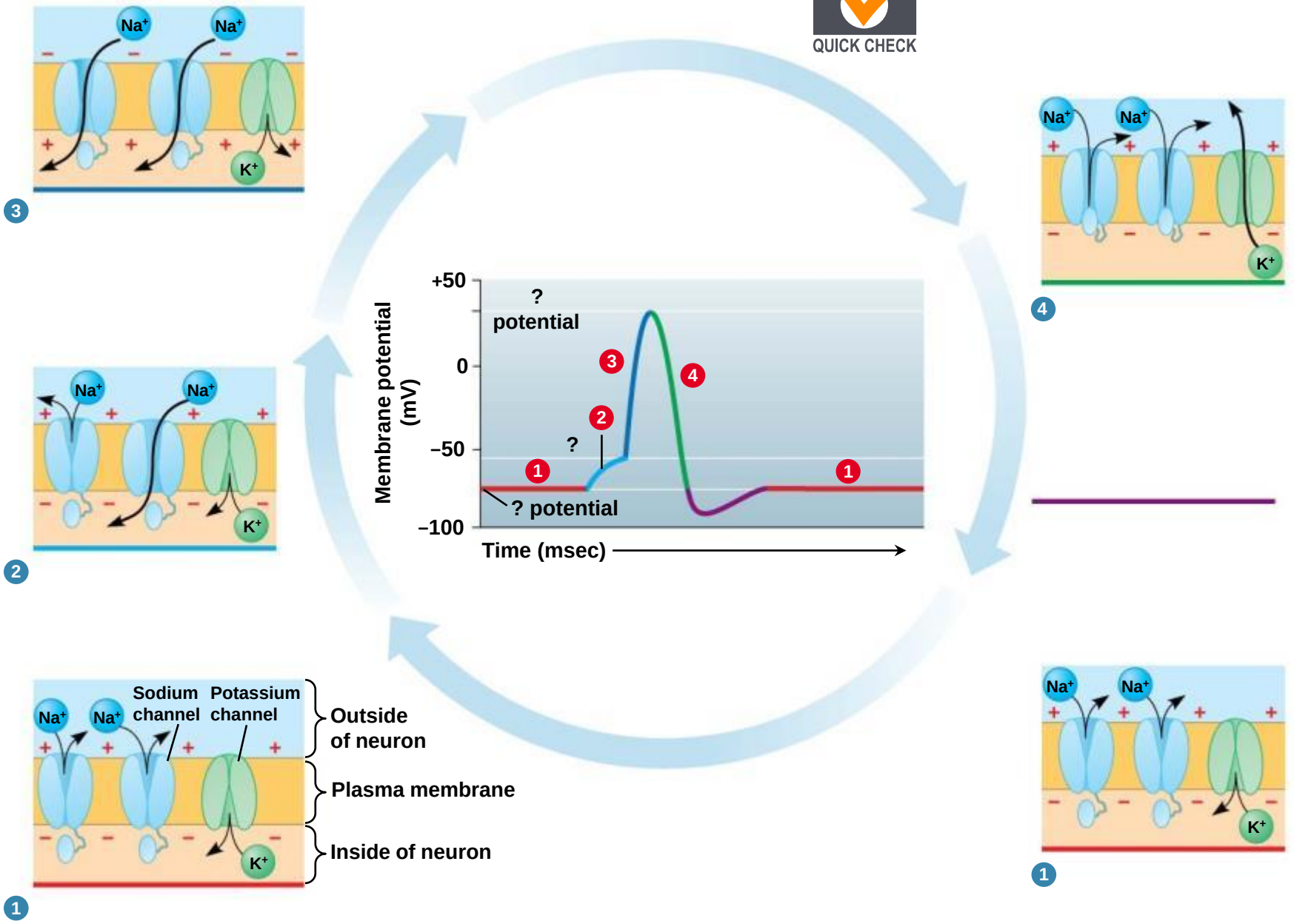




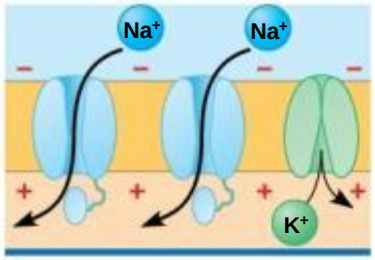




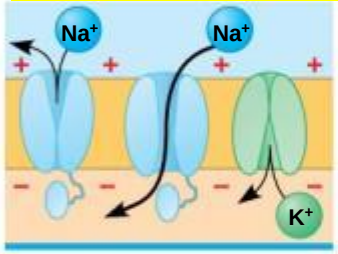
1 **Return to resting state.**


QUICK CHECK
Na+
Na+
K+
3
Na+
Na+
K+
4
Na+
Na+
K+
2
Membrane potential (mV)
+50
0
–50
–100
? potential
?
potential
1
2
3
4
1
Time (msec)
Na+
Na+
Sodium channel
Potassium channel
K+
Outside of neuron
Plasma membrane
Inside of neuron
1
Na+
Na+
K+
1

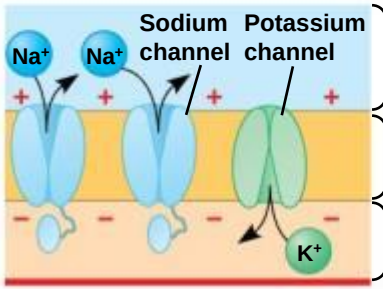
QUICK CHECK



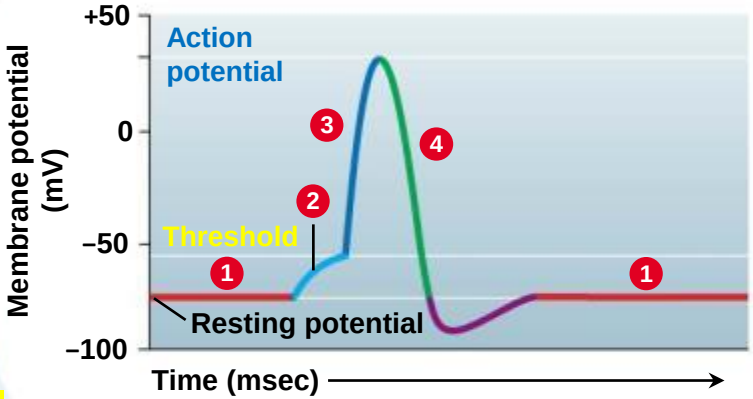
3 Additional Na^+ channels open, K^+ channels are closed; interior of cell becomes more positive. MEMBRANE POLARITY REVERSES from resting state.

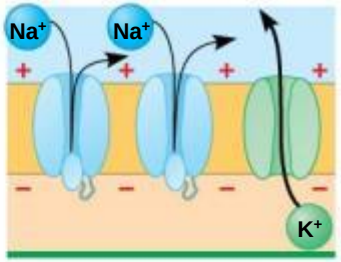


2 DEPOLARIZATION: A stimulus opens some Na^+ channels; if THRESHOLD is reached, an action potential is triggered.

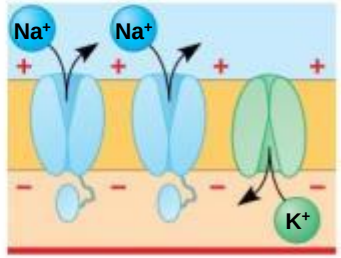


1 RESTING STATE: Voltage-gated Na^+ and K^+ channels are closed; resting potential is maintained by Sodium-Potassium Pump channels (not shown).





4 REPOLARIZATION: Na^+ channels close and inactivate; K^+ channels open, and K^+ rushes out; interior of cell is more negative than outside.



1 Return to resting state.

TRY IT

1

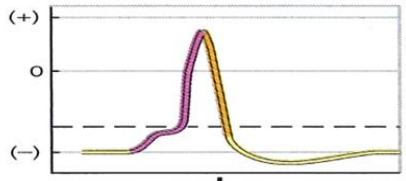
is divided into

includes cells called

2

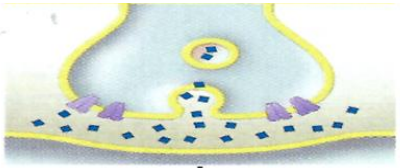
transmit

3



trigger release of

4



at

5

6

includes

7

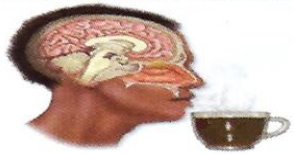
8

9

includes

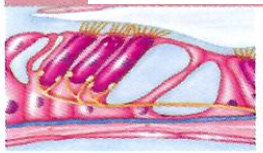
10

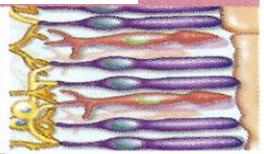
11



rely on

12





such as those in the

13

14

TRY IT

NERVOUS SYSTEM

is divided into

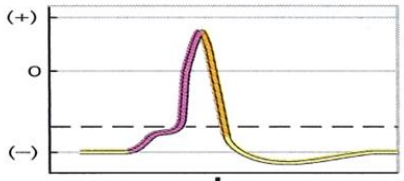
- **Central nervous system**
  - includes
    - **Spinal cord**
    - **Brain**
- **Peripheral nervous system**
  - includes
    - **Sensory pathways**
      - rely on
        - **Sensory receptor cells**
          - such as those in the
            - **Ears**
            - **Eyes**
    - **Motor pathways**

includes cells called

Neurons

transmit

Action potentials



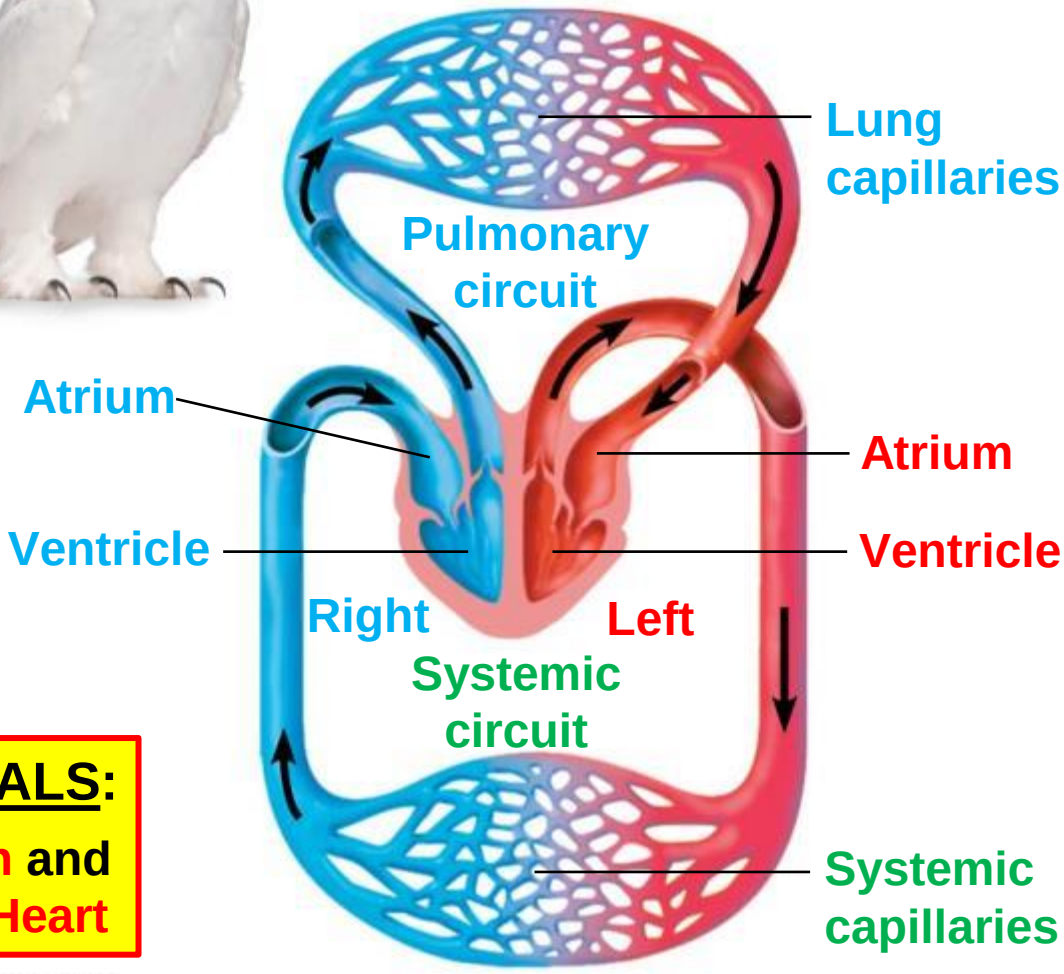
trigger release of

Neurotransmitters

at

Synapses

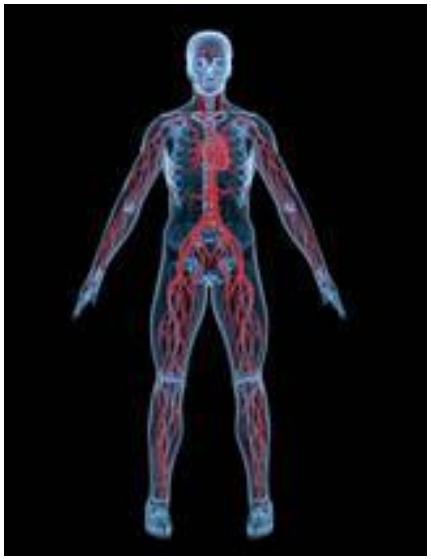
Circulatory System



BIRDS & MAMMALS:

Double Circulation and Four-Chambered Heart

The Circulatory System facilitates exchange with all Body Tissues.



To sustain life, the body must

- **acquire nutrients**
- **exchange gases**
- **dispose of waste products.**

The **Circulatory System** facilitates these exchanges. It consists of:

- **a muscular pump (heart)**
- **a circulatory fluid (blood)**
- **a set of tubes (vessels) to carry the circulatory fluid.**

The Circulatory System facilitates exchange with all Body Tissues.

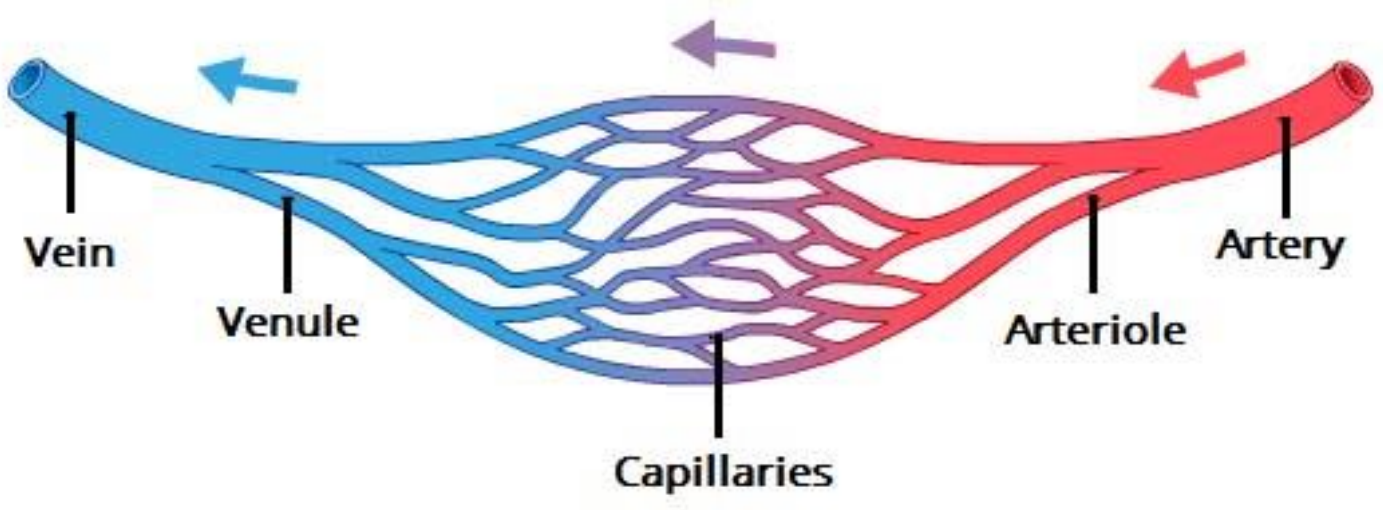
The vertebrate circulatory system is often called a **CARDIOVASCULAR SYSTEM**, with **three main types of vessels:**

1. **Arteries** carry blood ***AWAY*** ***from the heart*** to body organs and tissues.
2. **Veins** ***return blood*** ***TO*** ***the heart***.
3. **Capillaries** convey blood ***BETWEEN*** ***arteries and veins*** within each tissue.

The Circulatory System facilitates exchange with all Body Tissues.

Large **ARTERIES** branch into **Arterioles**, which give rise to **Capillaries**, which branch into networks called **Capillary Beds**, which infiltrate every organ and tissue in the body.

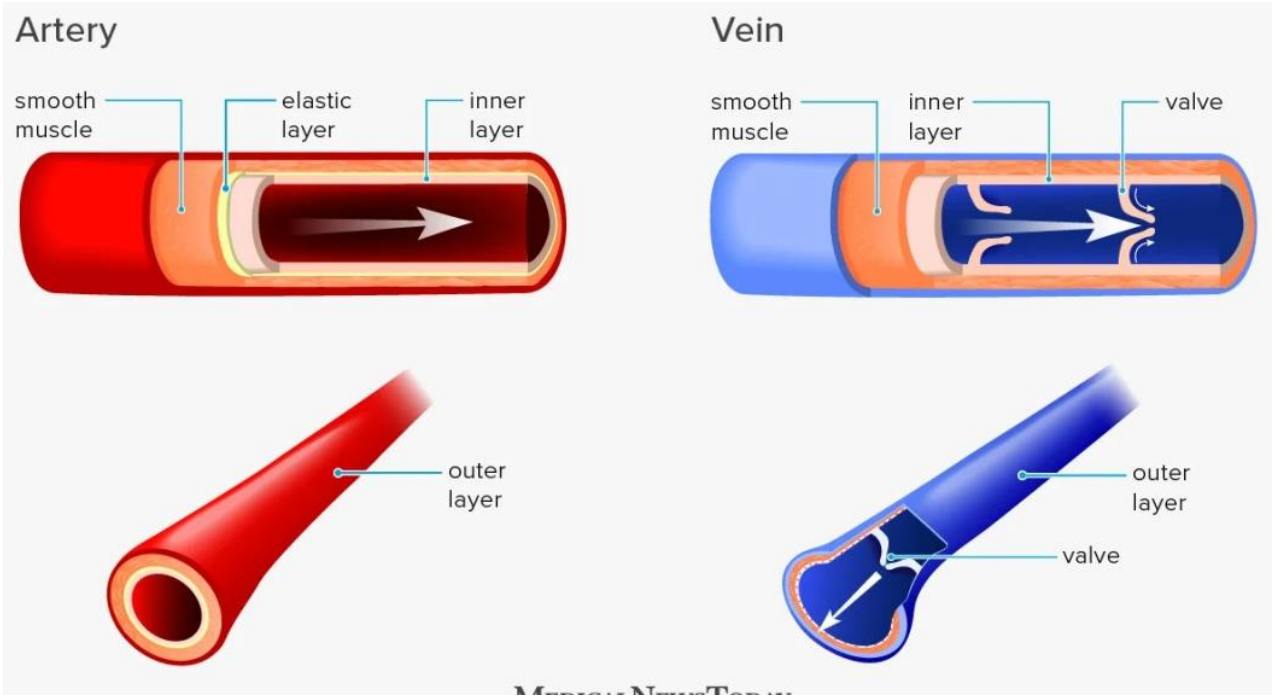
Capillaries converge into **Venules**, which in turn converge into larger **VEINS** that return blood to the **Heart**.

