Human Body Systems: Maintaining Homeostasis

I. Nervous System Intro

A. The nervous system controls & coordinates all essential functions of the human body

B. Specialized cells (neurons) allow messages to be carried from one cell to another so all parts of the body can communicate efficiently

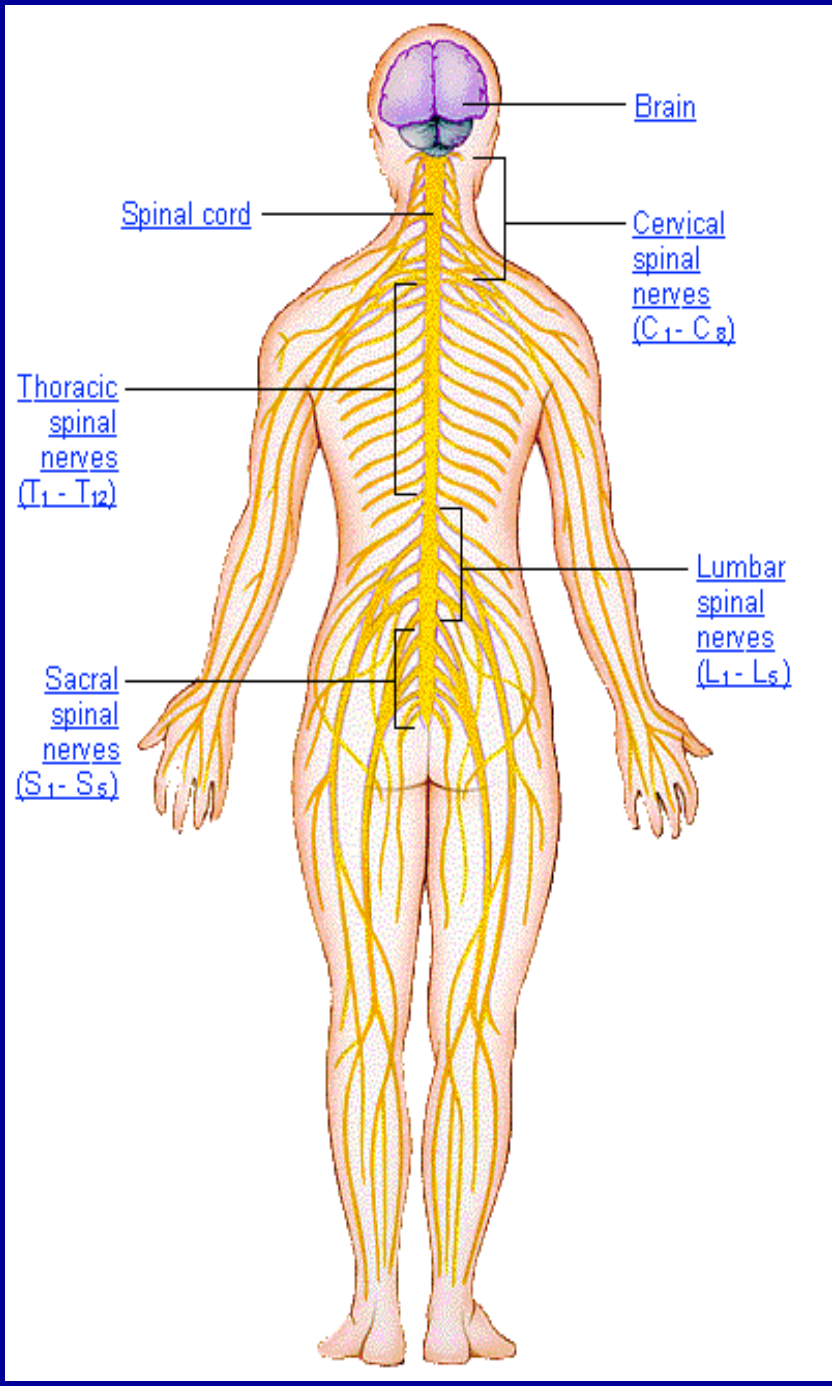
C. 4 functions of the nervous system:

1. Gathers info from the outside world & inside the body (senses)
2. Transmits info to the brain
3. Processes info to determine the best response (integrates)
4. Sends signals to muscles, glands, & organs so they can respond (motor)

II. Neurons

A. The nervous system is an enormous network of "one-way streets" (neurons)

-Nerve: bundle of many neurons




Human Nervous System
Dissected, mounted and labeled by two Students
in their sophomore year, during the term 1925-26,
at the Kirksville Osteopathic College
It represents a special project additional to the
work required by the College in Dissection.
To Dr. George M. Laughlin
in whom Osteopathic Education, as interpreted in
Kirksville, has found a champion second only to
its revered founder, this mount is respectfully dedicated
material and moral endeavors
The Kirksville Osteopathic College
With the compliments of the Dissectors:

B. 3 types:

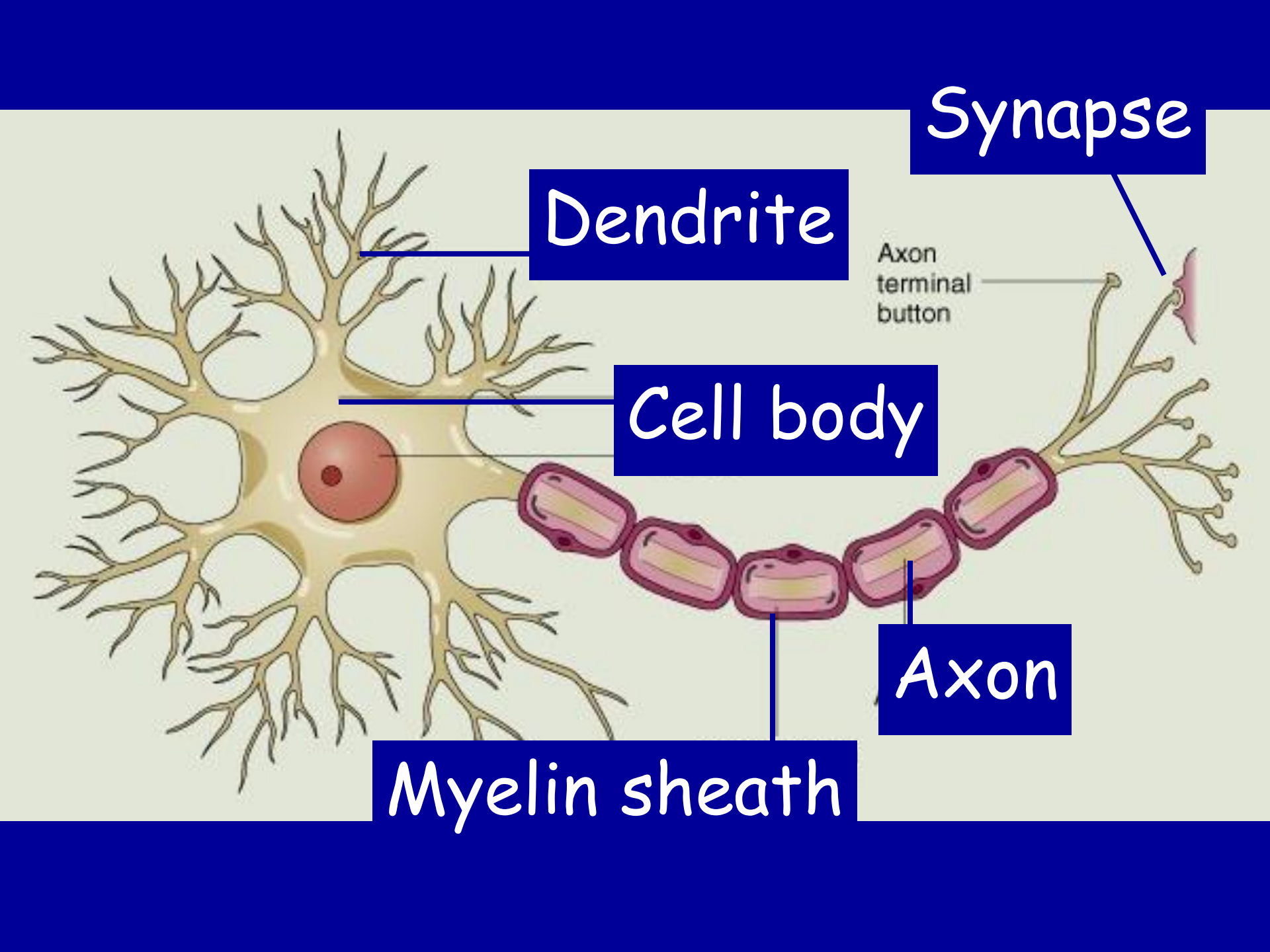
1. Sensory neurons: receptors detect changes and send info to the brain
2. Motor neurons: carry signals from brain to muscles & glands
3. Interneurons: carry impulses between sensory & motor neurons