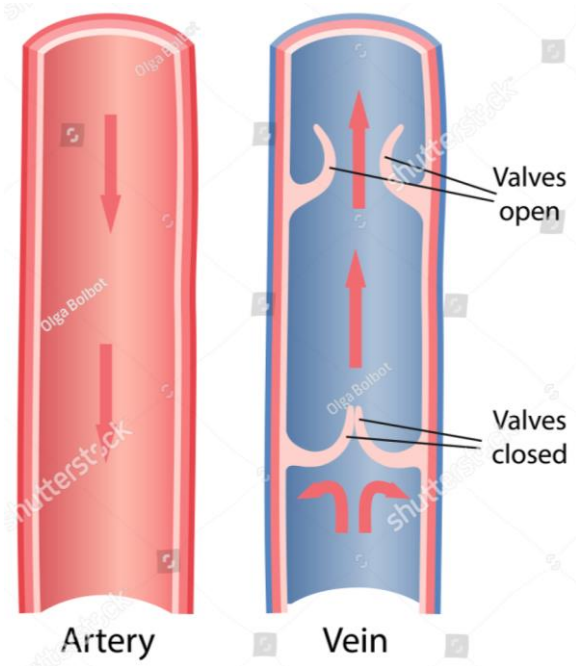


The Circulatory System facilitates exchange with all Body Tissues.

ARTERIES carry oxygenated blood from the heart throughout the body except for the pulmonary arteries, which carry deoxygenated blood to the lungs.

VEINS have thinner walls and possess **VALVES** to prevent blood from reversing (*varicose veins*).



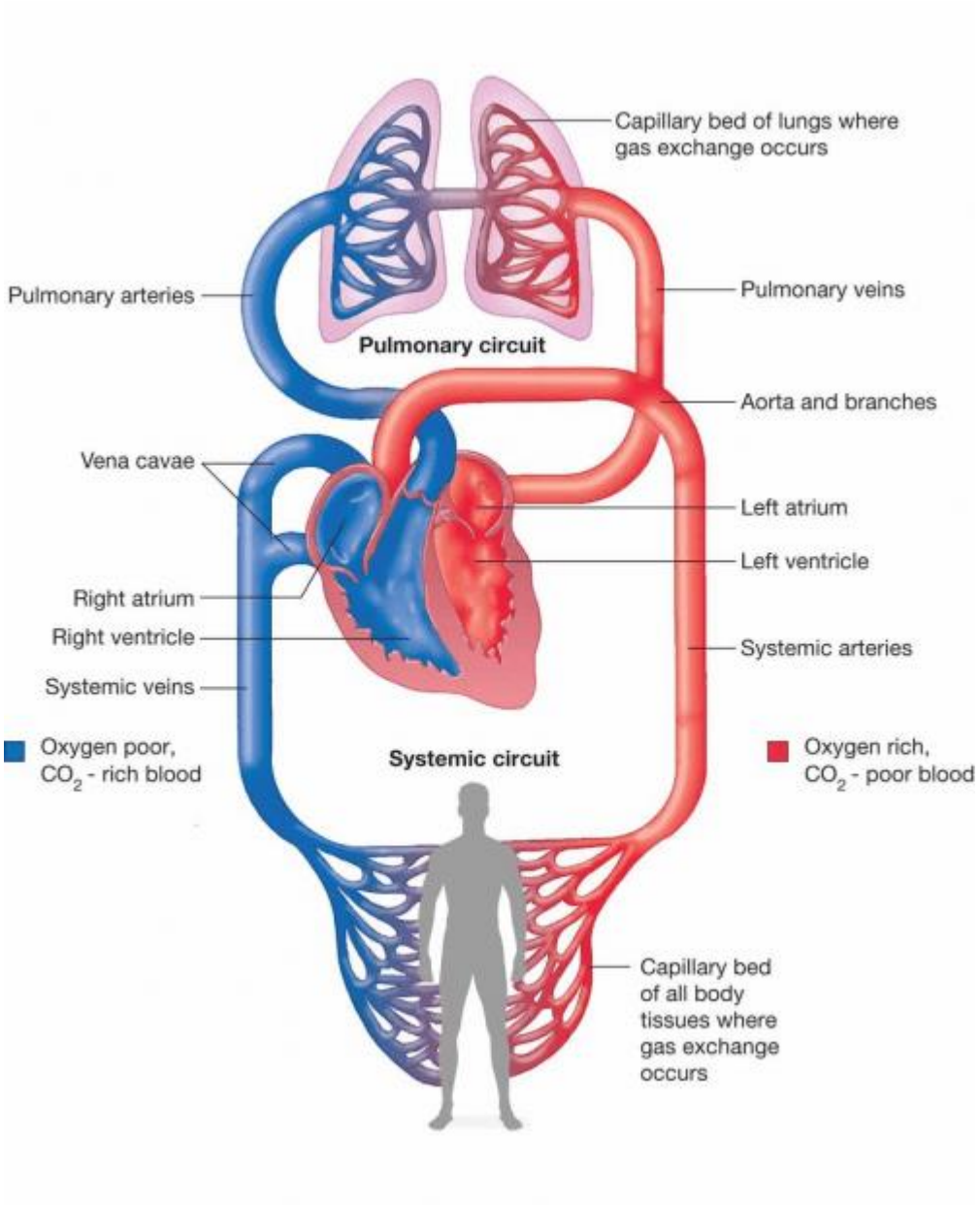


The Circulatory System facilitates exchange with all Body Tissues.

Land vertebrates have a **Double Circulation:**

The **PULMONARY CIRCUIT** carries **oxygen-poor blood** between the **heart** and the **lungs**.

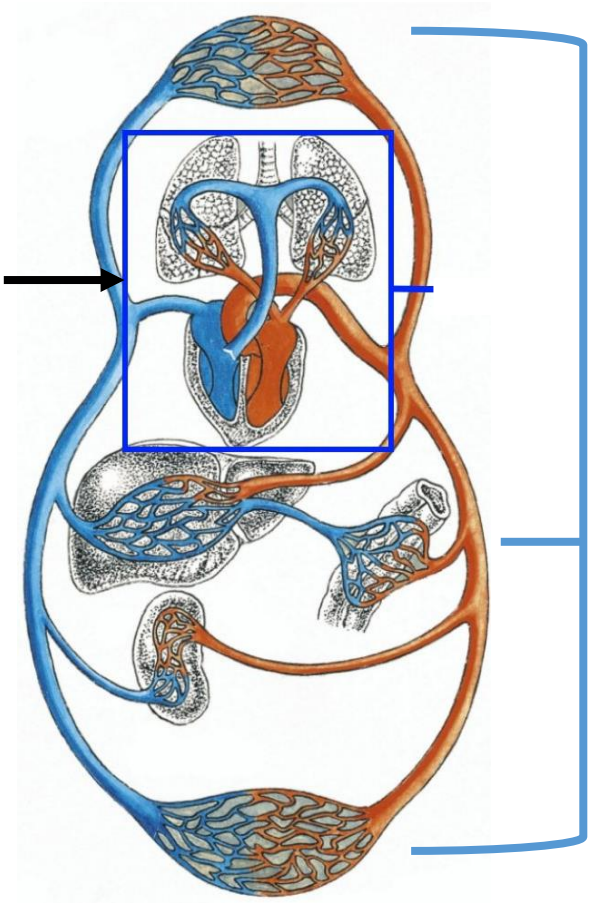
The **SYSTEMIC CIRCUIT** carries **oxygen-rich blood** between the **heart** and the rest of the **body**.



The Circulatory System facilitates exchange with all Body Tissues.

In all **Birds** and **Mammals**, the heart has **four chambers** with **two atria** and **two ventricles.**

PULMONARY CIRCUIT

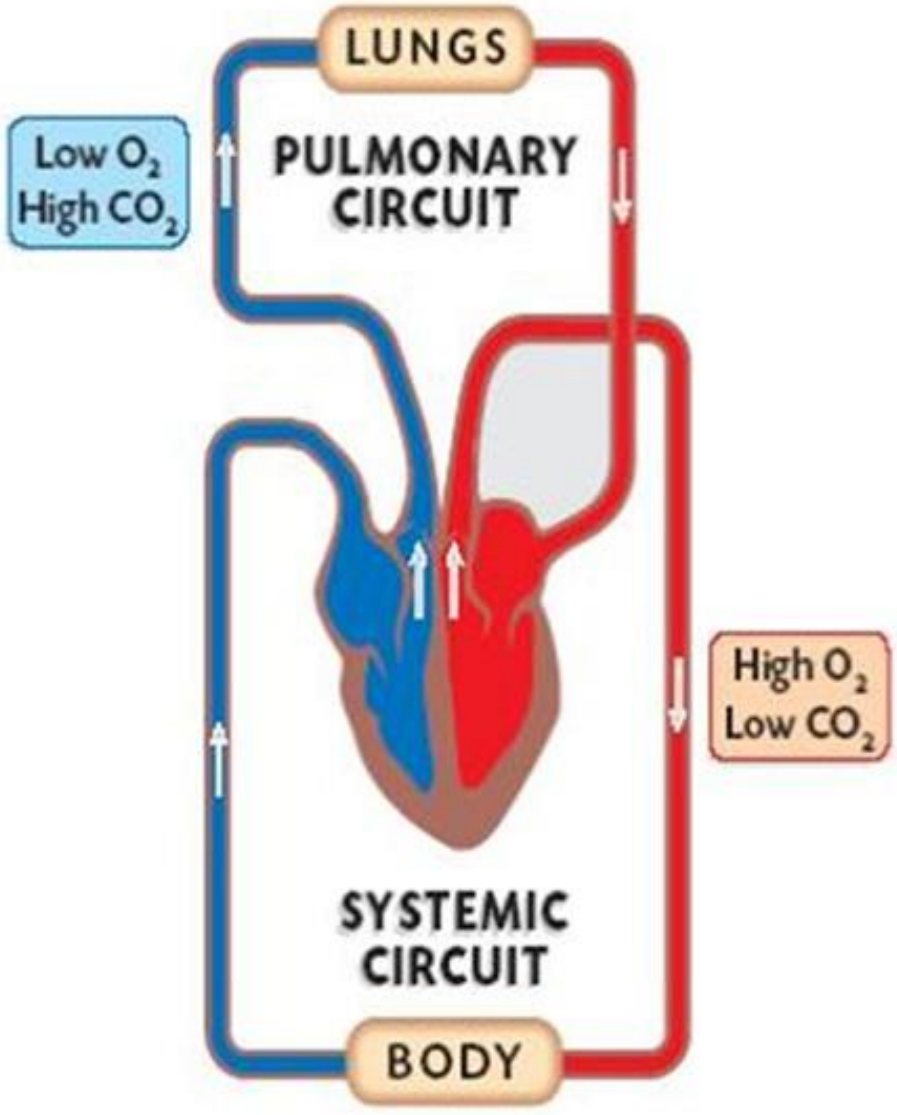


SYSTEMIC CIRCUIT

The **right side** of the heart handles only **oxygen-poor blood.**

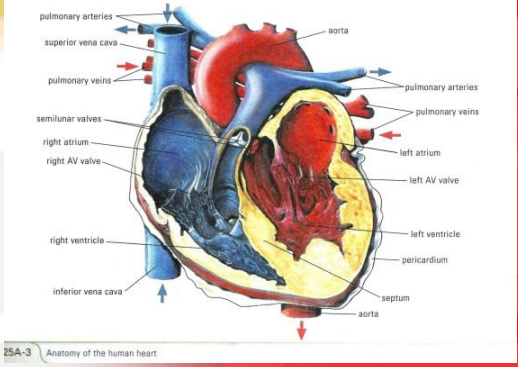
The **left side** receives and pumps only **oxygen-rich blood.**

Double circulatory system



- A **double circulatory system** separates the oxygenated and the deoxygenated blood.
- The pulmonary circuit pumps blood to the lungs.
- The systemic circuit pumps blood to the body systems (i.e. The head, limbs, and trunk).

HEART



- **Main component** of the circulatory system.
- Muscular Organ (**Cardiac Muscle**), about the size of your fist, that pumps the blood.
- **4 chambers** with **4 valves** through which blood must pass on each trip around the body.
- Avg 70 beats per minute.
- Pumps **Oxygen-rich blood** coming from the lungs to all parts of the body through a network of blood vessels.
- **Pacemaker** → special tissue inside the heart that causes it to beat automatically.

HEART

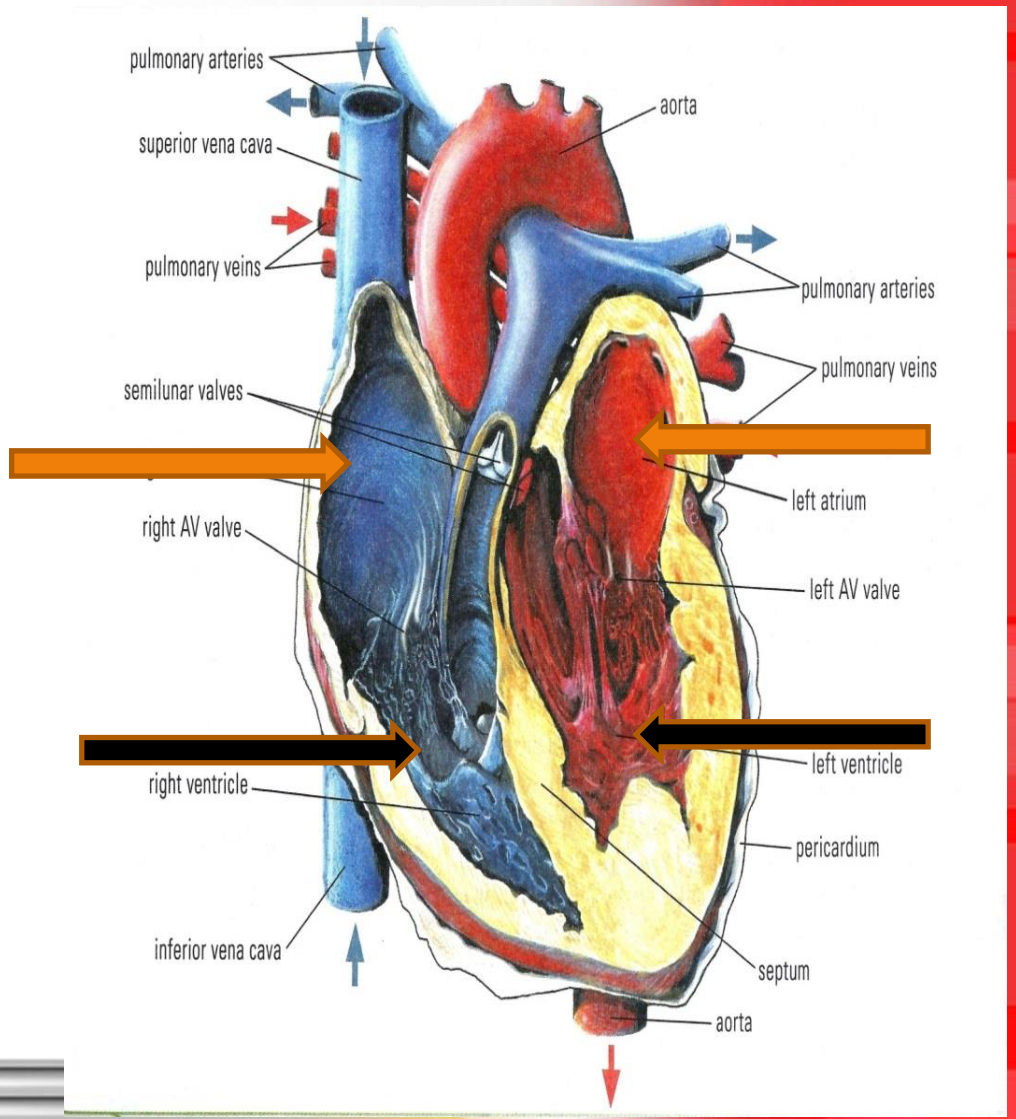
The heart has 4 hollow spaces called **chambers.**

ATRIA: upper, thin-walled chambers.

- Blood enters **the heart** through the **atria**.

VENTRICLES: lower, larger, thick-walled chambers

- Blood **leaves the heart** through the **ventricles**.



Heart

Four Valves in the heart direct the flow of blood:

ATRIOVENTRICULAR Valves

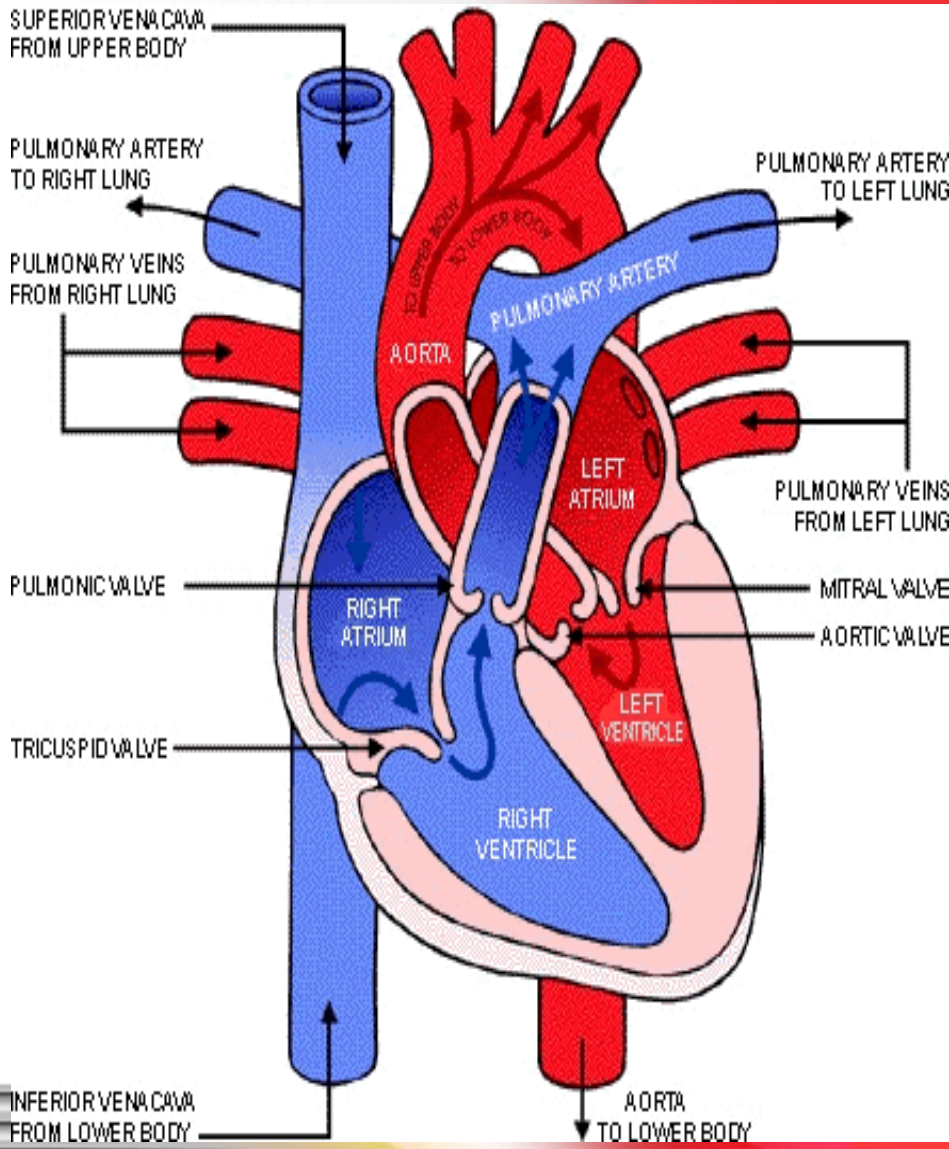
(Mitral & Tricuspid Valves)

- **ONE WAY valves separate the atrium and ventricle on each side of the heart.**
- **Allow blood to flow in only one direction: from atria to ventricles.**

SEMILUNAR Valves

(Pulmonary & Aortic Valves)

- **ONE WAY valves allow blood to leave the ventricles, but not return.**

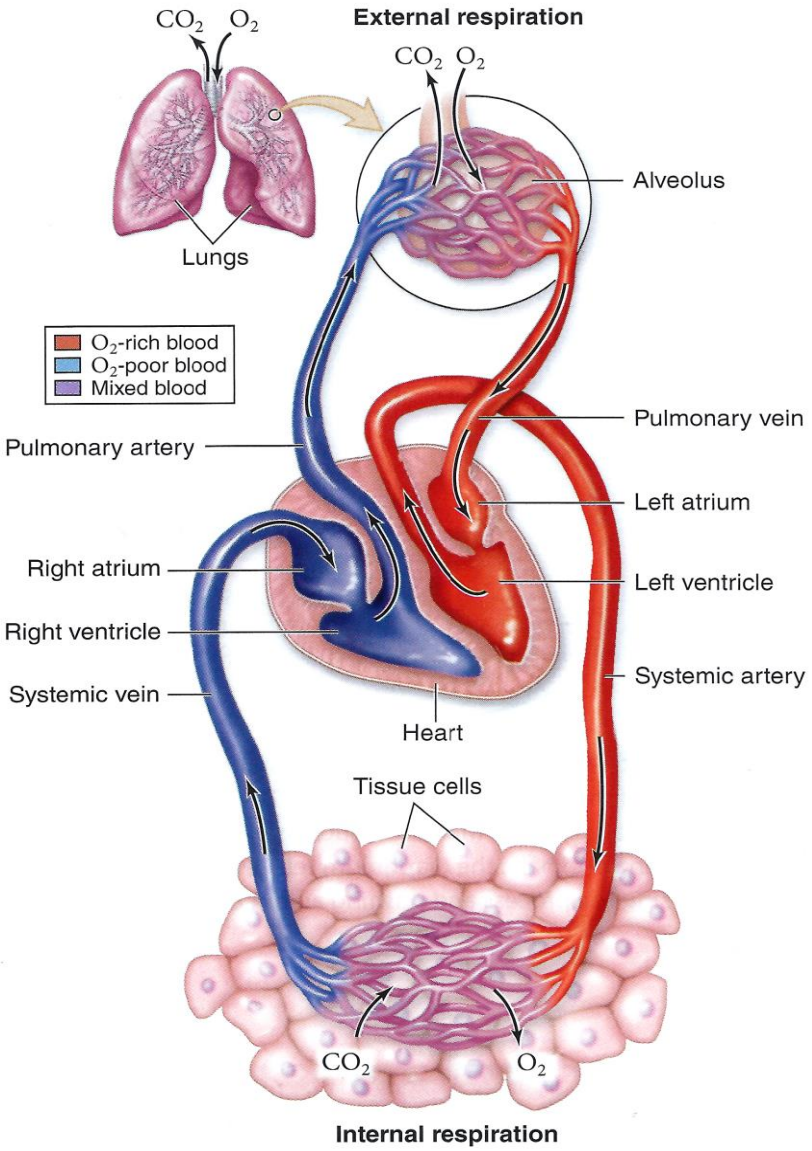


Heart

Each side of the heart pumps blood to a different part of the circulatory system.

PULMONARY CIRCULATION

- **Right Side of Heart pumps blood from the heart to the lungs.**
  - **Oxygen-poor blood is pumped by the right side of the heart through the lungs.**
  - **There it gives off carbon dioxide and picks up oxygen.**
  - **This oxygen-rich blood is then returned to the left side of the heart by the pulmonary VEINS.**

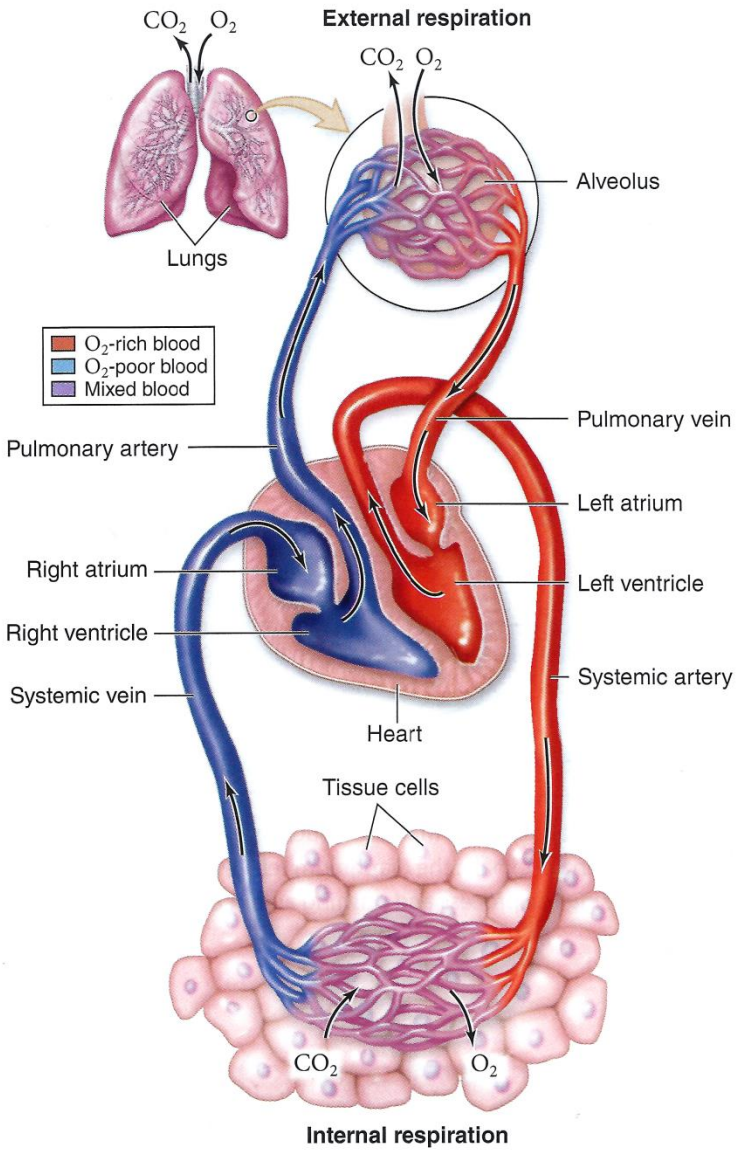


SYSTEMIC CIRCULATION

Heart

Left Side of Heart pumps blood **FROM** the heart to the rest of the body

- **Oxygen-rich blood leaves the heart to supply the body with oxygenated blood**
- **By the time blood returns from this systemic circulation, cells throughout the body have absorbed much of the blood's oxygen, and exchanged carbon dioxide for it.**
- **This blood is now oxygen-poor and ready for another trip to the lungs to become oxygen-rich again.**

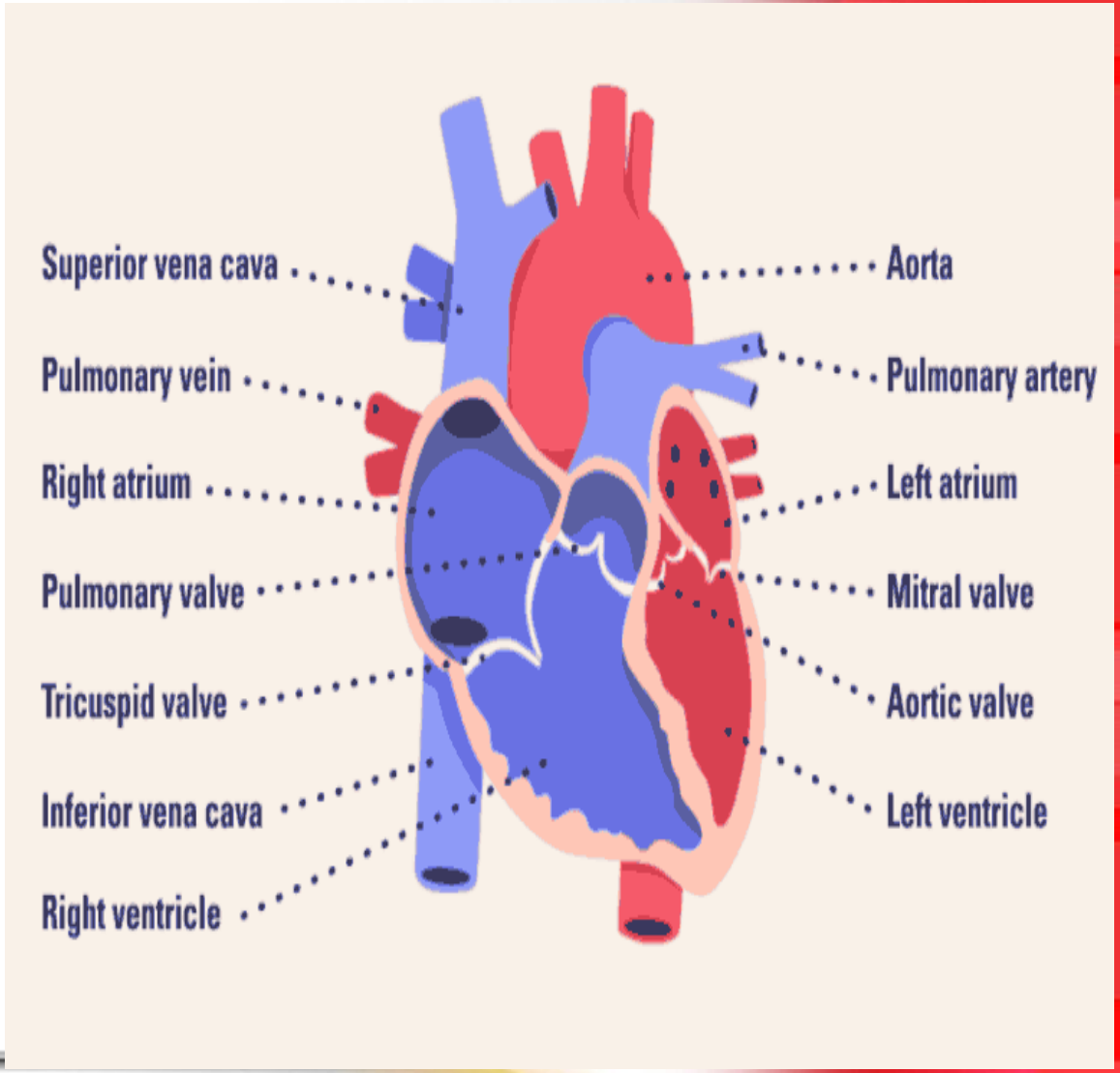


Blood Flow

1) **Oxygen-poor** blood from the body enters the inferior and superior **Vena Cava**.

2) Vena Cava empty into the **Right Atrium**.

3) Blood passes through the Right AV (Tricuspid) Valve into the **Right Ventricle**.

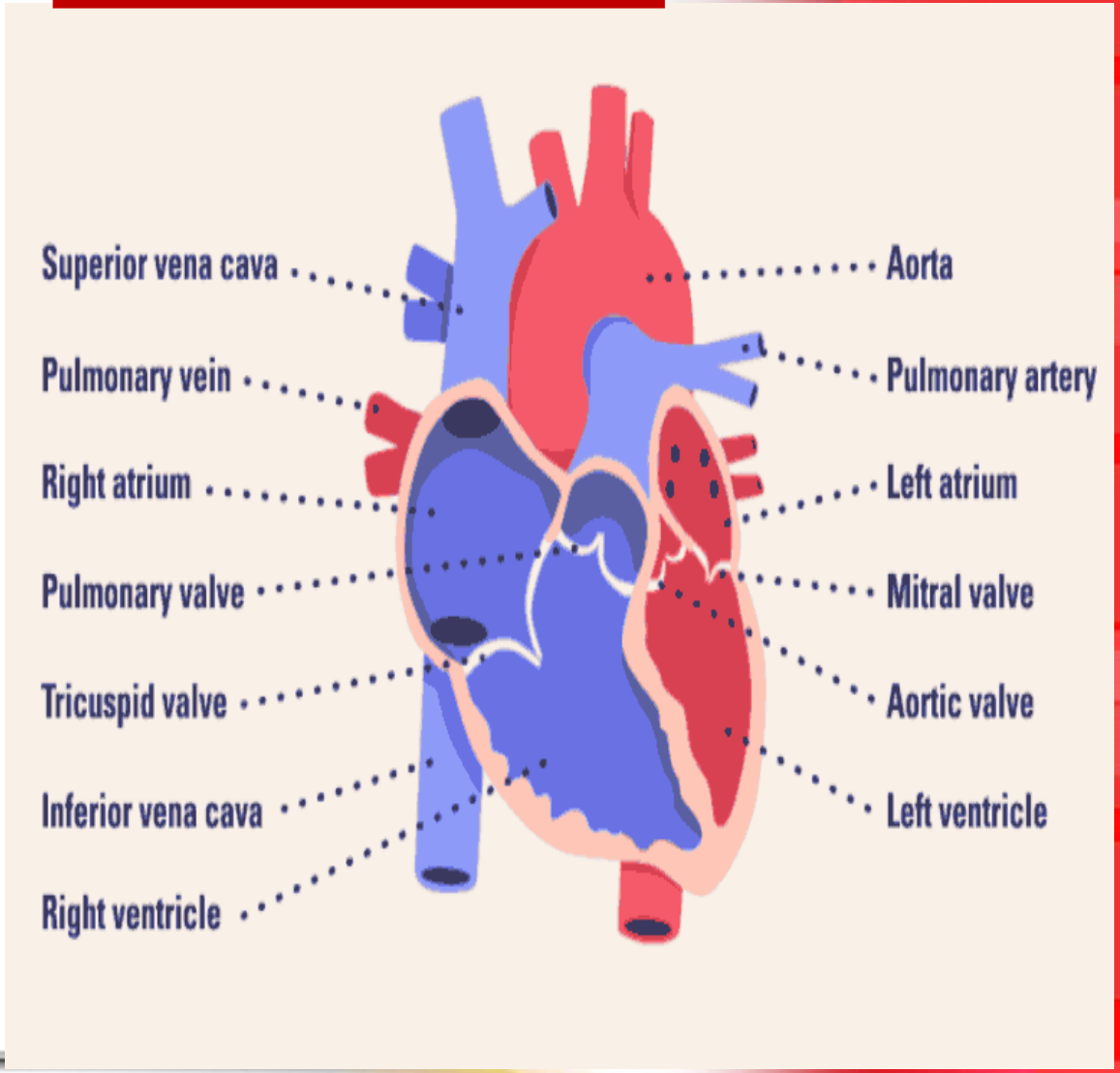


Blood Flow

4) Right Ventricle pumps **oxygen-poor** blood into pulmonary artery through the semilunar valve (to the lungs).

5) Pulmonary arteries transport blood to the lungs for gas exchange.

- Blood simultaneously picks up **oxygen** and discharges **carbon dioxide** and other wastes.

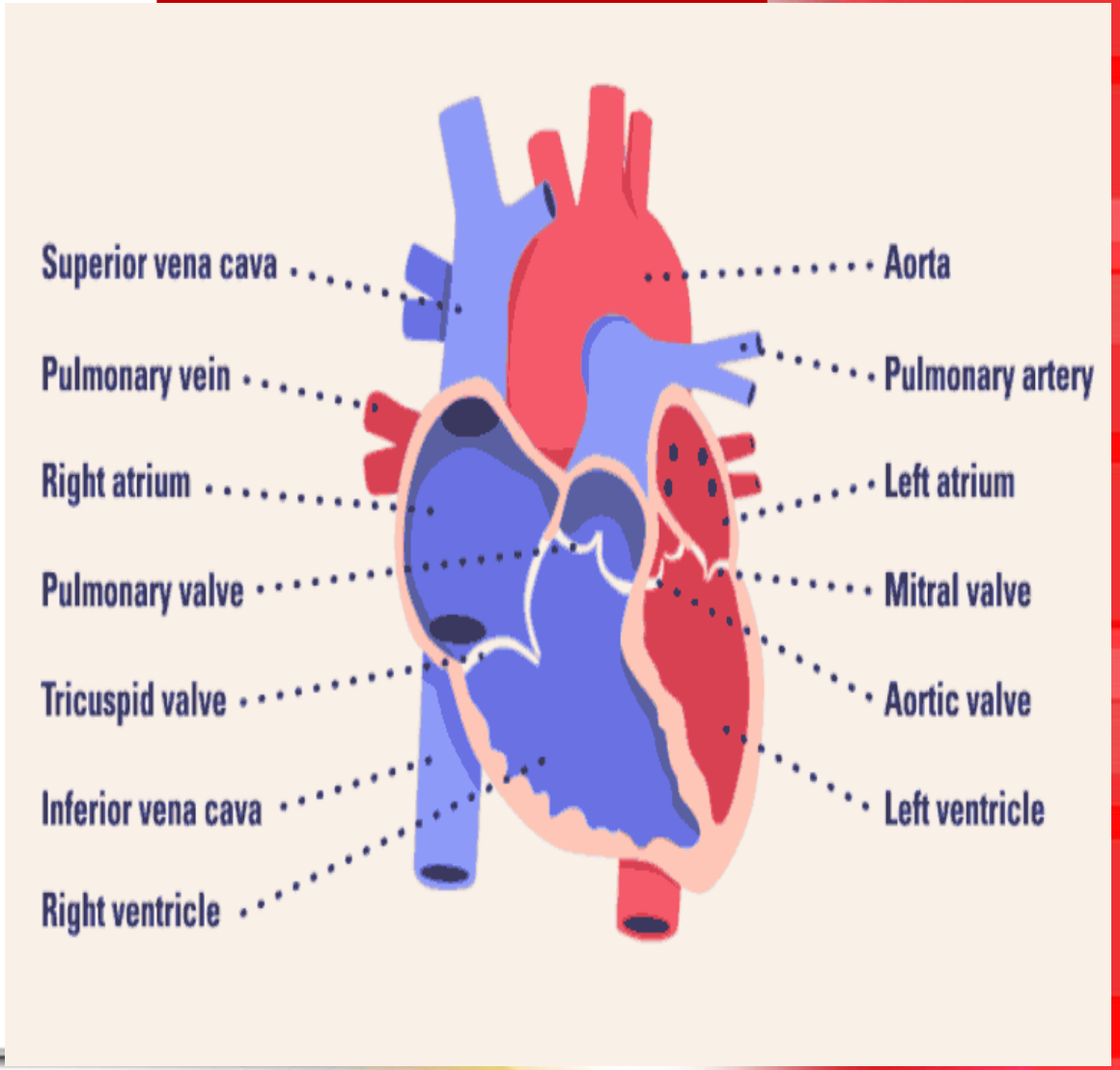


Blood Flow

6) Pulmonary Veins carry **oxygenated** blood from the lungs to the **Left Atrium**.