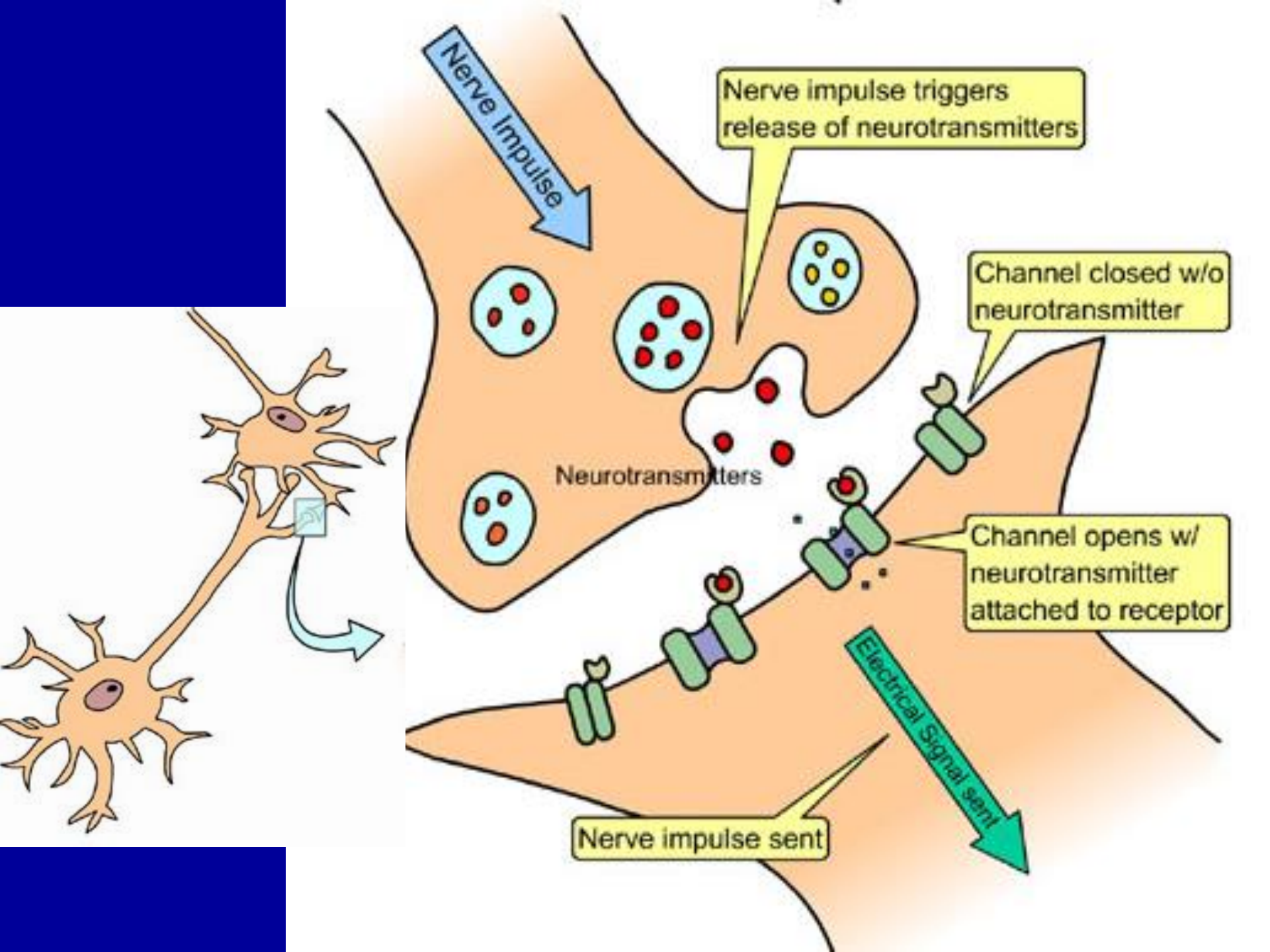
C. A neuron consists of 3 main parts:
   1. Cell body: contains nucleus & cytoplasm, where most cell functions take place
   2. Dendrites: branches spreading from cell body; receive stimulus and carry impulse to cell body
   3. Axon: fiber that carries impulses away from the cell body

D. Neurons may have dozens of dendrites, but only one axon

E. Myelin sheath: a lipid layer covering the axon; acts to insulate and speed up impulses
   - fat intake is essential during early childhood and pregnancy when the brain is developing