7) Blood passes through the Left AV Valve into the **Left Ventricle**.

8) Left Ventricle pumps oxygen-rich blood into **Aorta** (Largest artery in the body) through the semilunar valve (to the body).

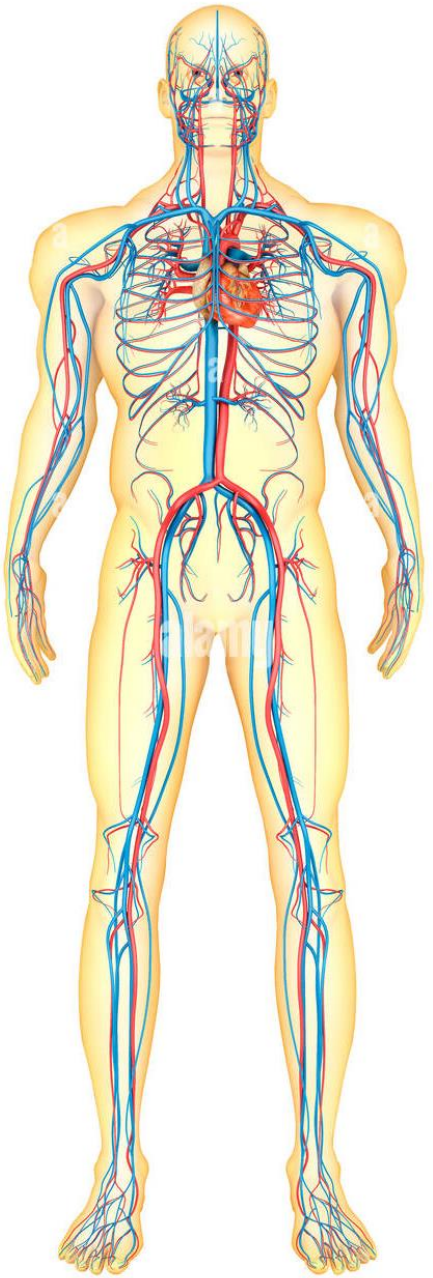


Blood Flow

9) As the blood passes through the capillaries, it delivers oxygen to the cells and absorbs carbon dioxide from them.

10) By the time the blood enters the veins, it is **deoxygenated**.

11) The veins collect the deoxygenated blood and return it to the heart.

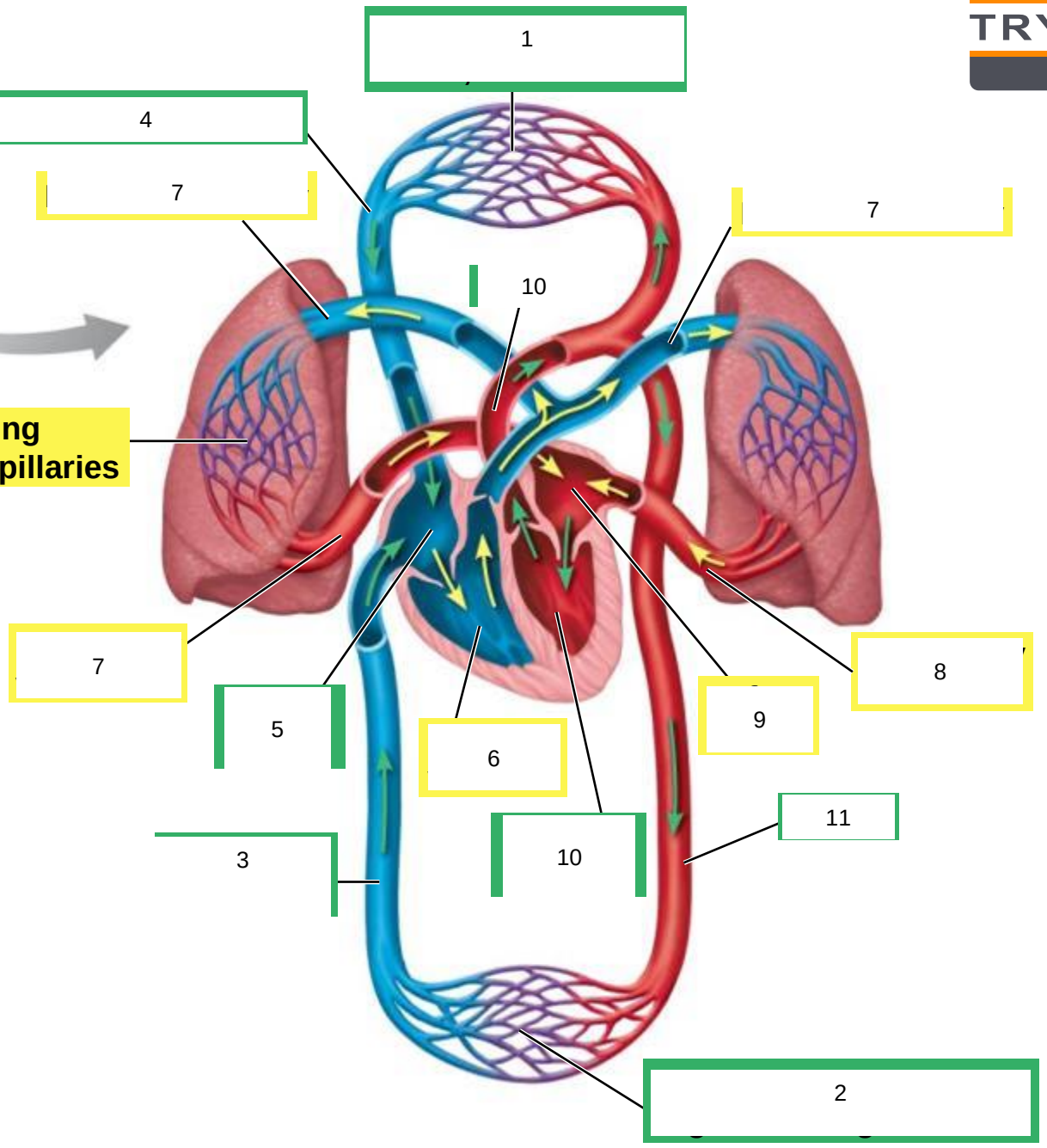


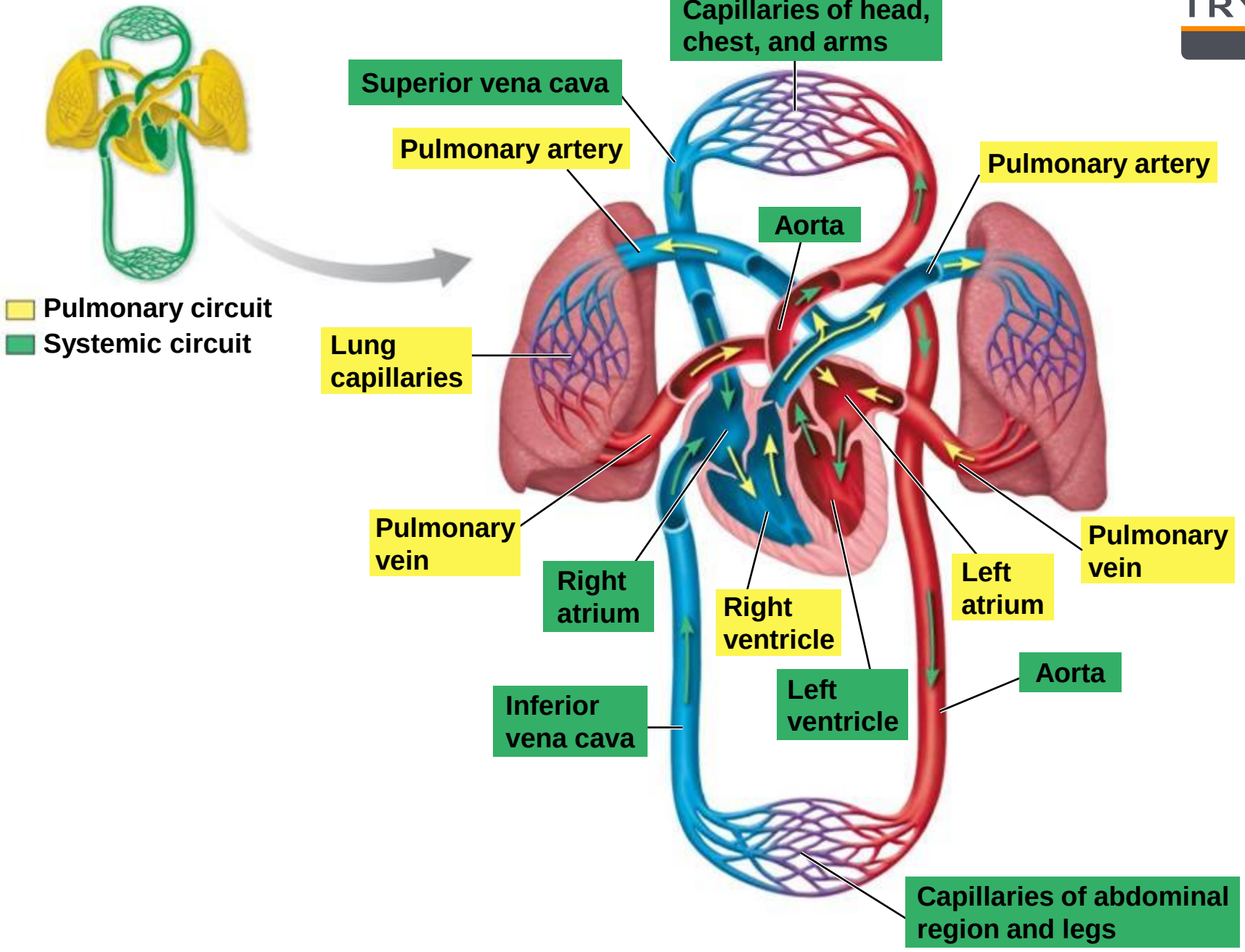
TRY IT

12 circuit

13 circuit

Lung capillaries




Pulmonary circuit
Systemic circuit
Capillaries of head, chest, and arms
Superior vena cava
Pulmonary artery
Pulmonary artery
Aorta
Lung capillaries
Pulmonary vein
Right atrium
Right ventricle
Left atrium
Pulmonary vein
Inferior vena cava
Left ventricle
Aorta
Capillaries of abdominal region and legs

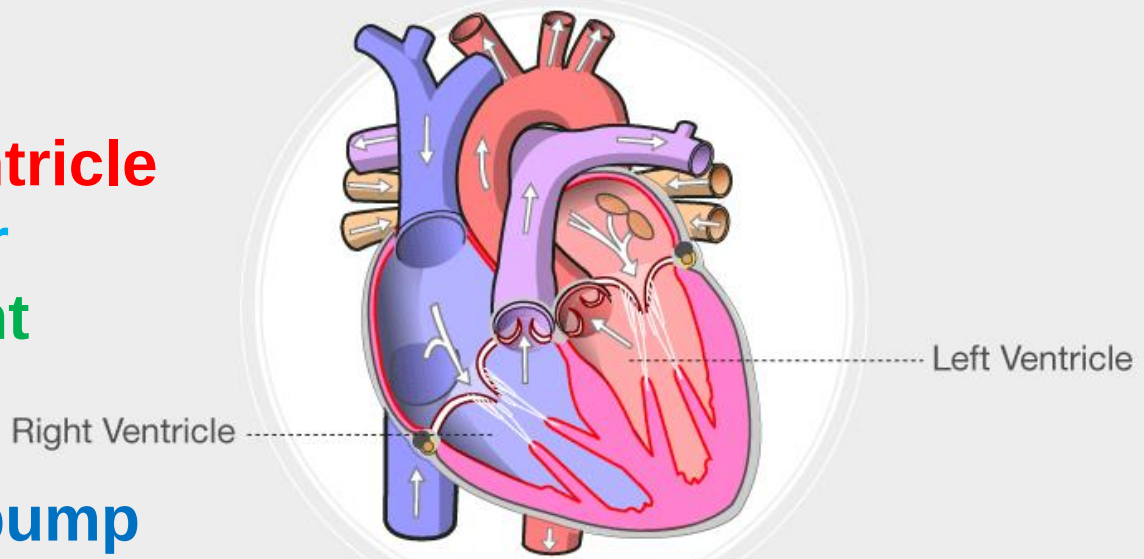
Heart

One drop of blood may circulate through the body at the rate of once every 23 seconds.

The walls of the Left Ventricle are about 3 times thicker than the walls of the right ventricle.

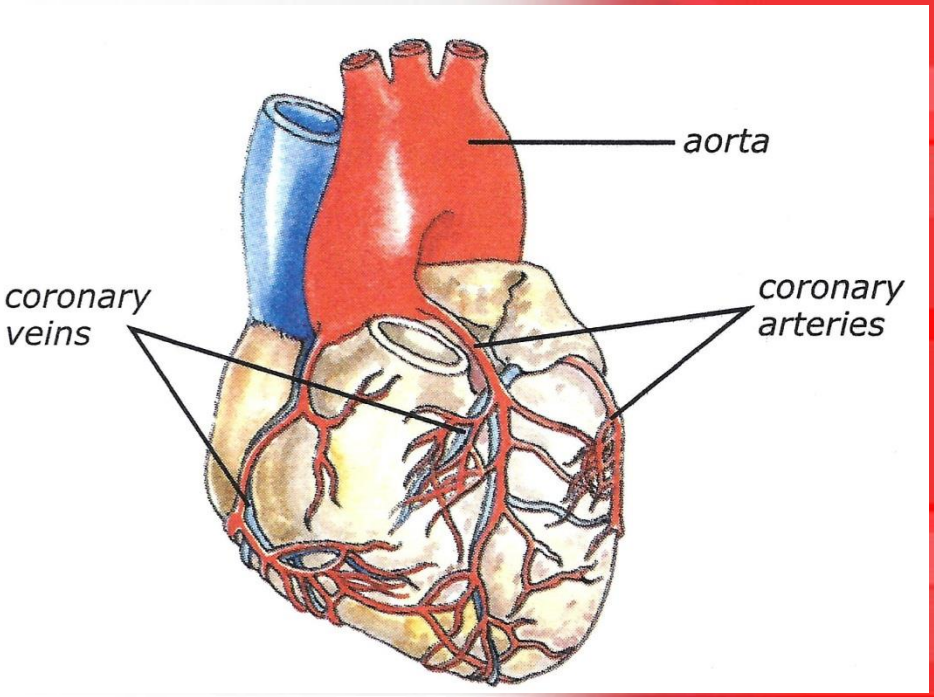
RIGHT Ventricle has to pump blood only to the lungs.

LEFT Ventricle has to push to the rest of the body.



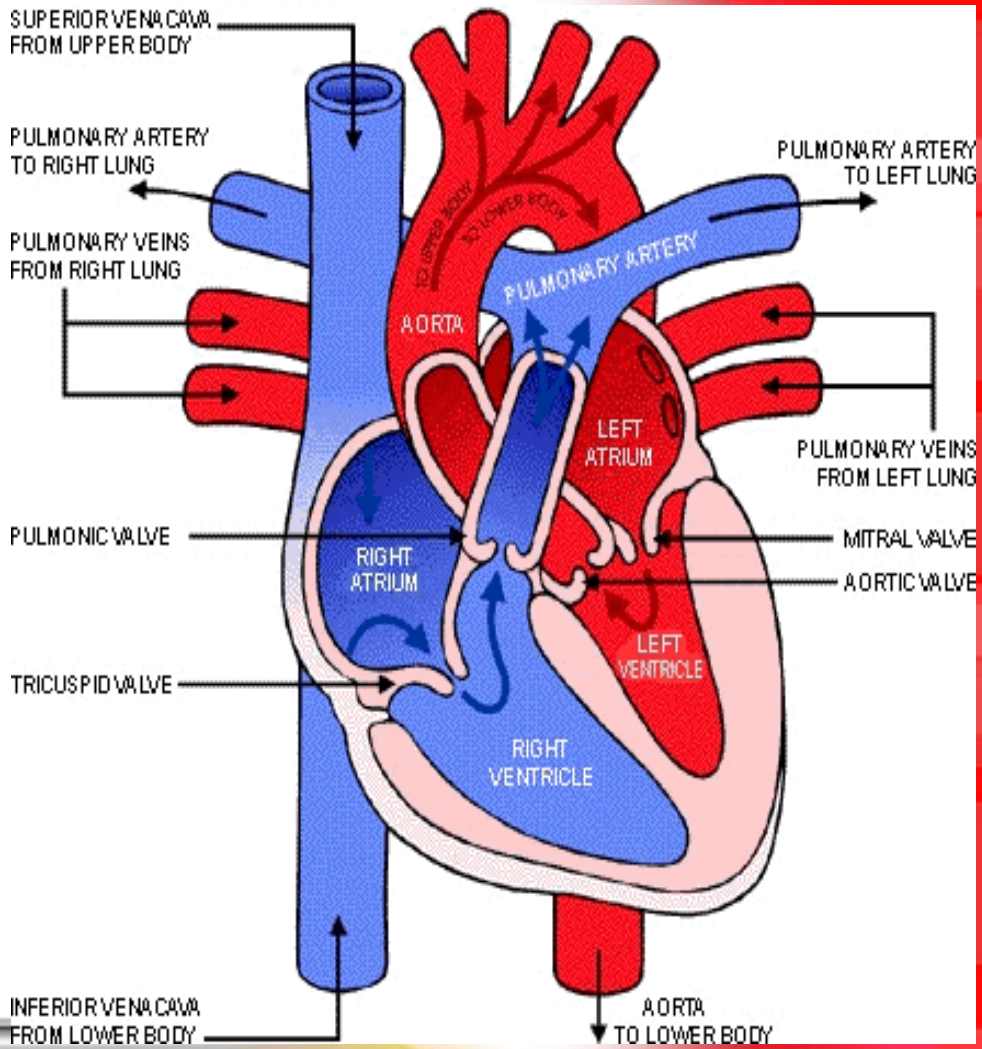
Nourishing the Heart

- The muscle of the heart receives almost no nourishment from the blood that flows through its chambers.
- The heart's nourishment is supplied primarily by two **CORONARY ARTERIES**.
- These arteries branch from the aorta and enter the heart muscle.



Blood Pressure

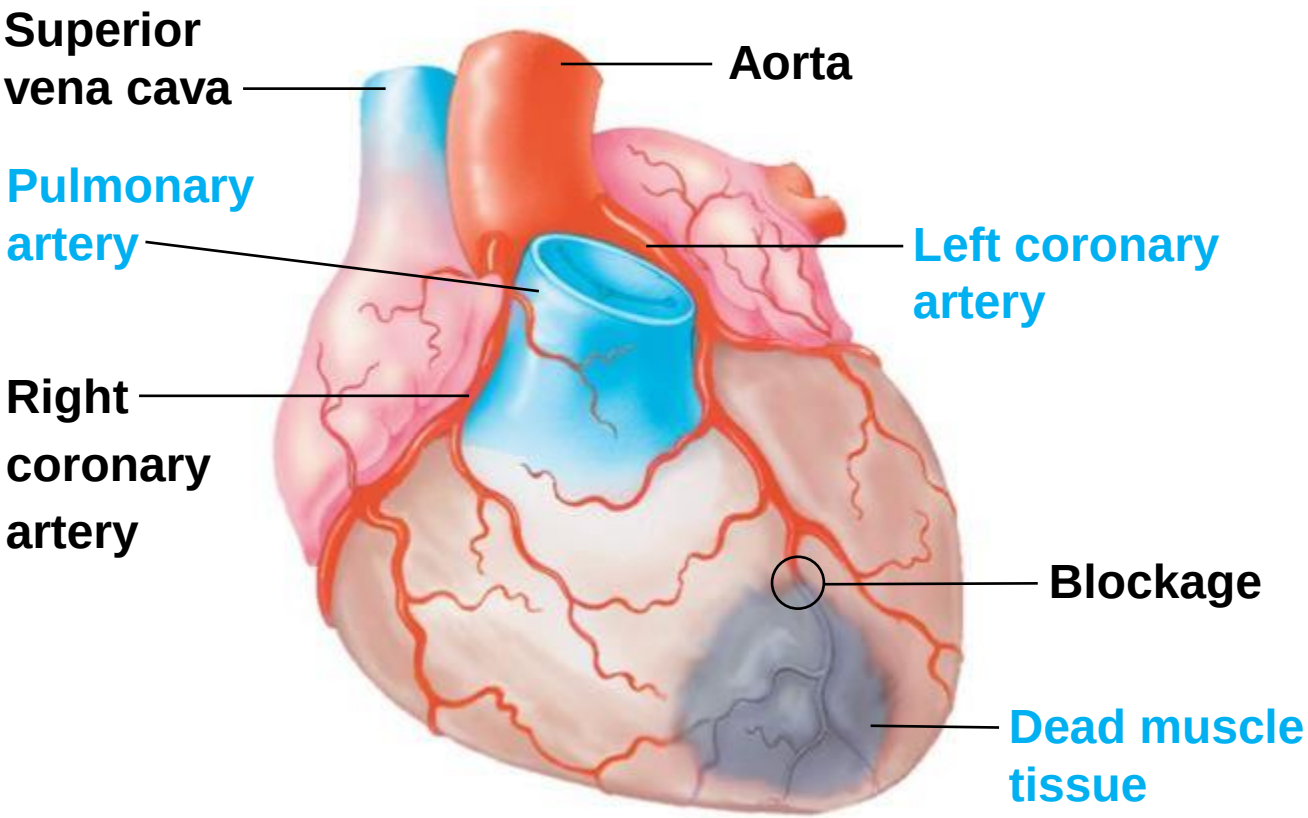
- When the heart contracts, both atria function together, and then both ventricles function together.
- **Both the right and left atria receive blood at the same time.**
- When **atria** contract, both AV valves open and blood flows into the ventricles **(SYSTOLE).**
- **After a brief pause, both ventricles contract, the AV valves close, and the semilunar valves open. (DIASTOLE).**
- The blood is then pumped into the pulmonary artery and aorta at the same time.



Heart Attacks

Each year more than 700,000 people in the United States die of a heart attack.

- **The most common warning sign of a heart attack is a dull pain, ache or “heaviness” in the center of the chest.**
- This sensation may spread to the neck, shoulders, and arms.
- **Person may feel weak, nauseated, short of breath and sweaty.**
- **Caused by a decreased supply of blood to the heart muscle**
  - **Occluded Coronary Arteries**


Superior vena cava
Aorta
Pulmonary artery
Left coronary artery
Right coronary artery
Blockage
Dead muscle tissue

THE BLOOD

The average adult has about **FIVE** liters of blood inside of their body

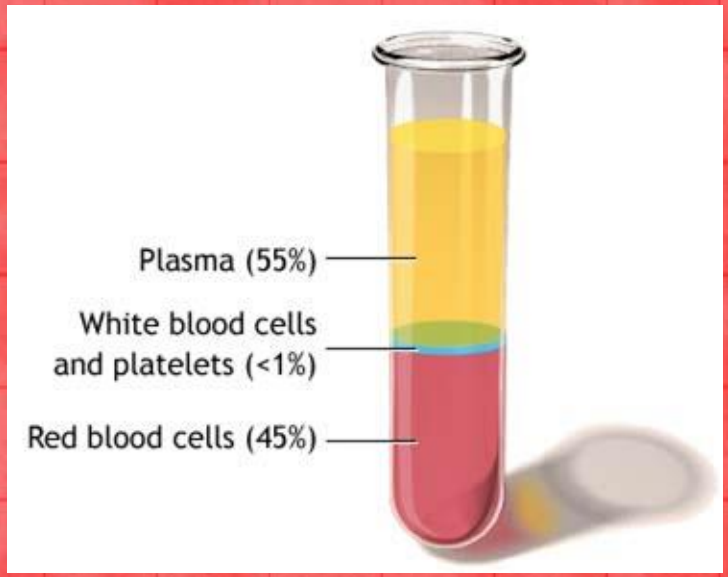
Parts of Blood:

Plasma – straw-colored part of blood that makes a little more than half the substance of blood.

White Blood Cells (WBC)

Red Blood Cells (RBC)

Platelets



BLOOD CELL FUNCTIONS

RED BLOOD CELLS

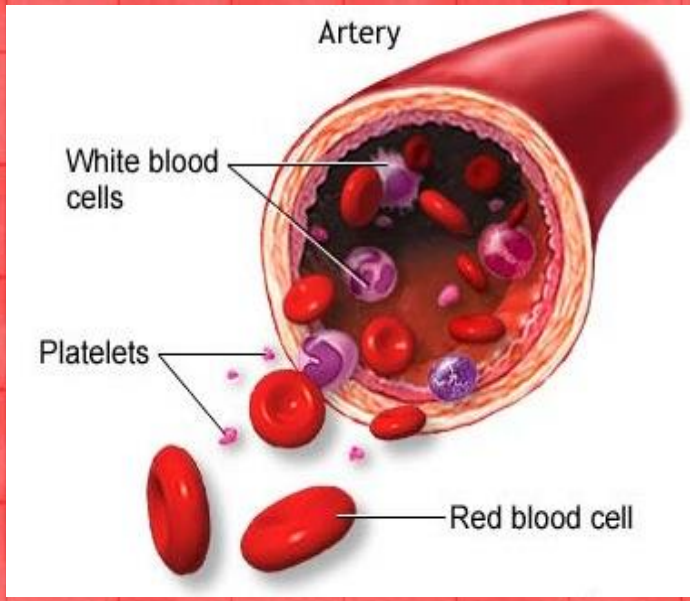
- Deliver oxygen, nutrients and others to body tissues.
- Remove waste and carbon dioxide from body tissues.

WHITE BLOOD CELLS

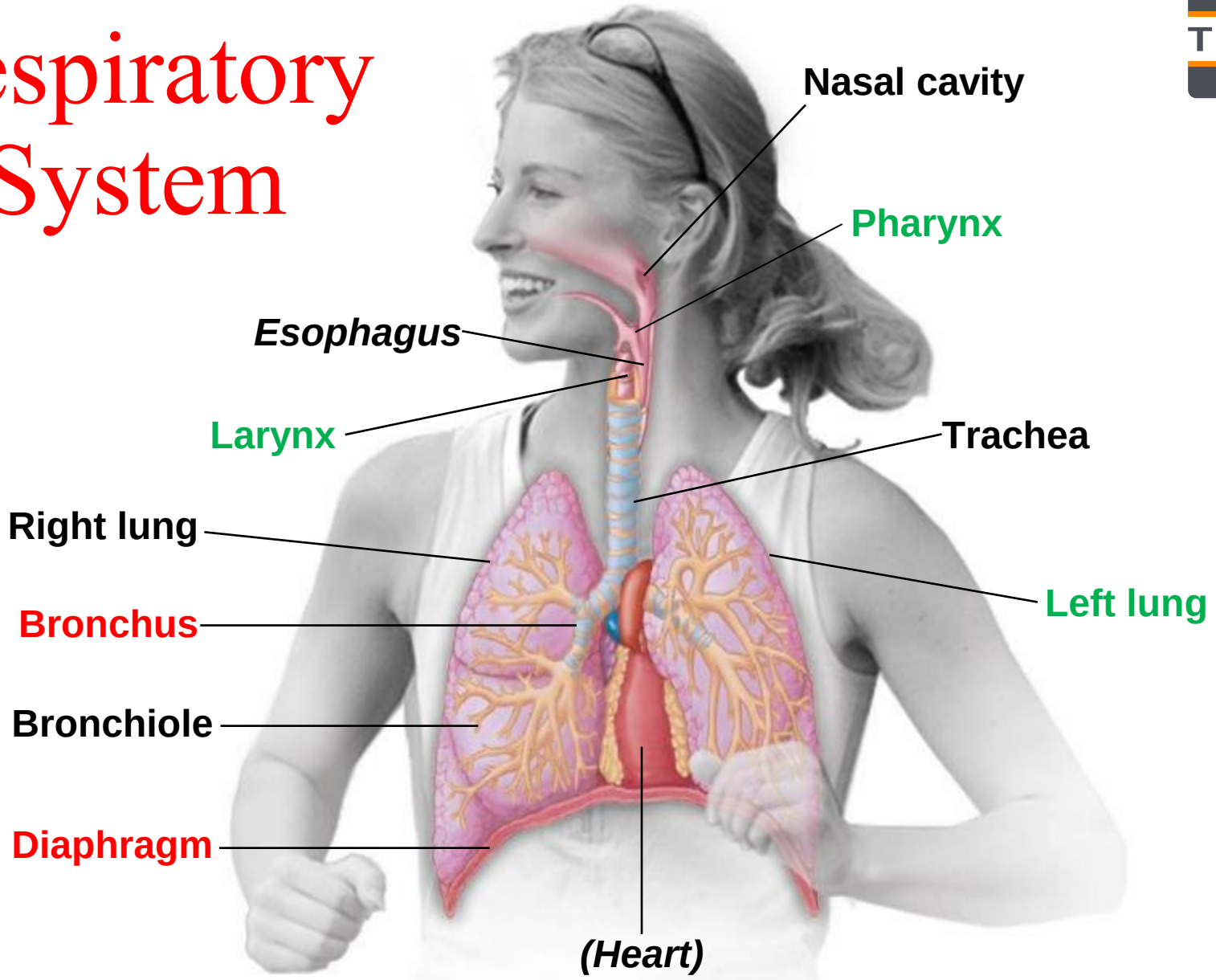
- Fight disease, infection.

PLATELETS

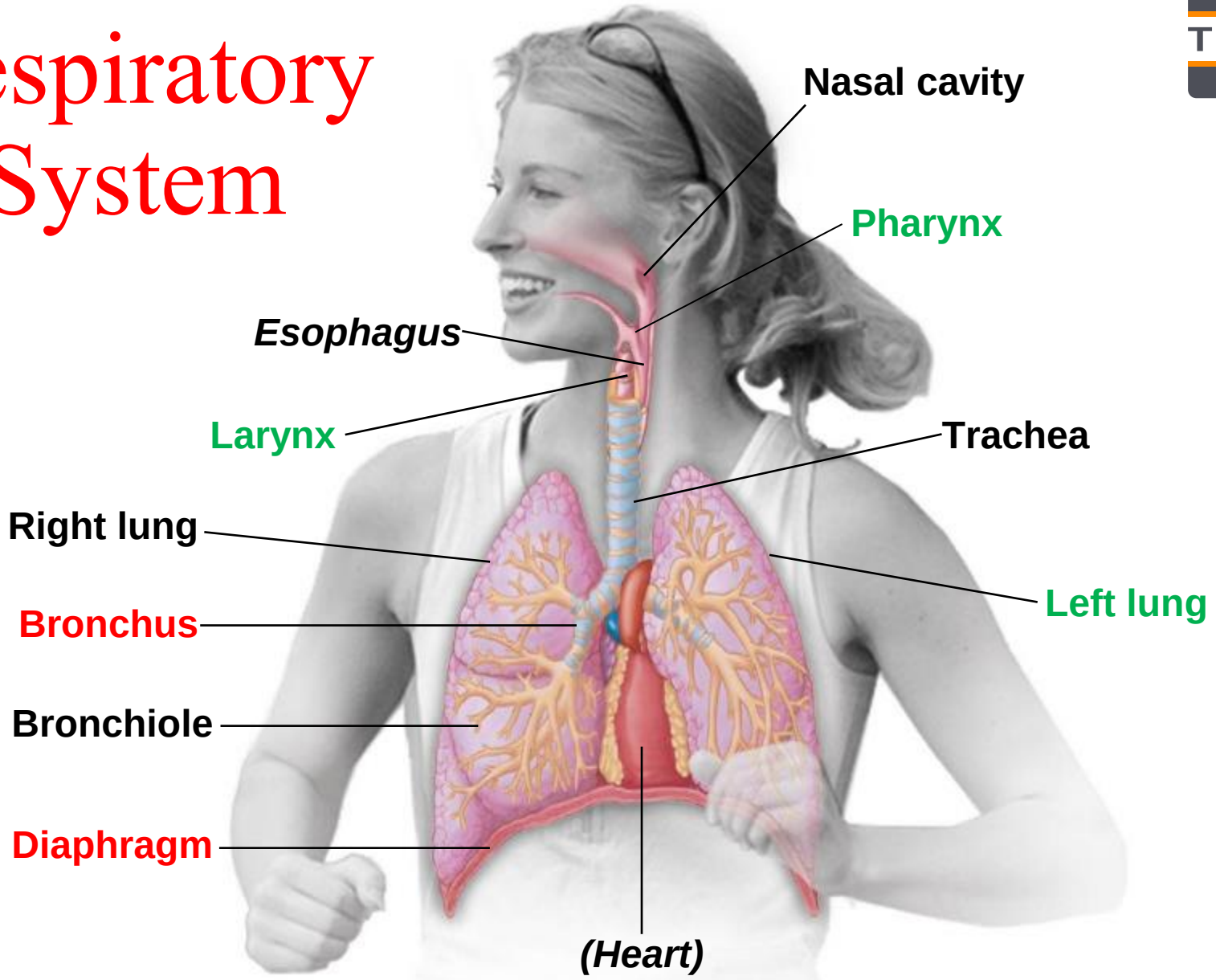
- Clot to prevent blood loss.



Respiratory System



Respiratory System



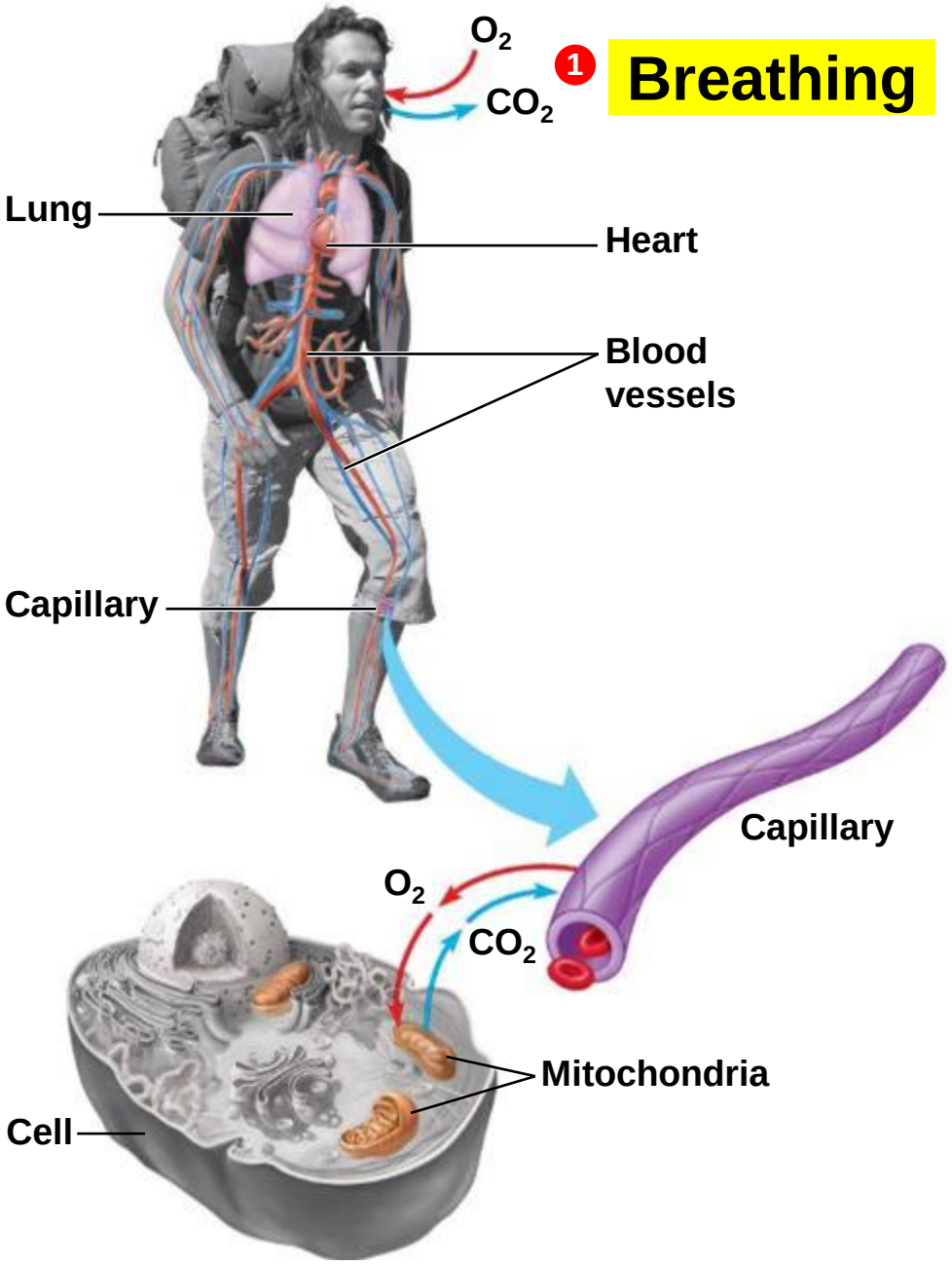
Respiratory System

Gas Exchange involves the **Respiratory** and **Circulatory** systems in servicing your body's cells.