F. Synapse: gap between 2 neurons

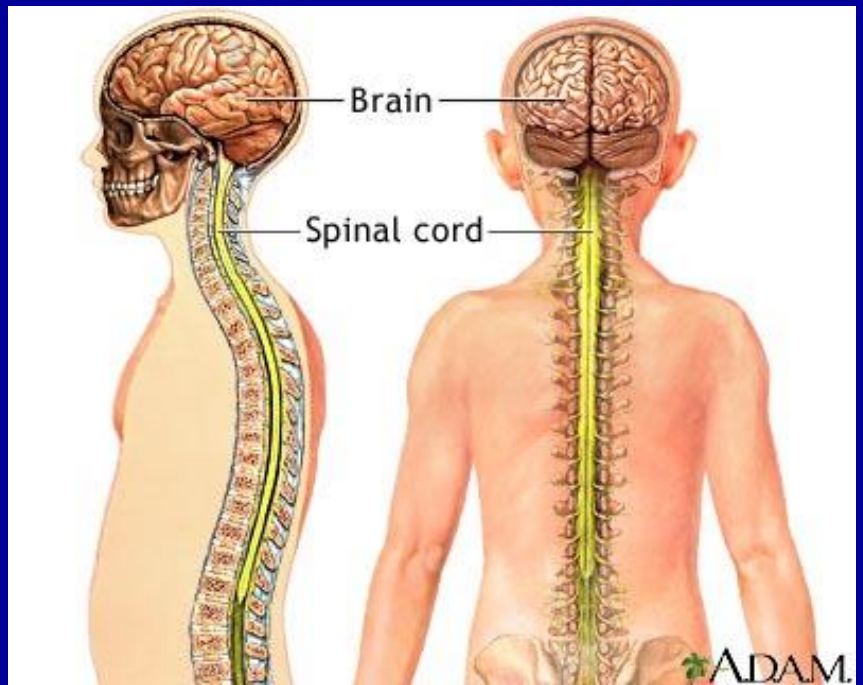

Synapse
Dendrite
Axon terminal button
Cell body
Axon
Myelin sheath

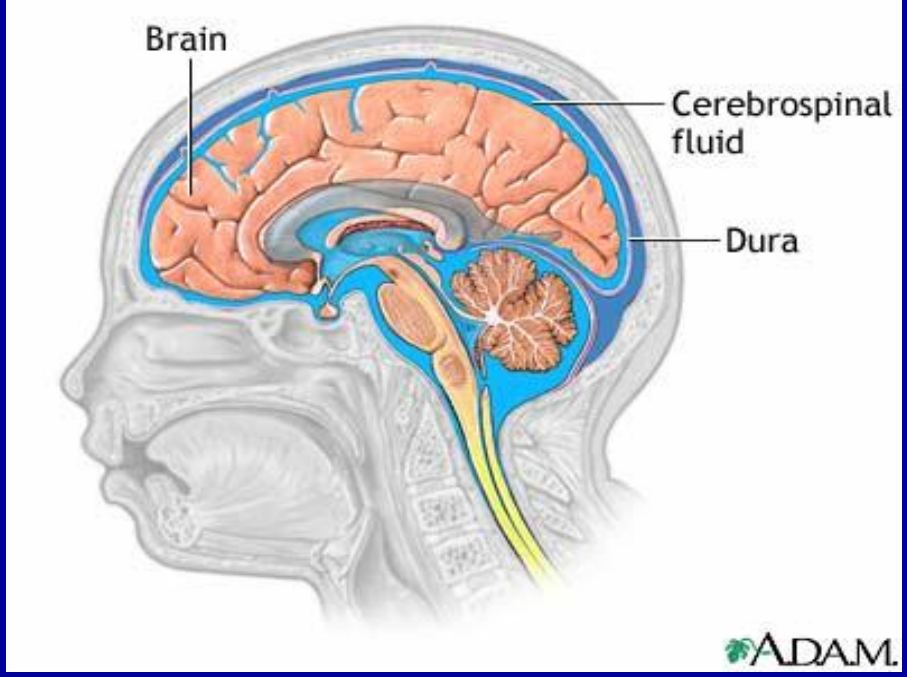

Nerve Impulse
Nerve impulse triggers release of neurotransmitters
Channel closed w/o neurotransmitter
Neurotransmitters
Channel opens w/ neurotransmitter attached to receptor
Electrical Signal sent
Nerve impulse sent

III. Central nervous system

A. Processes information and relays messages -- no contact with environment

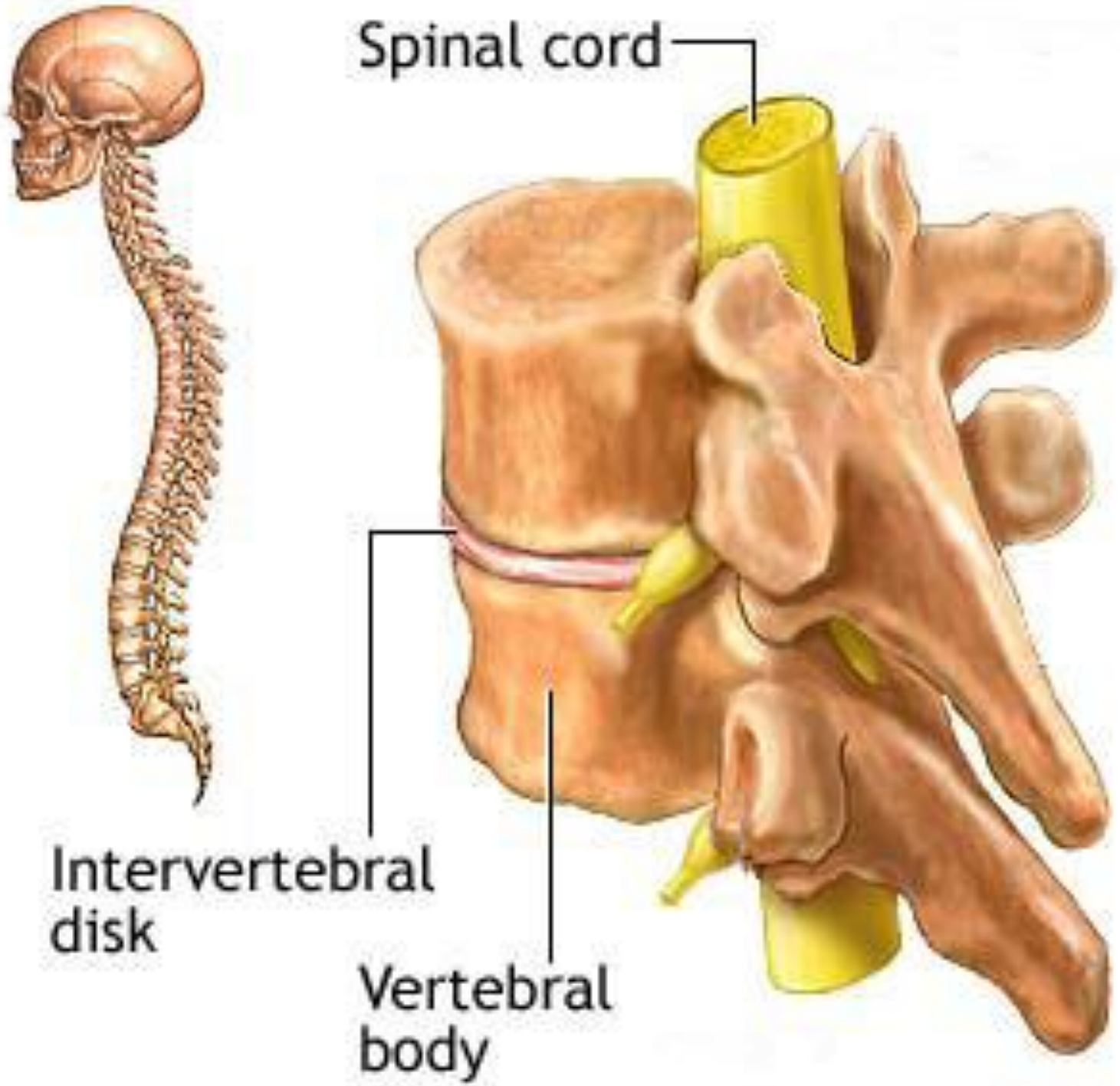
B. Brain & spinal cord

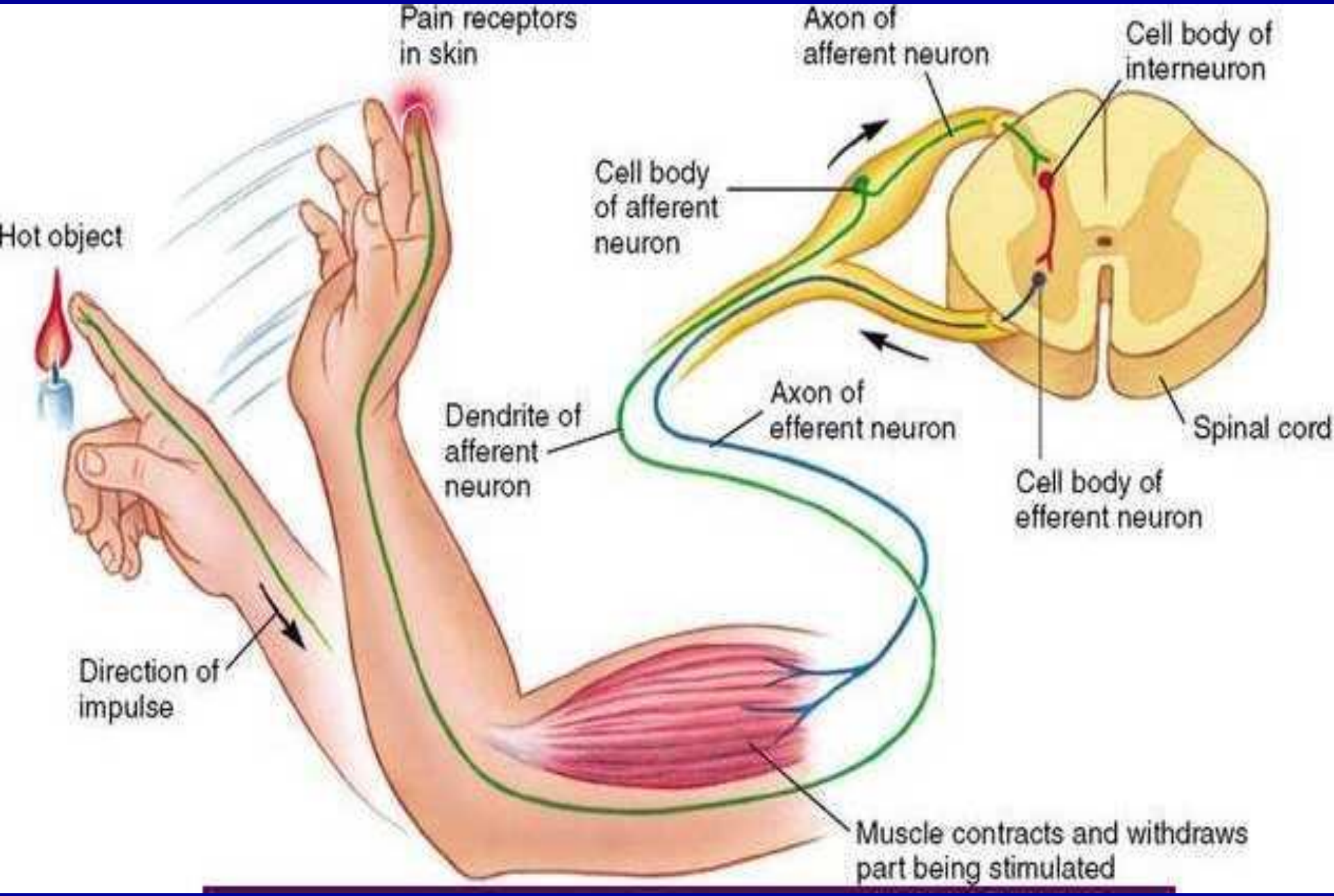




C. The brain
   1. has 100 billion neurons
   2. weighs about 3 pounds
   3. protected by skull, cerebrospinal fluid (CSF), and meninges (protective tissue)

D. Spinal cord - pencil thick & 18" long
   1. Link between brain and body
   2. 31 pairs of spinal nerves carry impulses to muscles & glands
   3. Sensory neurons carry impulses from receptors to the spinal cord
   4. Controls Reflexes


Spinal cord
Intervertebral disk
Vertebral body


Pain receptors in skin
Axon of afferent neuron
Cell body of interneuron
Cell body of afferent neuron
Hot object
Dendrite of afferent neuron
Axon of efferent neuron
Spinal cord
Cell body of efferent neuron
Direction of impulse
Muscle contracts and withdraws part being stimulated

IV. Peripheral nervous system

(31 Pairs Spinal nerves – 12 Pairs Cranial Nerves)

A. Sensory signals in, motor signals out

B. Motor functions divided:

1. Somatic nervous system: activities that are under conscious control
2. Autonomic nervous system: regulates involuntary functions

V. Digestion Overview

A. Purpose of digestion

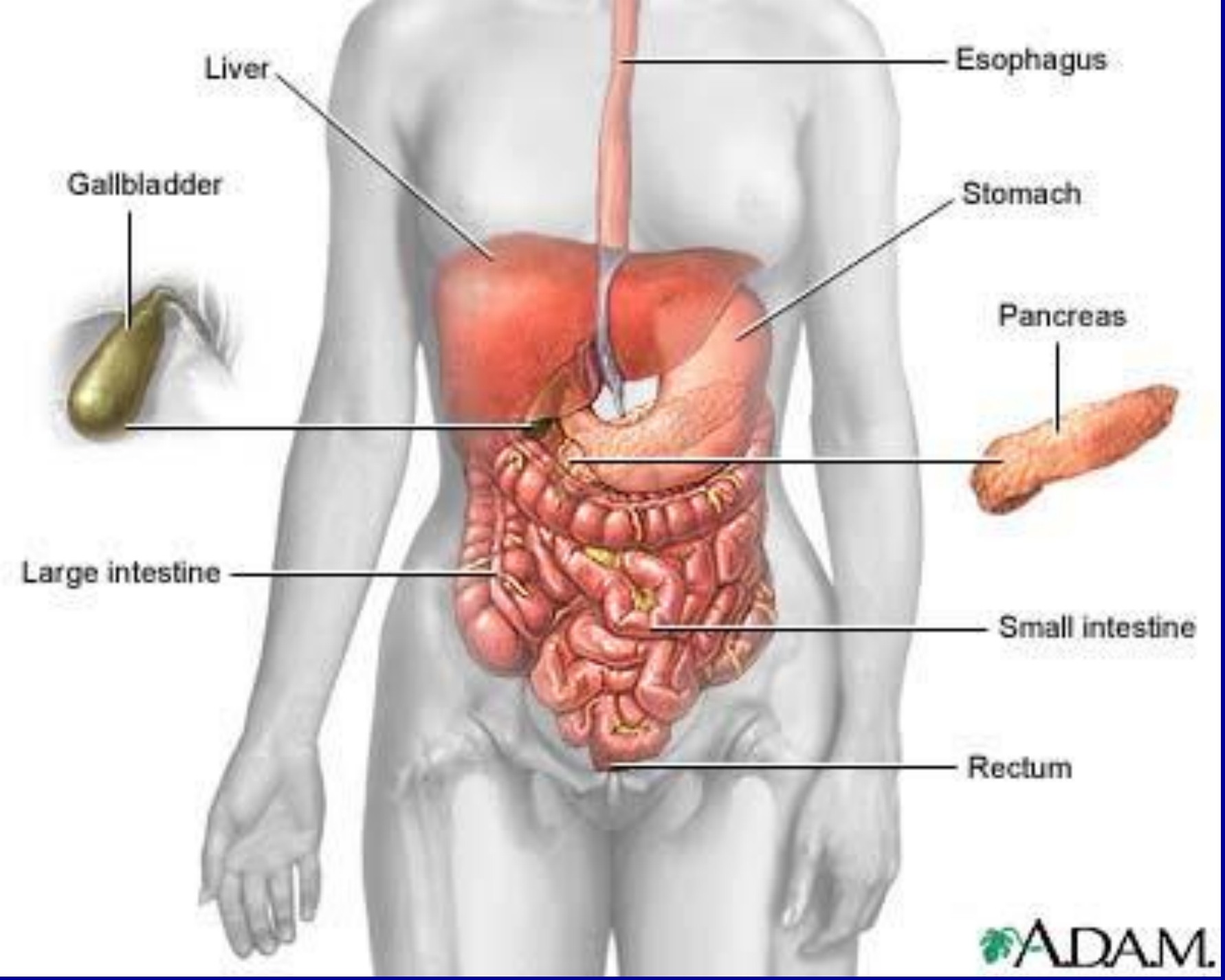
1. break down food molecules small enough so they can diffuse into cells and be absorbed.

B. Pharynx (Throat)
   1. Passageway for both food and air
   2. Splits in two:
      a) Trachea - tube that brings air to and from the lungs
      b) Esophagus - tube that takes food to stomach
   3. Epiglottis - flap of tissue that covers trachea while swallowing

C. Stomach- Expandable Muscular Sac that churns food and chemically digest Proteins -Has HcL - Ulcers

D. Small Intestine- Chemically breaks food down and absorbs nutrients into blood

E. Large Intestine- Takes undigested food and absorbs water into blood - removes undigested food from body


Liver
Esophagus
Gallbladder
Stomach
Pancreas
Large intestine
Small intestine
Rectum
A.D.A.M.