Three Phases of Gas Exchange occur in humans:

1. **Breathing.**
2. **Transport of gases by the circulatory system.**
3. **Exchange of gases with body cells**:
   - Body tissues take up **oxygen** and release **carbon dioxide.**

Inhalation (take in oxygen)

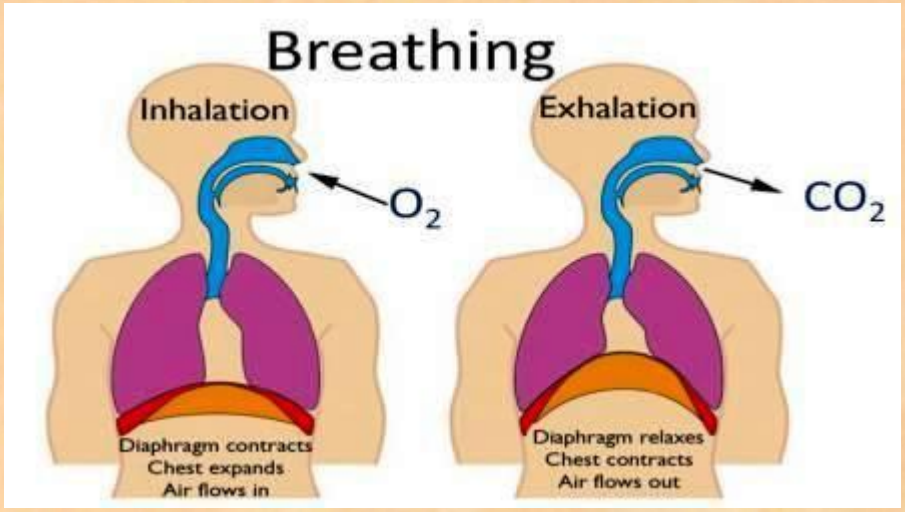


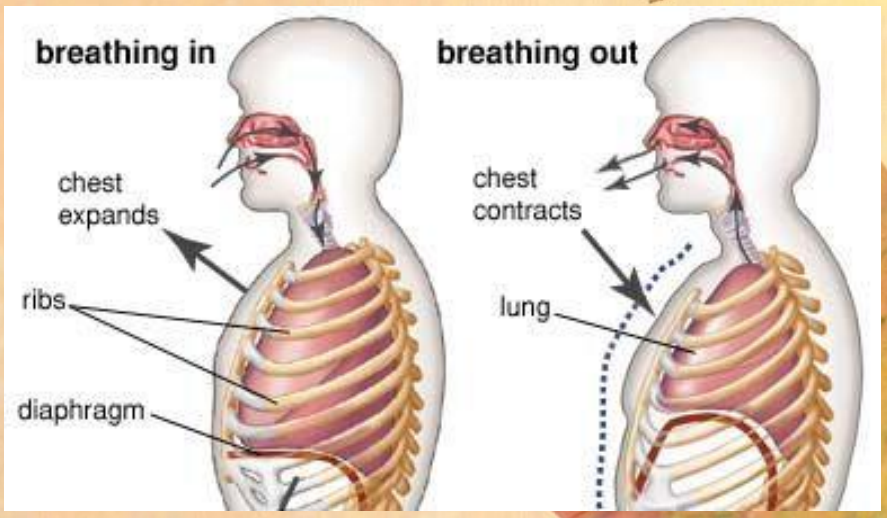
Exhalation (breathe out carbon dioxide)

Breathing

Ventilation of the lungs through alternating **inhalation** and **exhalation.**

- Air is not moved by the lungs, but by the **muscles surrounding the lungs: Diaphragm** and **Rib Cage Muscles.**



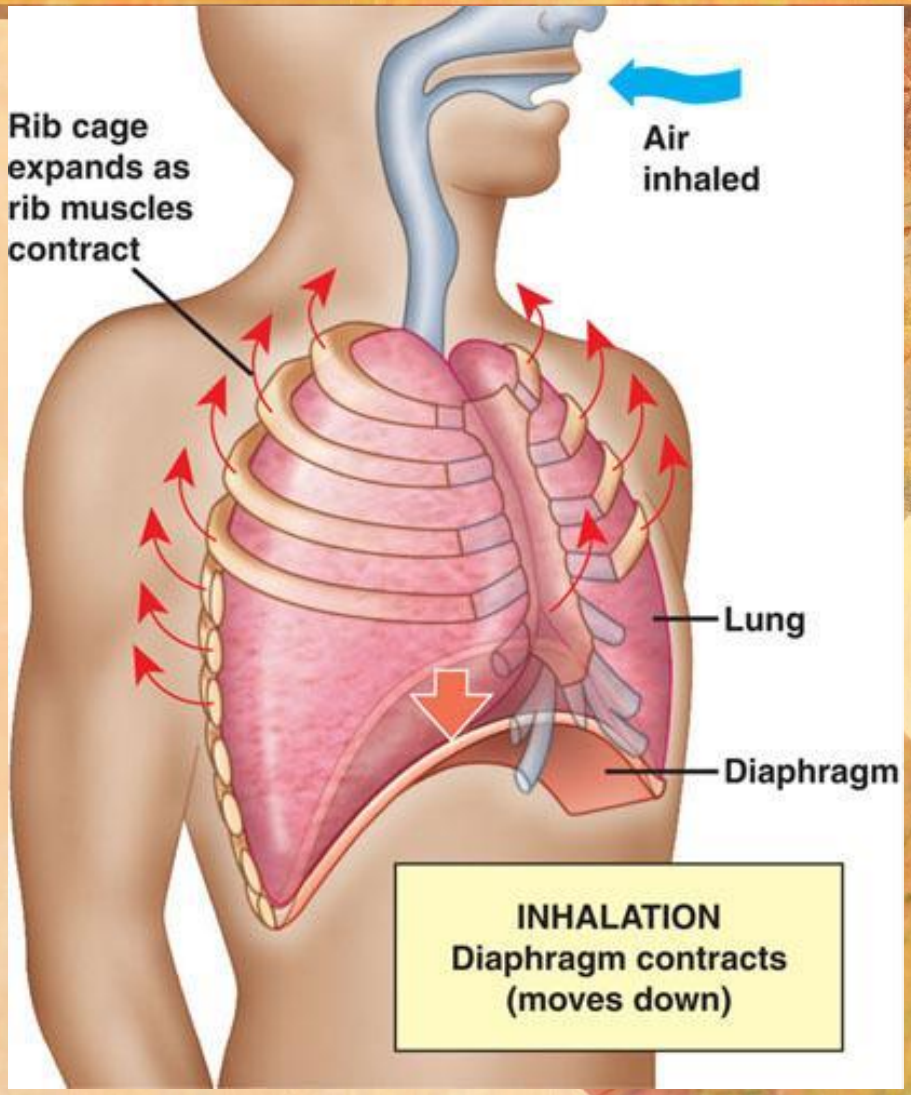


INHALING

The Diaphragm

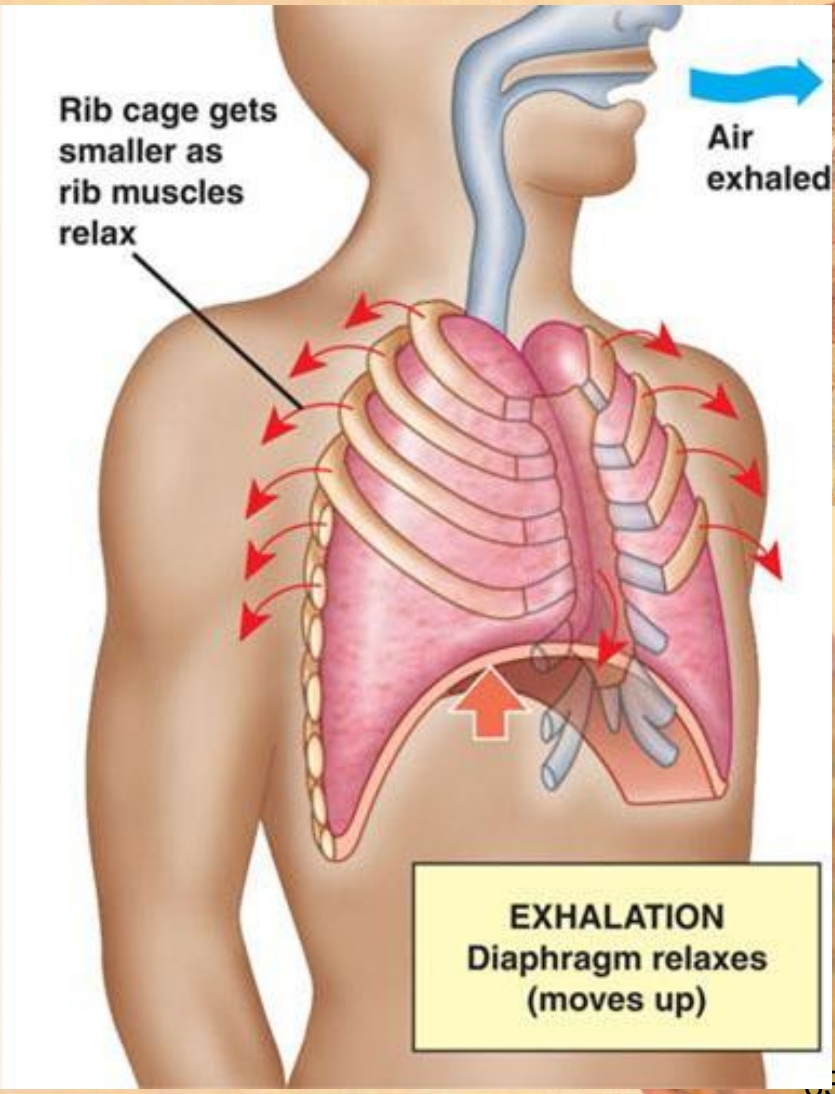
separates the abdominal cavity from the thoracic cavity & helps ventilate the lungs.

- Diaphragm lowers,
- **Rib Cage moves up and out;**
- Lungs expand,
- **air rushes in.**



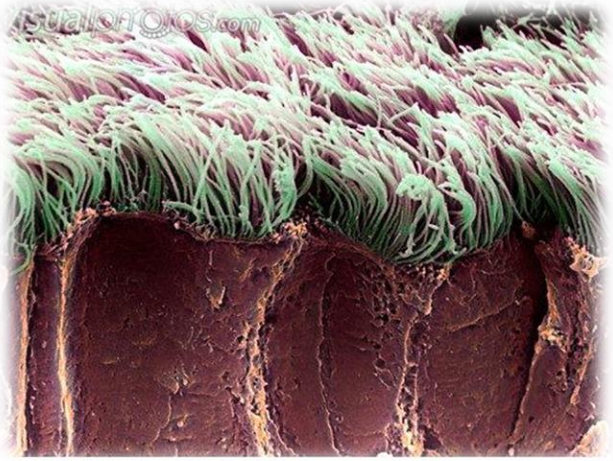
EXHALING

- Diaphragm relaxes and moves up,
- Rib Cage moves down and in;
- Pressure in the Lungs increases,
- and air is pushed out of the lungs.



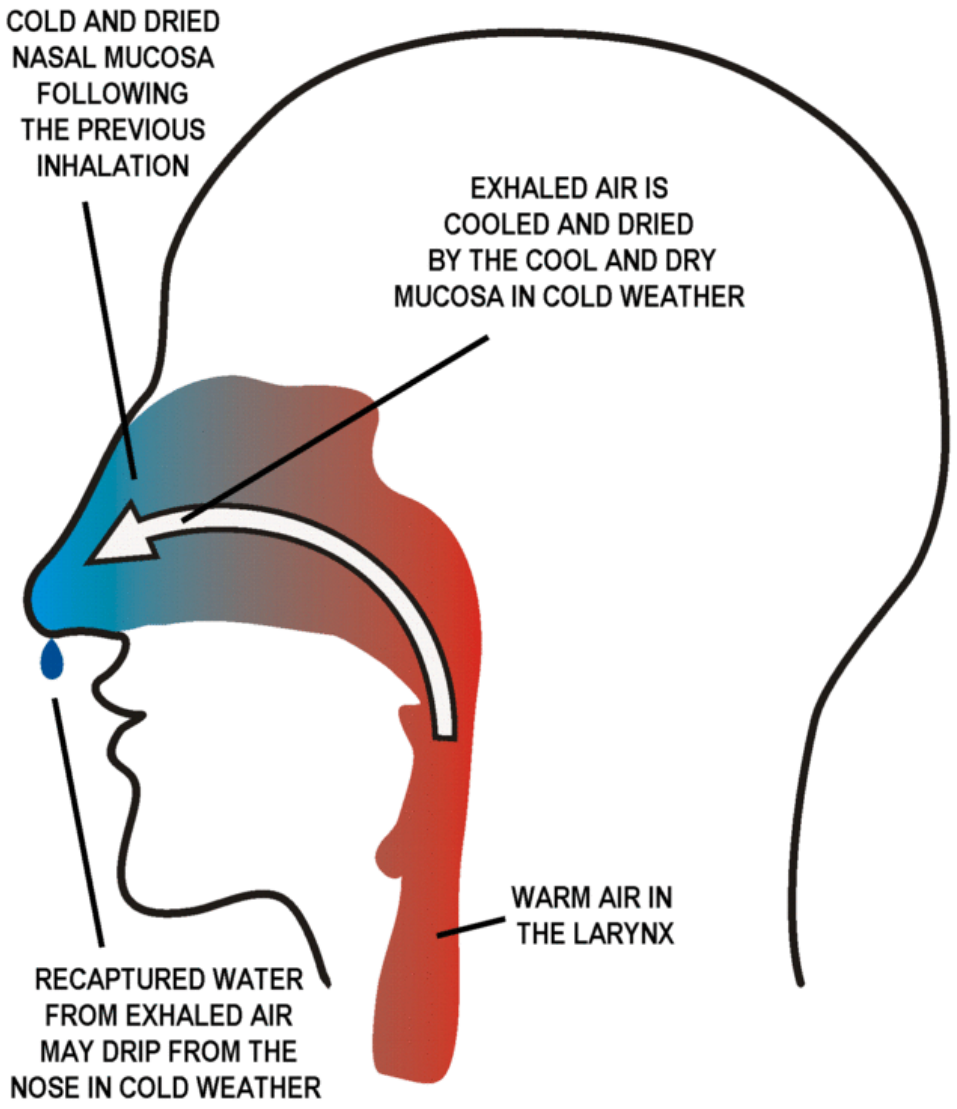
In humans, AIR is

- inhaled through the **Nostrils** into the **Nasal Cavity.**
- filtered by hairs and mucous surfaces.



- warmed and humidified.
- sampled for odors.

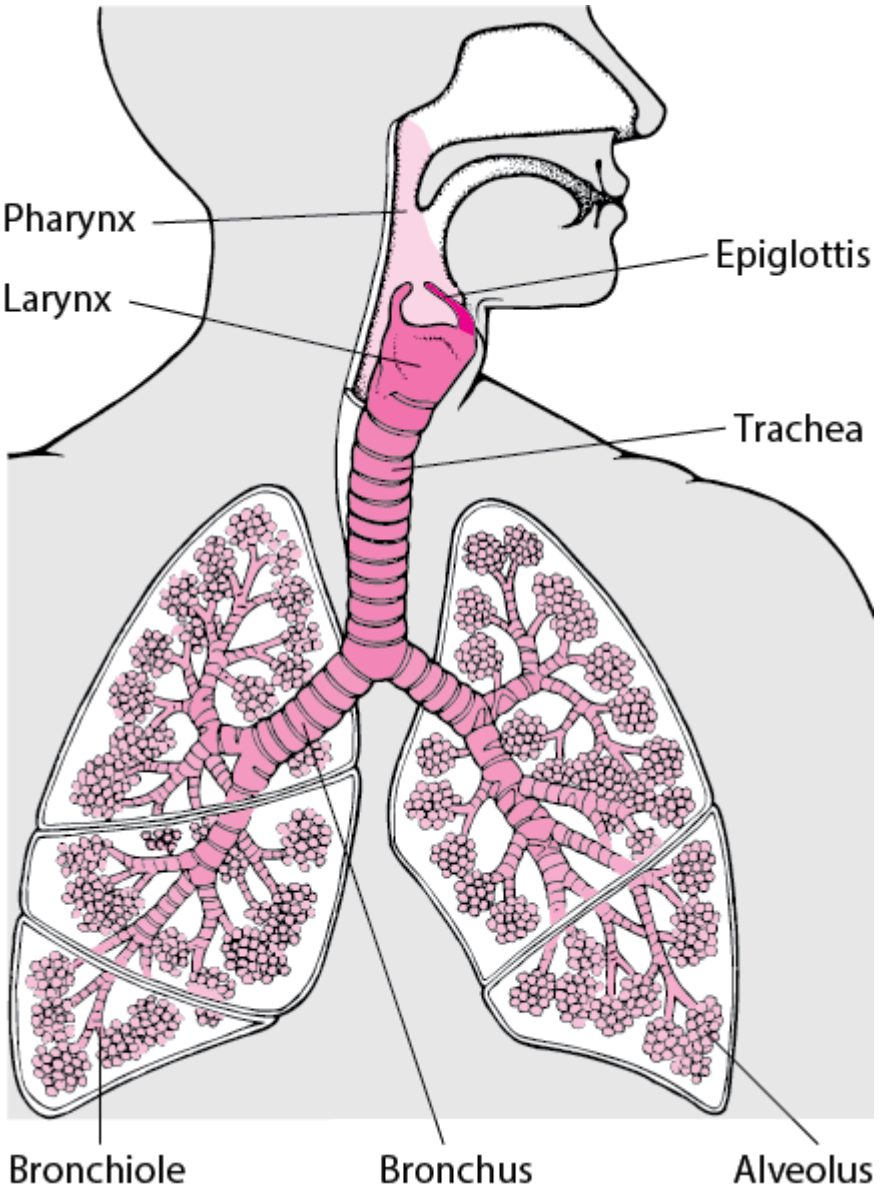
Pathway In



Pathway to the Lungs

From the **Nasal Cavity**, air next passes

- to the **Pharynx**,
- then to the **Larynx**, past the **Vocal Cords**,
- into the **Trachea**, held open by cartilage rings;
- into the paired **Bronchi**,
- into **Bronchioles**,
- to the **Alveoli**, grapelike clusters of air sacs, where **gas exchange** occurs.

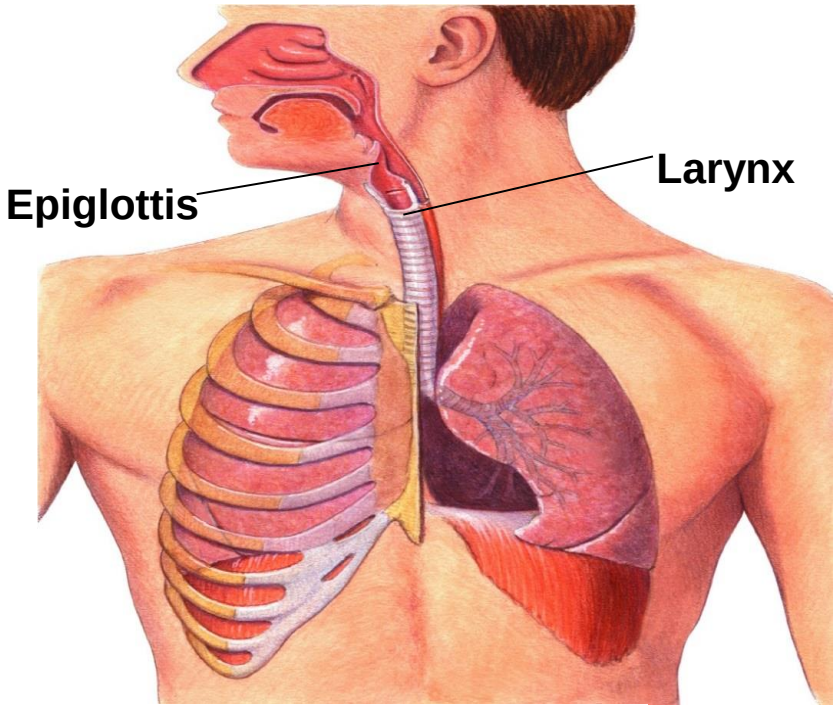


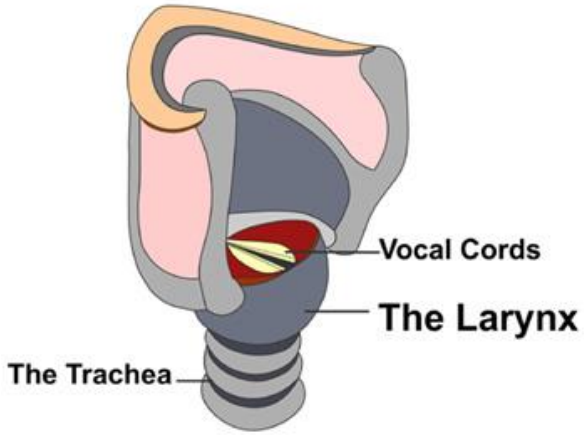
The Human Respiratory System

- The **epiglottis** covers the entrance to the trachea when you swallow.