F. Pancreas- Produces juice with many digestive enzymes – releases this juice into Small Intestine

G. Liver- Produces Bile (Breaks down Fats) and releases Bile into Gall Bladder

H. Gall Bladder-Releases Green Bile into Small Intestine

VI. Intro to the circulatory system

A. delivers materials to & from cells

B. What materials: nutrients, O_2, CO_2, H_2O, wastes, hormones

C. some organisms rely on diffusion to transport materials

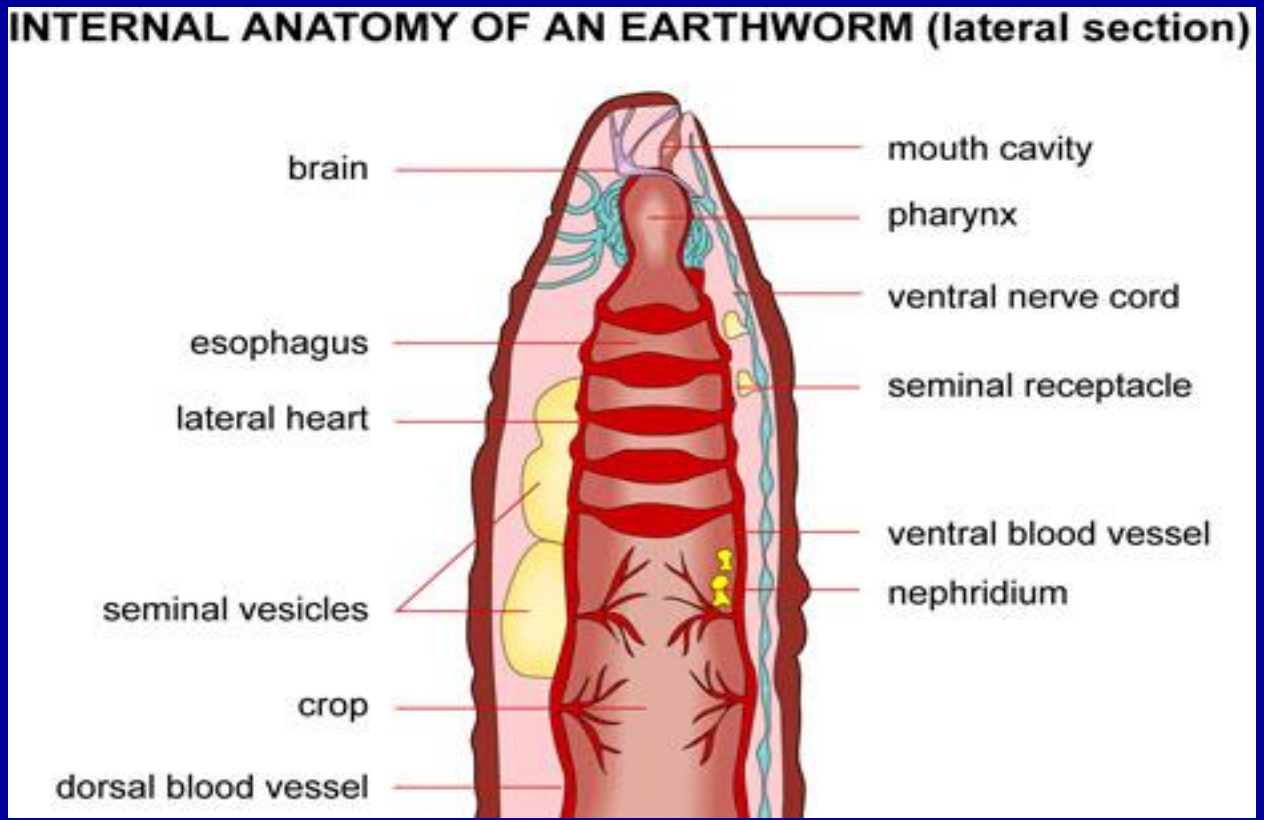
1. Limits their size(Thickness)
2. E.g. jellyfish, unicellular organisms, flatworms

D. Simple heart with open circulatory system

1. Blood is not always in blood vessels
2. Blood leaves heart in Blood Vessels
3. Blood DIFFUSES back to Heart
4. Insects, Clams, Crayfish…

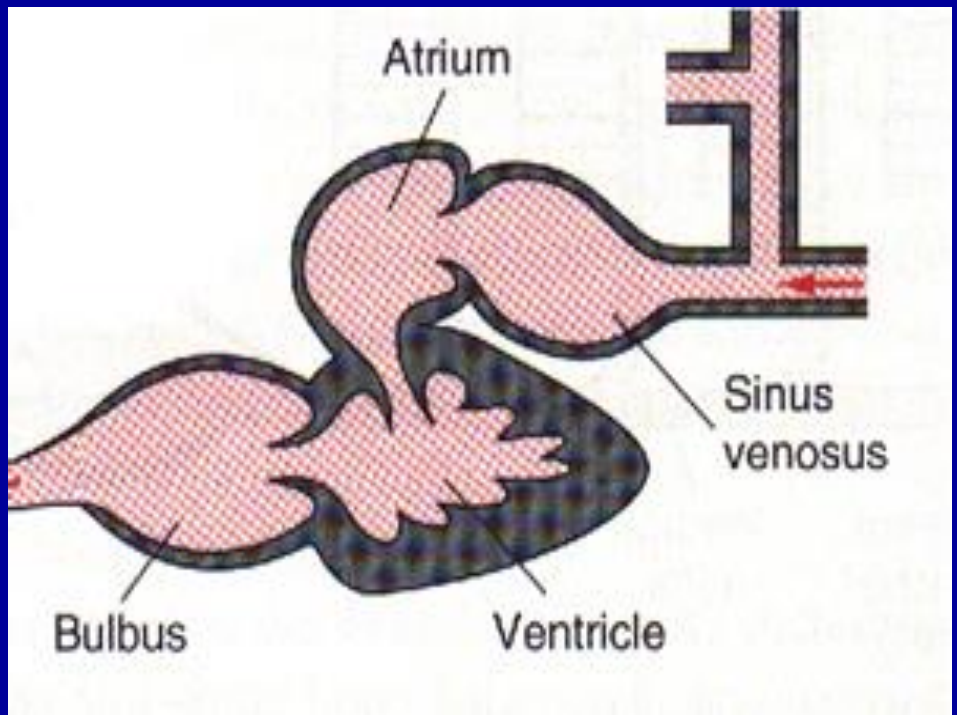
E. Simple heart with a closed circulatory system

1. Blood is always in blood vessels
2. E.g. earthworm, octopus



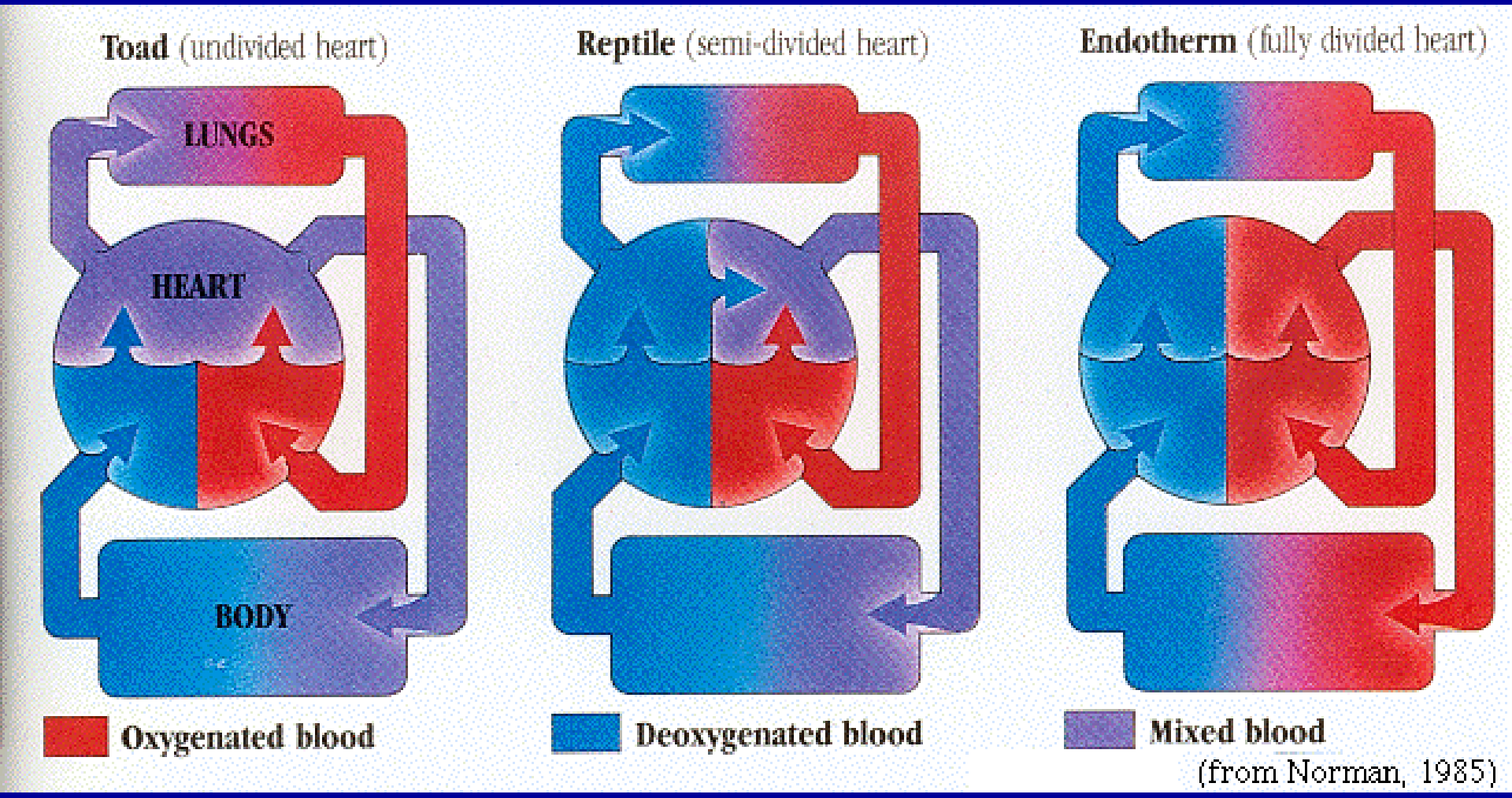
F. 2-chamber heart

1. Atrium: collecting chamber
2. Ventricle: pumping chamber
3. Blood pumped past the gills to pick up oxygen, then to the body
4. E.g. fish



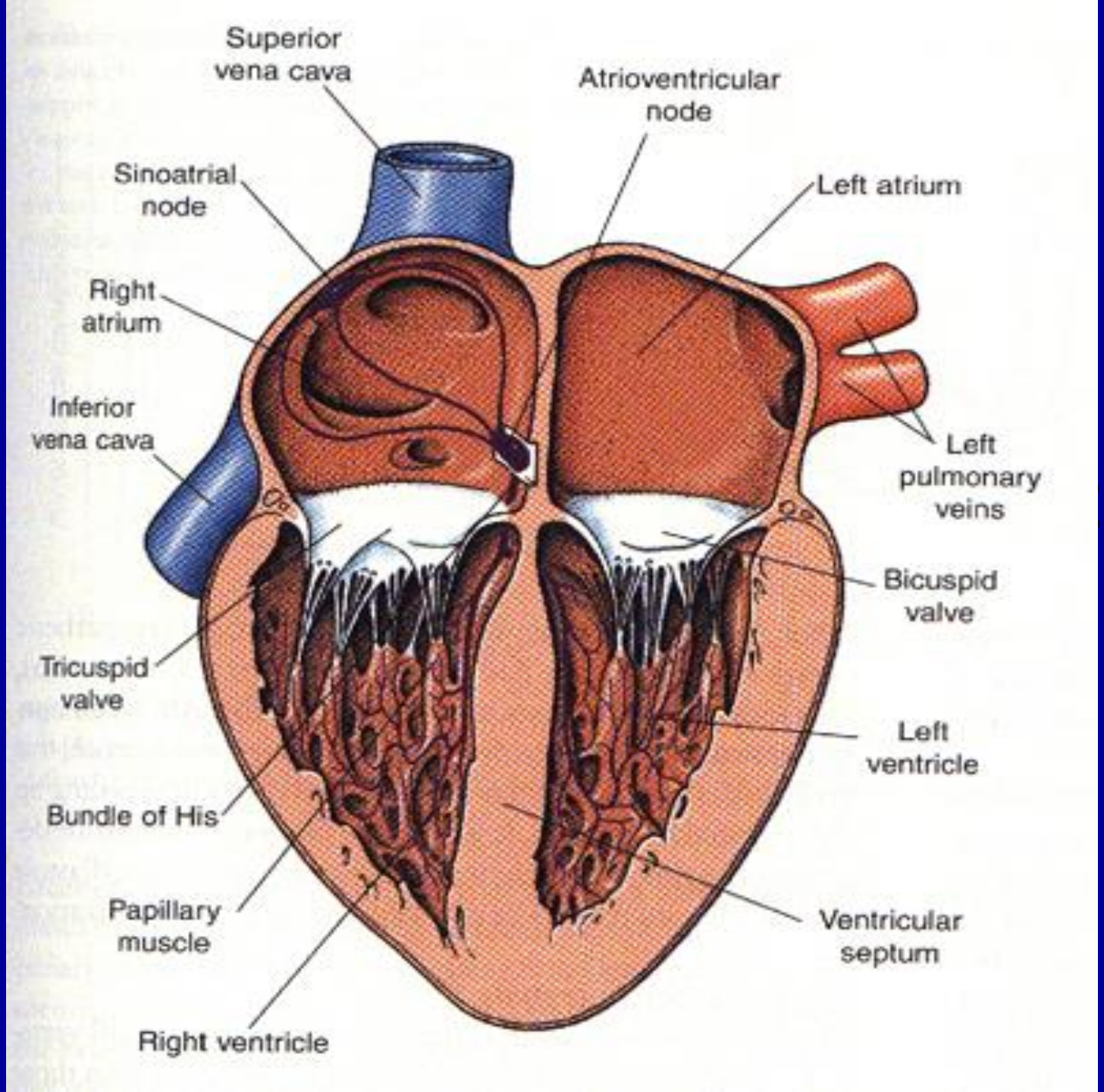
G. 3-chamber heart

1. 2 atria
   a) O_2 rich blood from lungs/gills
   b) O_2 poor blood from body
2. Blood mixes in the ventricle and gets pumped to lungs & body
   inefficient to have mixing
3. E.g. amphibians, some reptiles



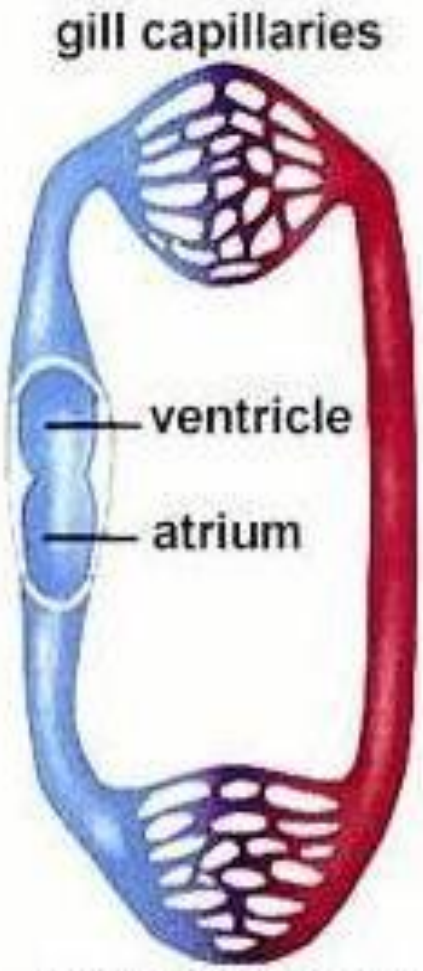
(from Norman, 1985)

H. 4-chamber heart
   1. 2 atria & 2 ventricles
   2. One side takes O_2 rich blood from lungs and pumps it to body
   3. Other side takes O_2 poor blood from body & pumps it to lungs
   4. Most efficient system
   5. E.g. Birds & mammals