At the top of the trachea is the **larynx** (voice box):

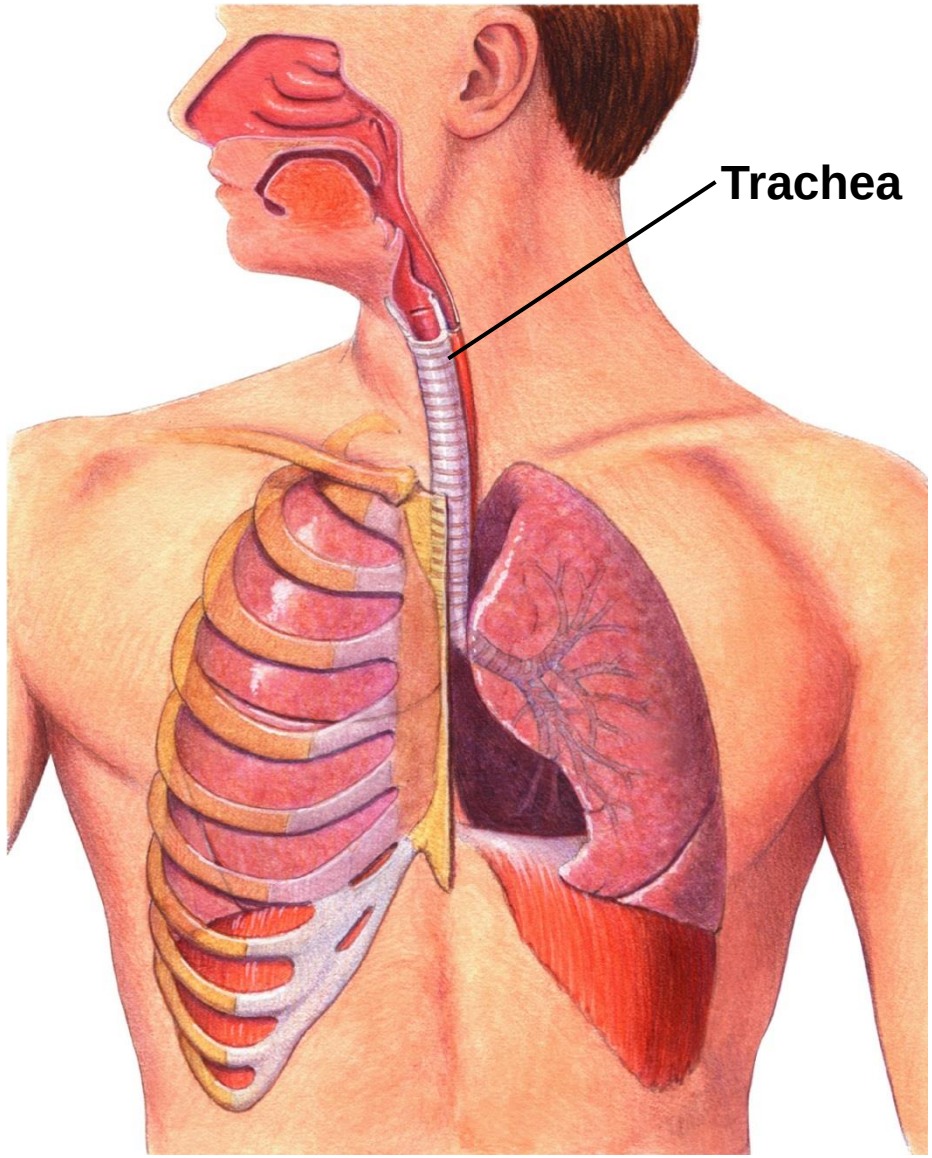
contains two elastic folds of tissue called **vocal cords.**





The Human Respiratory System

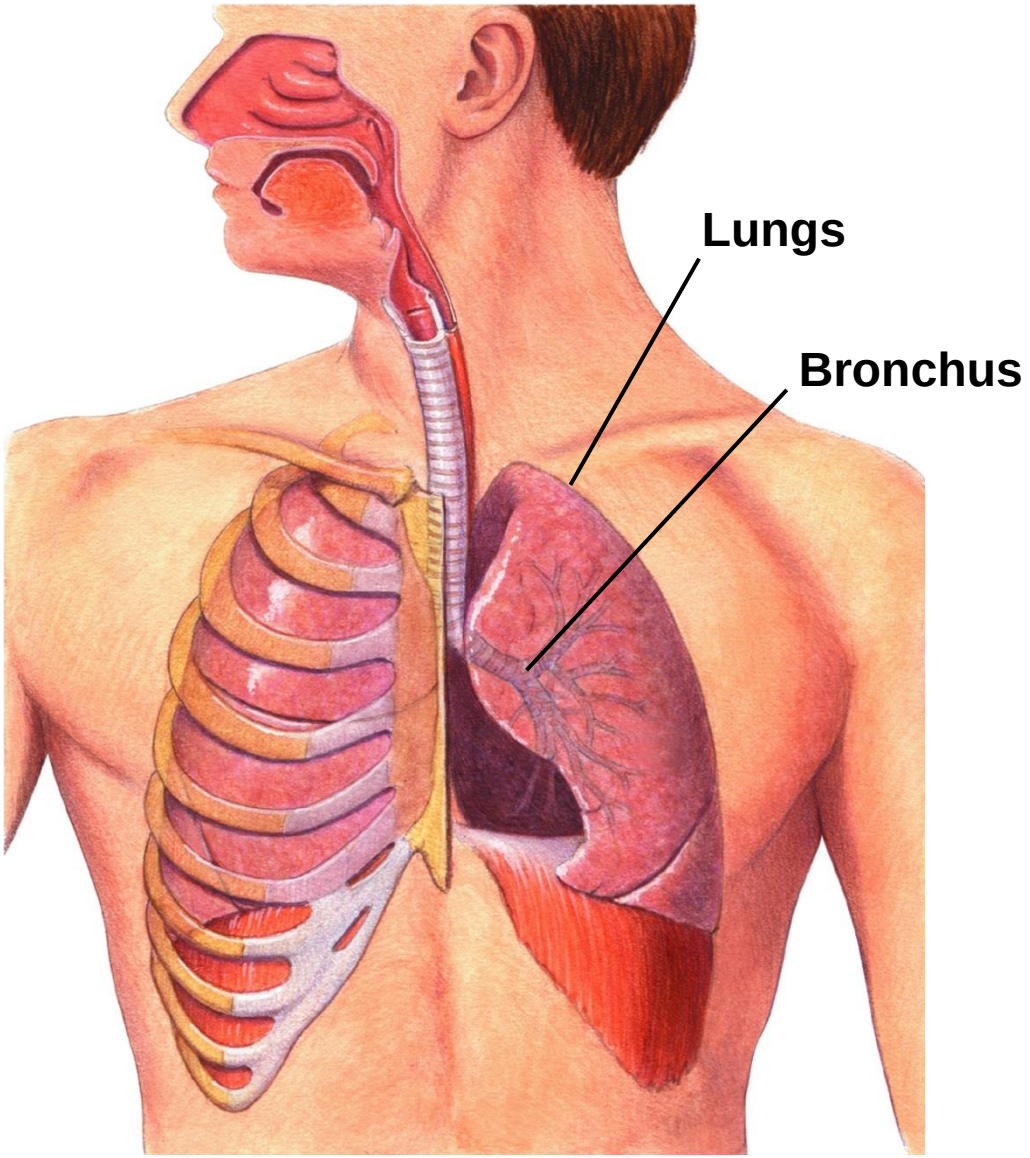
Air then moves into the **trachea** (windpipe).



The Human Respiratory System

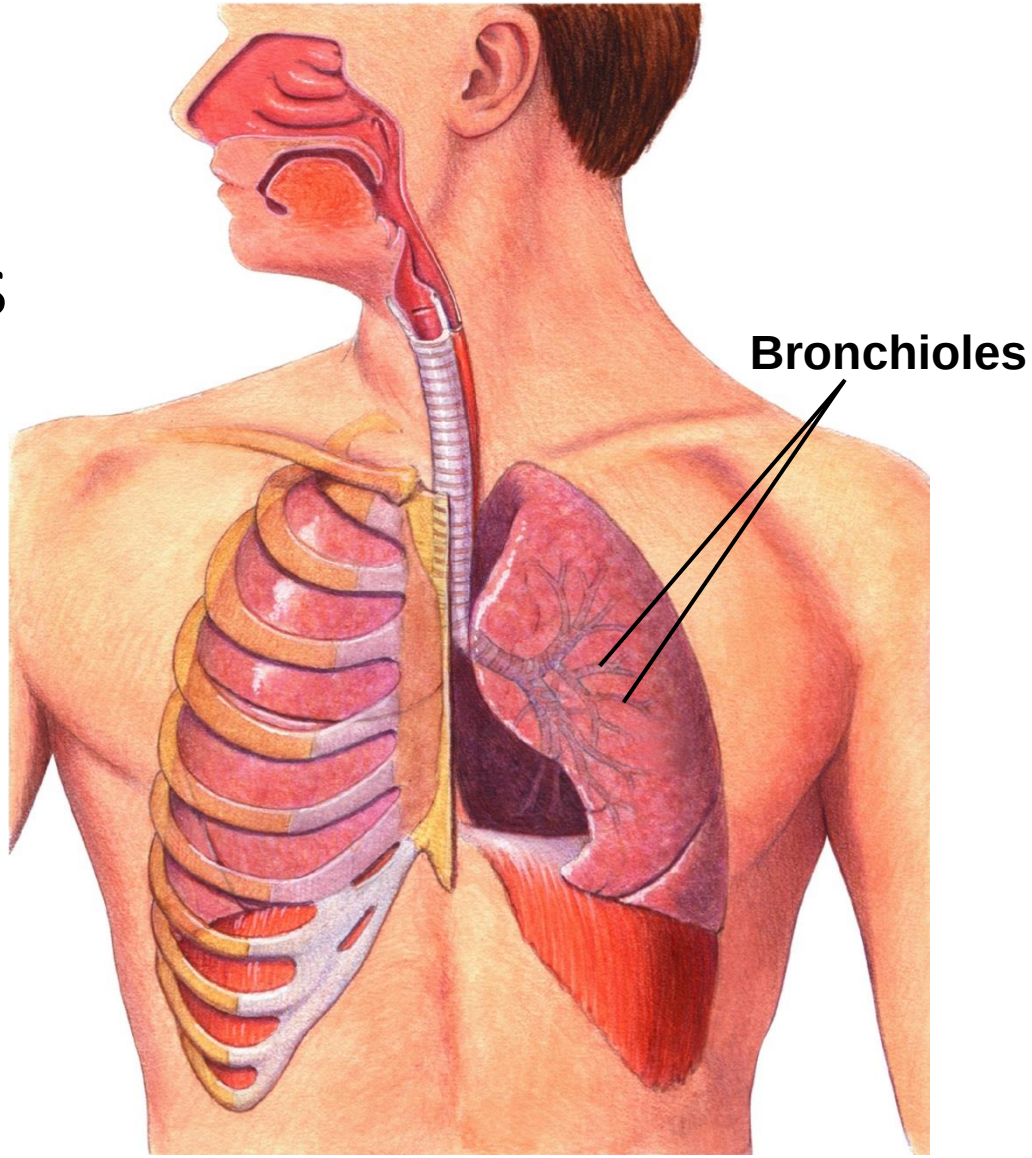
Air then passes through the trachea into two large passageways in the chest cavity called **bronchi**.

Each bronchus leads into one of the lungs.



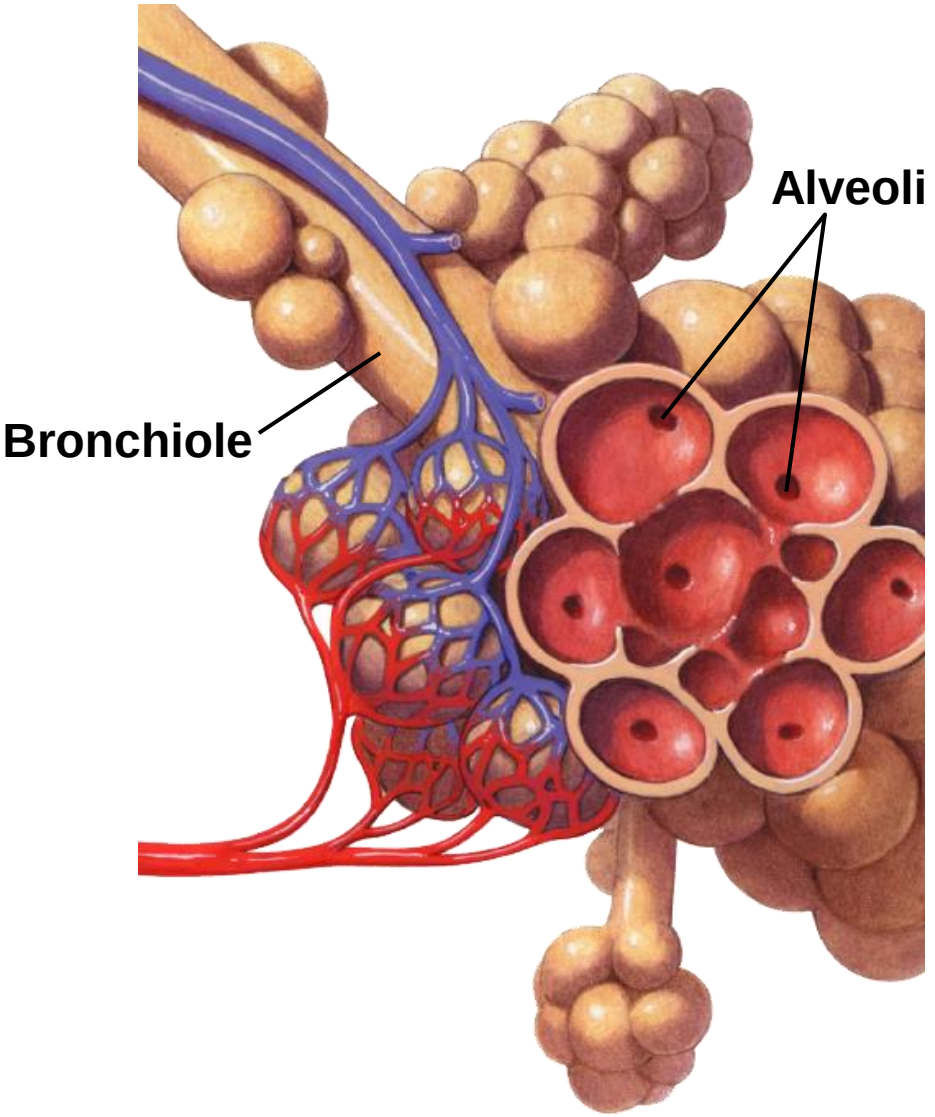
The Human Respiratory System

In each lung, the bronchus subdivides into smaller bronchioles.



The Human Respiratory System

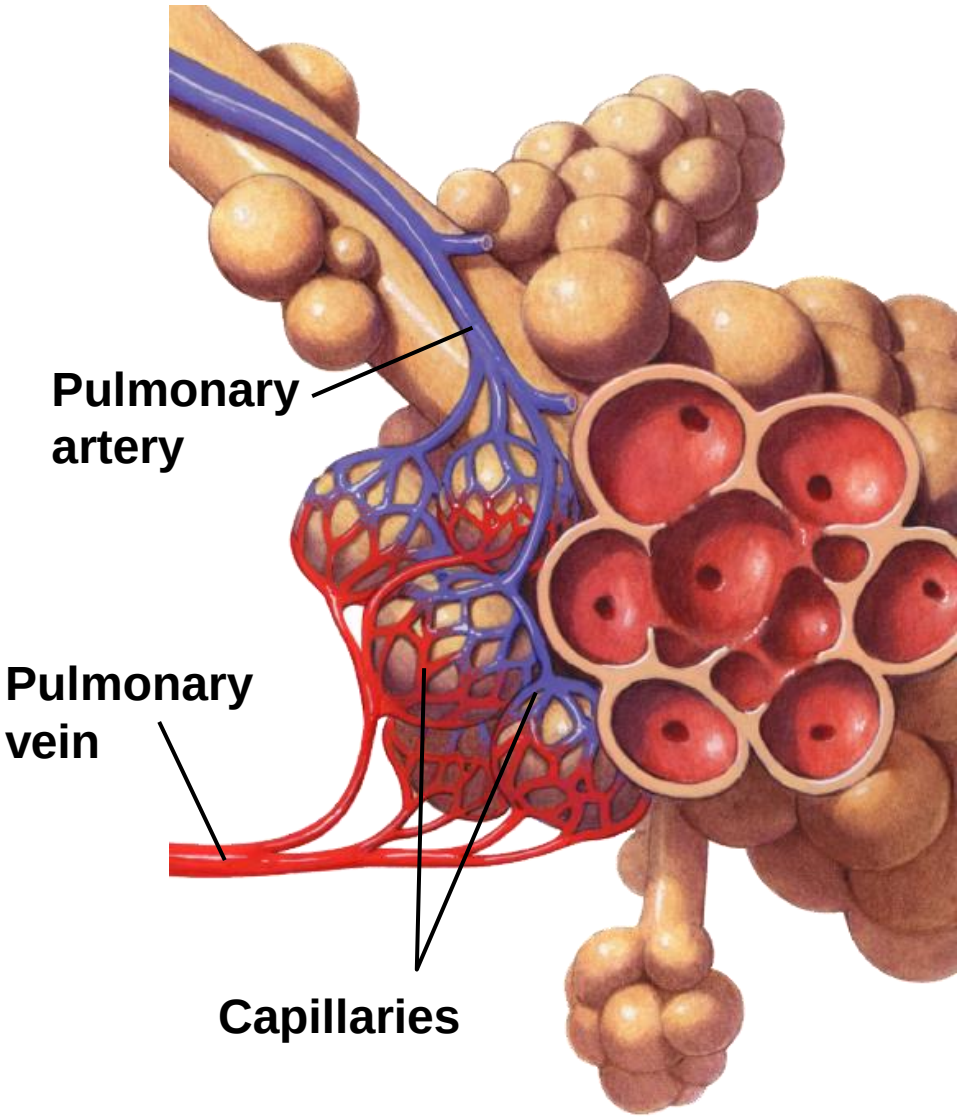
Bronchioles subdivide into millions of tiny air sacs called **alveoli** (s: alveolus).