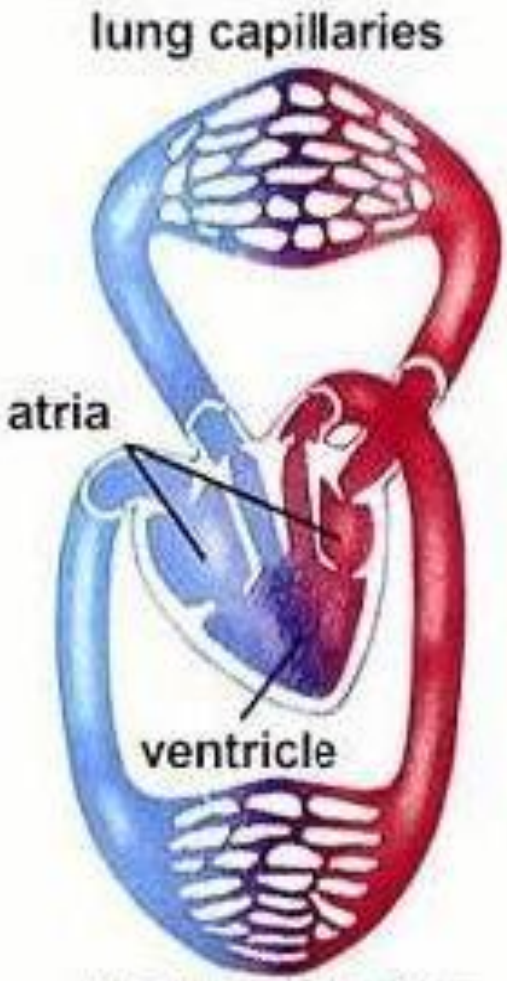

Superior vena cava
Atrioventricular node
Sinoatrial node
Left atrium
Right atrium
Inferior vena cava
Left pulmonary veins
Bicuspid valve
Tricuspid valve
Left ventricle
Bundle of His
Papillary muscle
Ventricular septum
Right ventricle

)

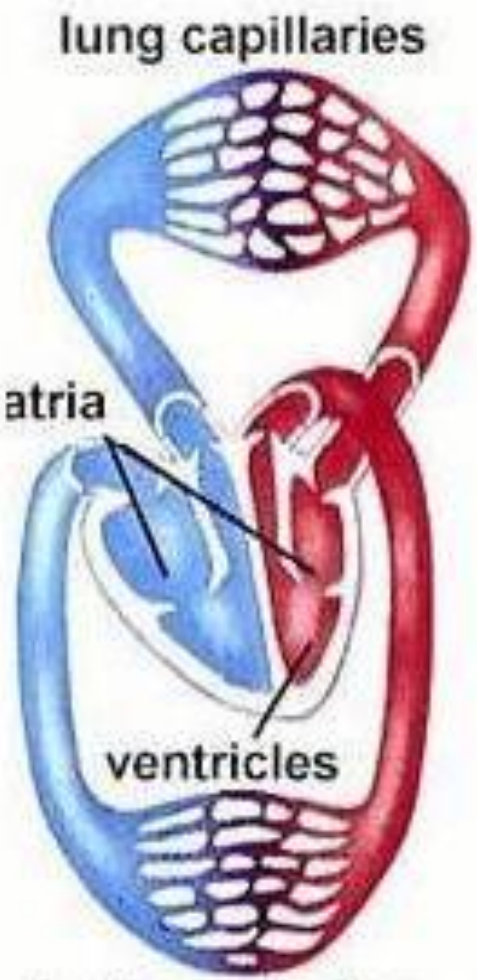
Fish Heart:
One Atrium,
One Ventricle,
"Single Circulation"



b) Reptile/Amphibian Heart:
Two Atria, One Ventricle
(both oxygenated and
deoxygenated blood
are mixed),
"Double Circulation"

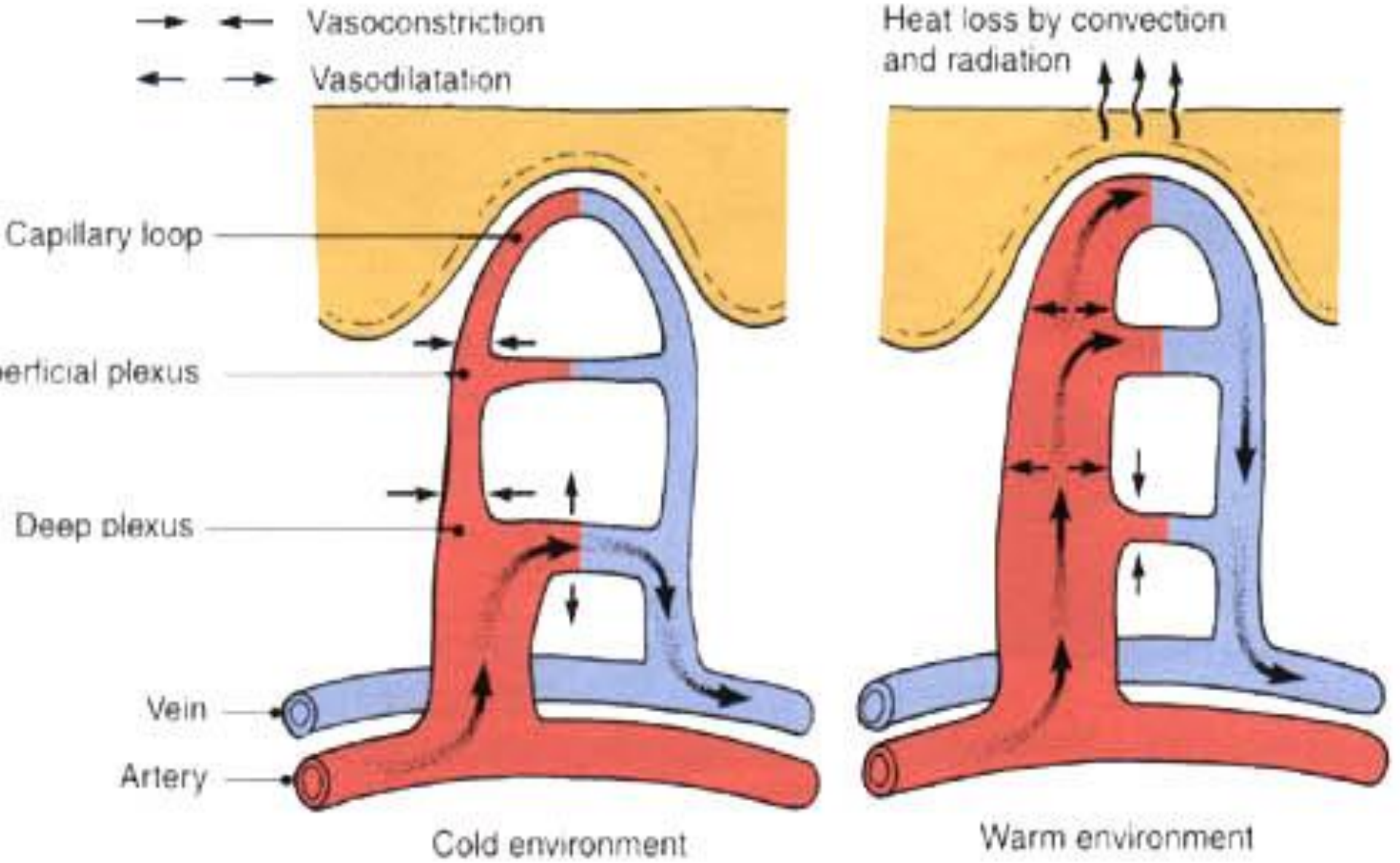


c) Mammalian Heart:
Two Atria, Two Vent
(oxygenated and
deoxygenated blood
separate),
"Double Circulation"



VII. Human Circulatory System

A. Blood
   1. Carries materials to cells (O_2, food)
   2. Carries wastes away from cells (CO_2, toxins)
   3. Fights pathogens
   4. Maintains body temp - vessels close to the skin dilate or constrict to release/retain heat



Variations in the blood supply to the skin under cold and warm conditions.