The Human Respiratory System

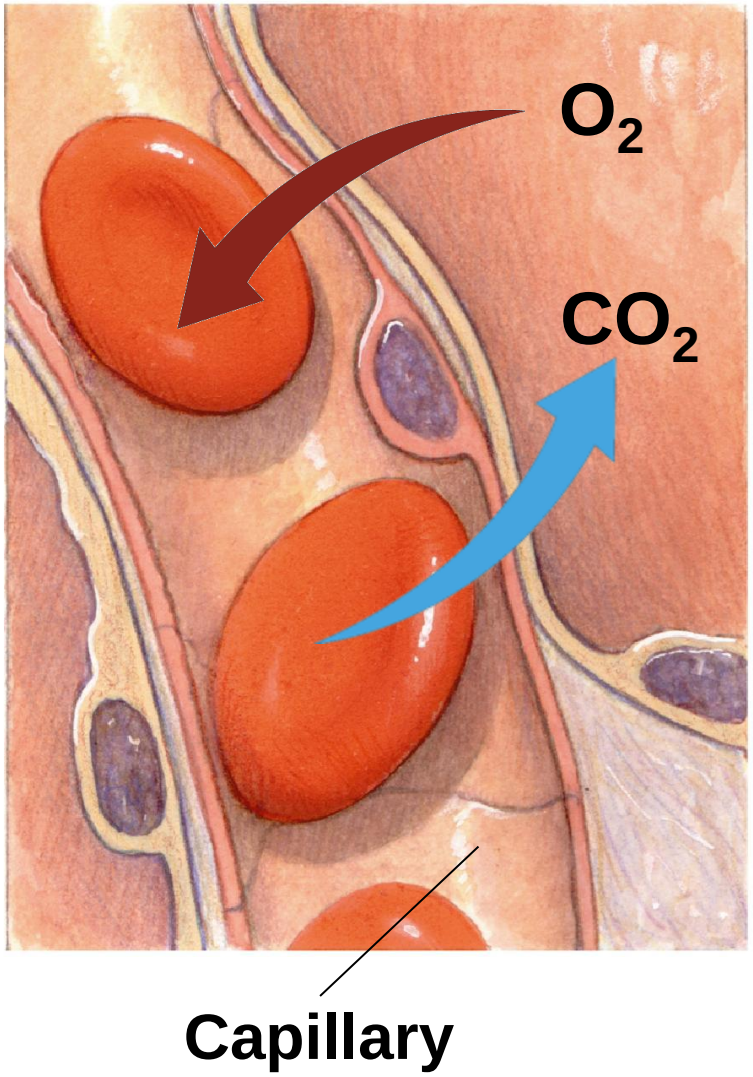
Alveoli are grouped in clusters.

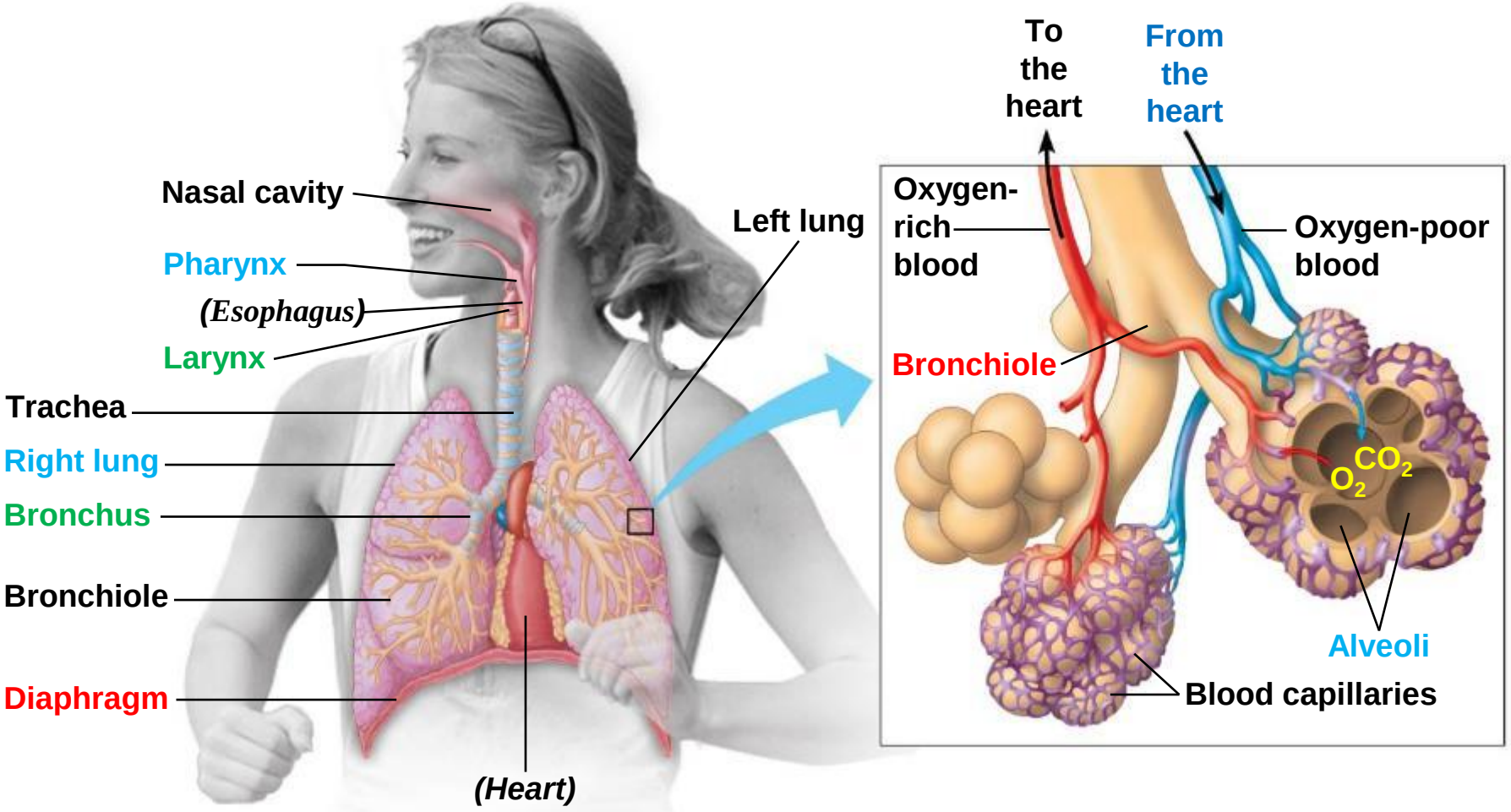
A network of **capillaries** surrounds each alveolus.



Alveoli: Gas Exchange

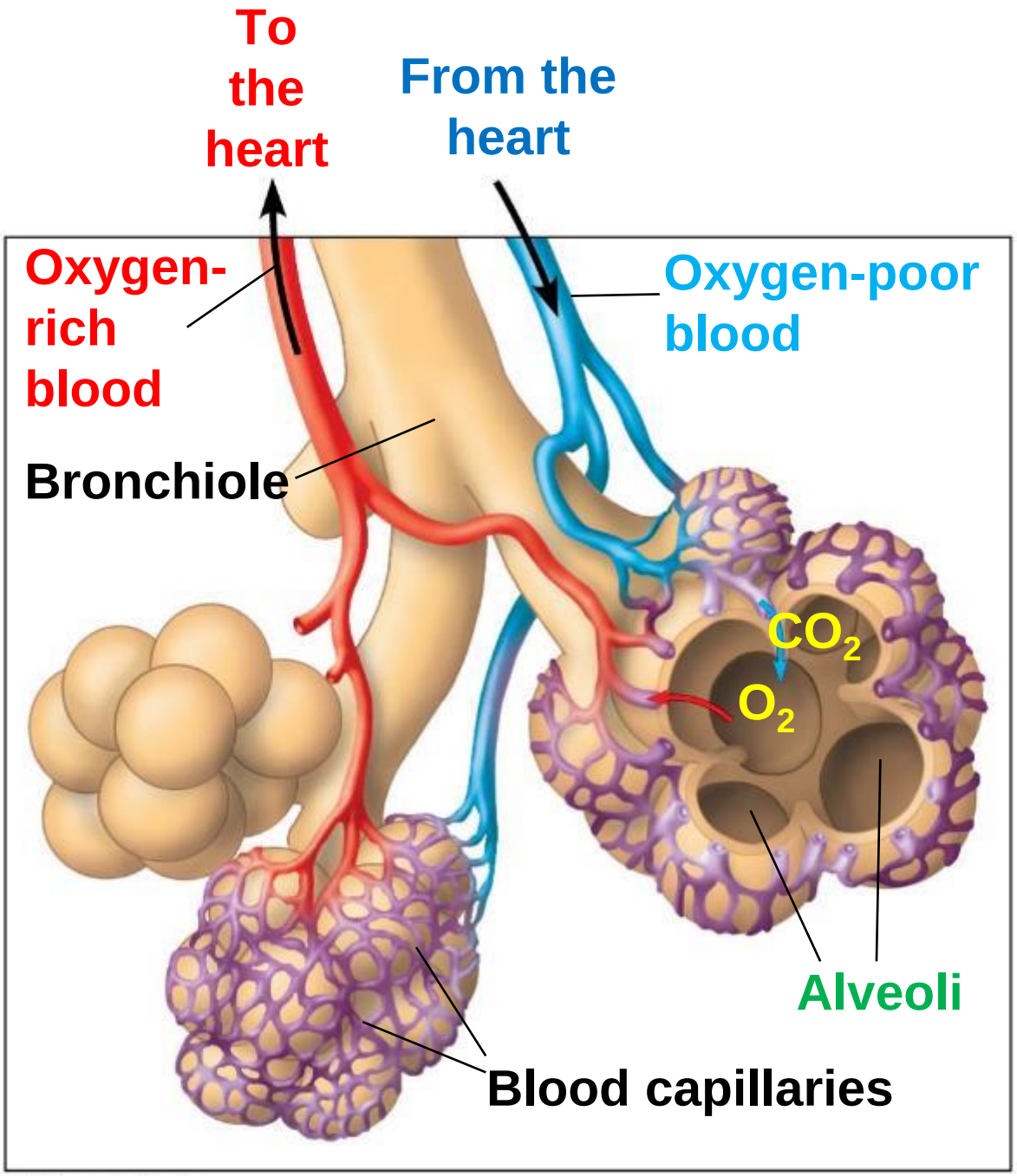
- Gas exchange takes place in the alveoli.
- **Oxygen** diffuses from the alveoli into the blood.
- **Carbon dioxide** diffuses from the blood into the alveolus.

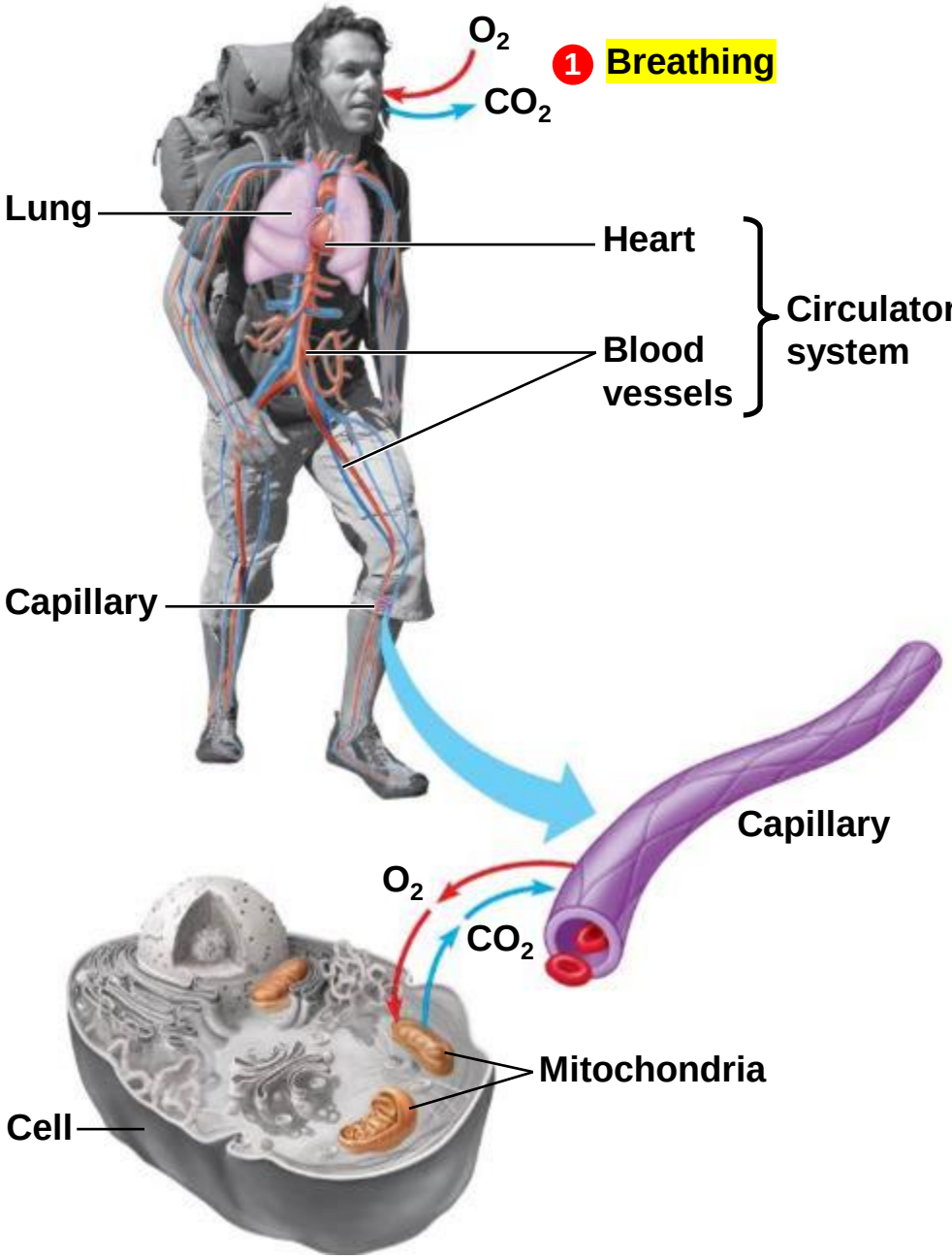



Nasal cavity
Pharynx
(Esophagus)
Larynx
Trachea
Right lung
Bronchus
Bronchiole
Diaphragm
(Heart)
Left lung
To the heart
From the heart
Oxygen-rich blood
Oxygen-poor blood
Bronchiole
CO_2
O_2
Alveoli
Blood capillaries

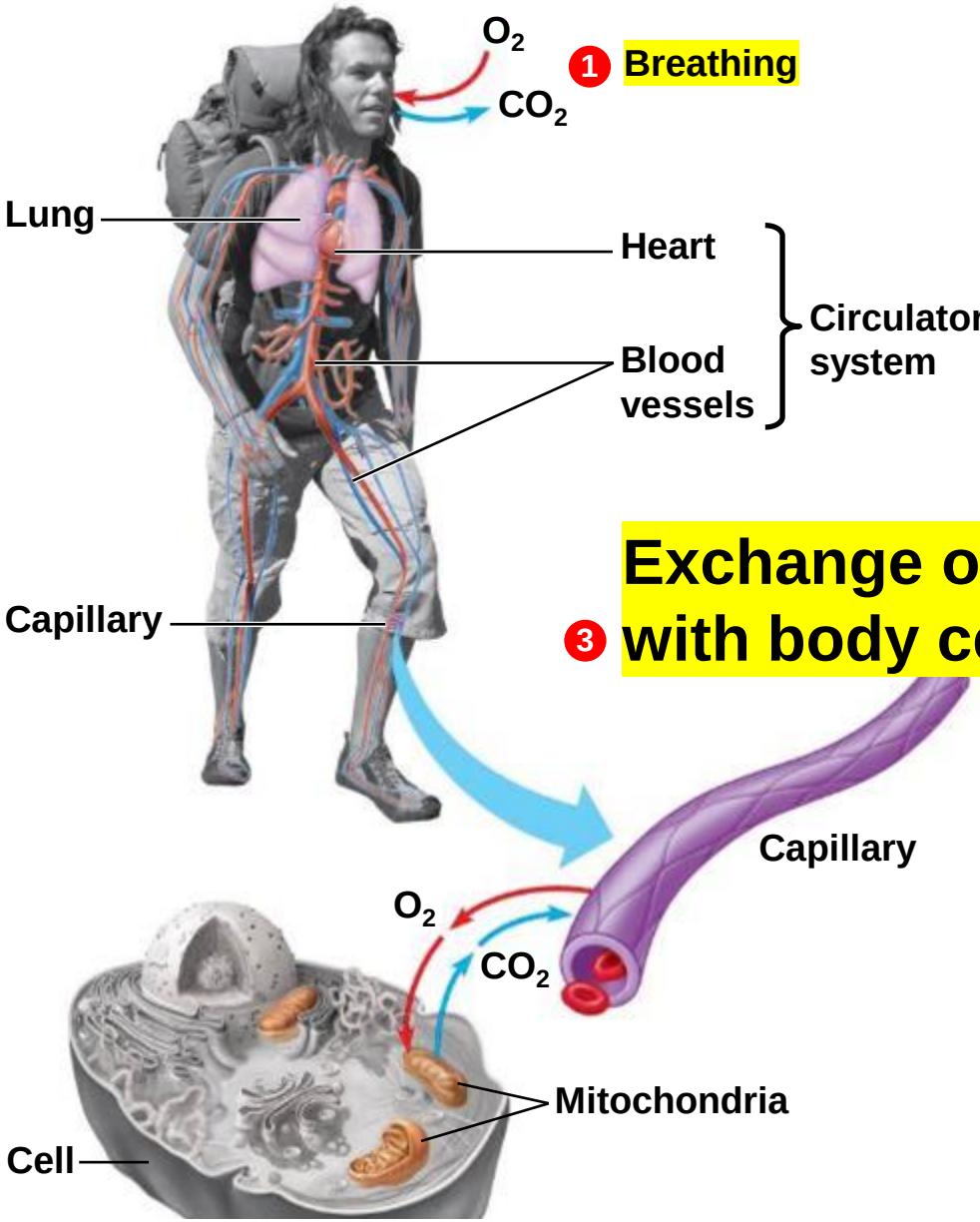
Gas Exchange

- **Alveoli** walls are only **one cell thick.**
- Many tiny **Capillaries** surround the alveoli; their walls are also **one cell thick.**
- In alveoli,
  - O_2 diffuses **into the blood.**
  - CO_2 diffuses **into the alveoli**.
- **Oxygen** in the air passes through the walls of both the alveoli and the capillaries to **enter the blood.**
- **Carbon Dioxide** in the blood can pass just as easily **into the alveoli.**


To the heart
From the heart
Oxygen-rich blood
Oxygen-poor blood
Bronchiole
CO_2
O_2
Alveoli
Blood capillaries



2 **Transport of gases by the circulatory system throughout the body.**



Cellular respiration

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + ATP$$