B. Blood vessels - 70,000 miles!

1. Arteries

a) Carry blood away from the heart

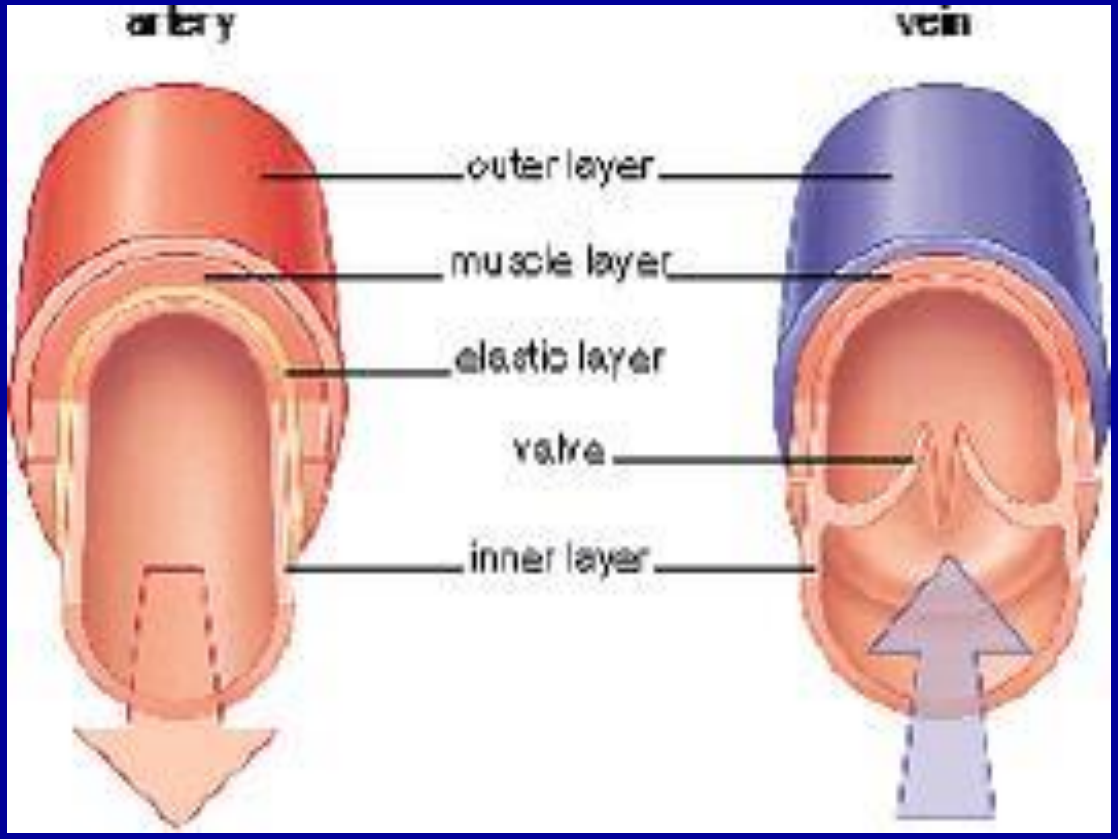
b) Artery walls are thick, muscular & elastic to withstand high blood pressure

c) Pulse = artery walls expanding with heartbeat

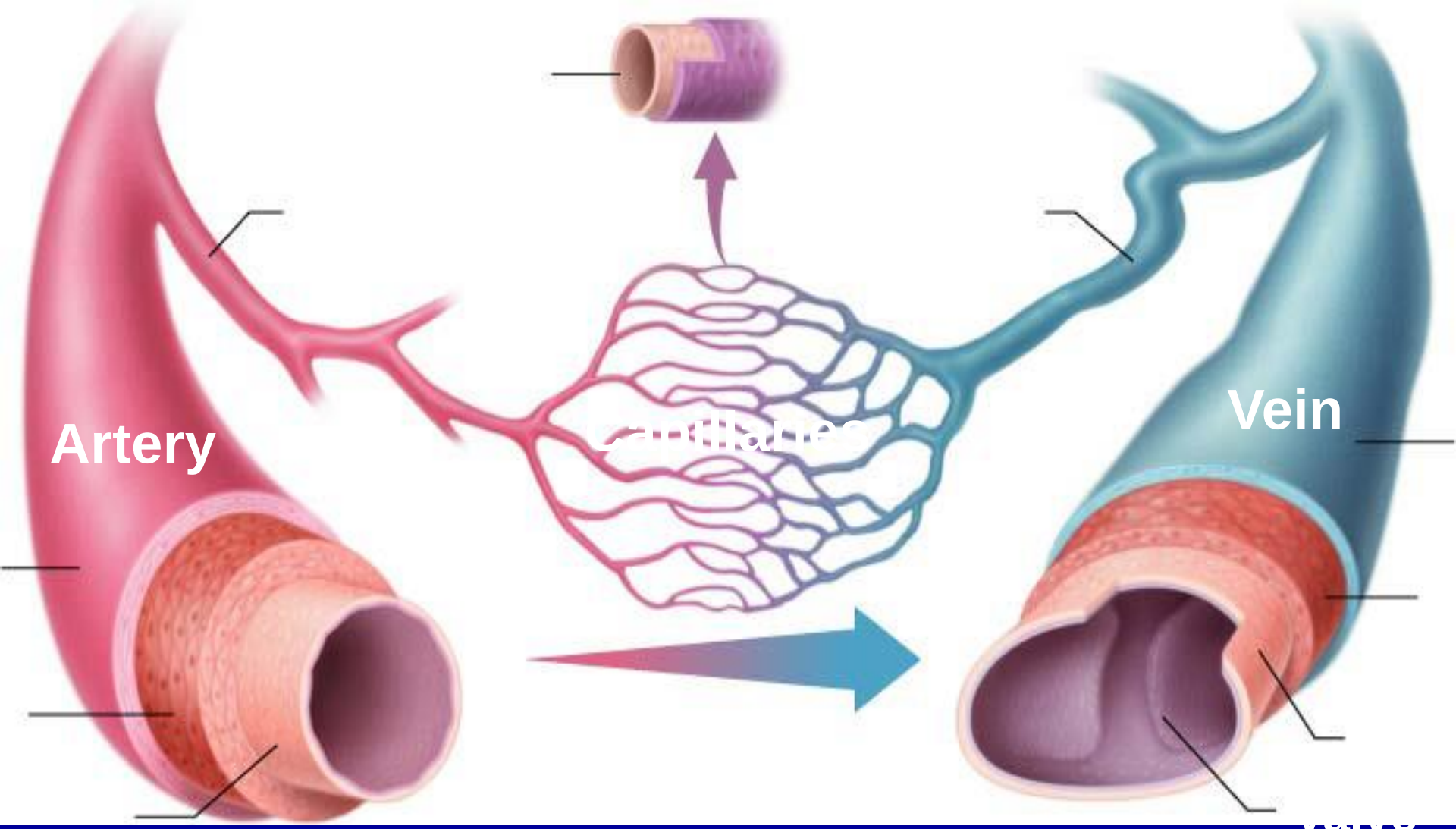
d)Aorta = largest artery
e)Pulmonary arteries - the only arteries that carry oxygen poor blood
f)Arterioles - smallest branches
g)Pressure from the heart moves blood through these vessels

2. Veins
   a) Carry blood toward the heart
   b) Veins have thin, nonelastic walls, and valves
   c) Vena cava - largest vein
   d) Pulmonary veins - only veins that carry oxygen rich blood

e)Venules - smallest branches
f)Pressure in veins is very low
g)Blood is pushed through veins by contractions of surrounding muscles
h)Valves in veins prevent backflow of blood


artery
vein
outer layer
muscle layer
elastic layer
valve
inner layer

3. Capillaries
   a) Tiny blood vessels that connect arteries to veins
   b) Microscopic -- RBCs pass through single file
   c) Capillary walls are 1 cell thick
   d) Exchange between blood & body takes place here


Artery
Vein

VIII. What is the purpose of respiratory systems?

A. To exchange gases
   1. CO_2 out of the body
   2. O_2 into the body - to the cells

Interesting Trivia:

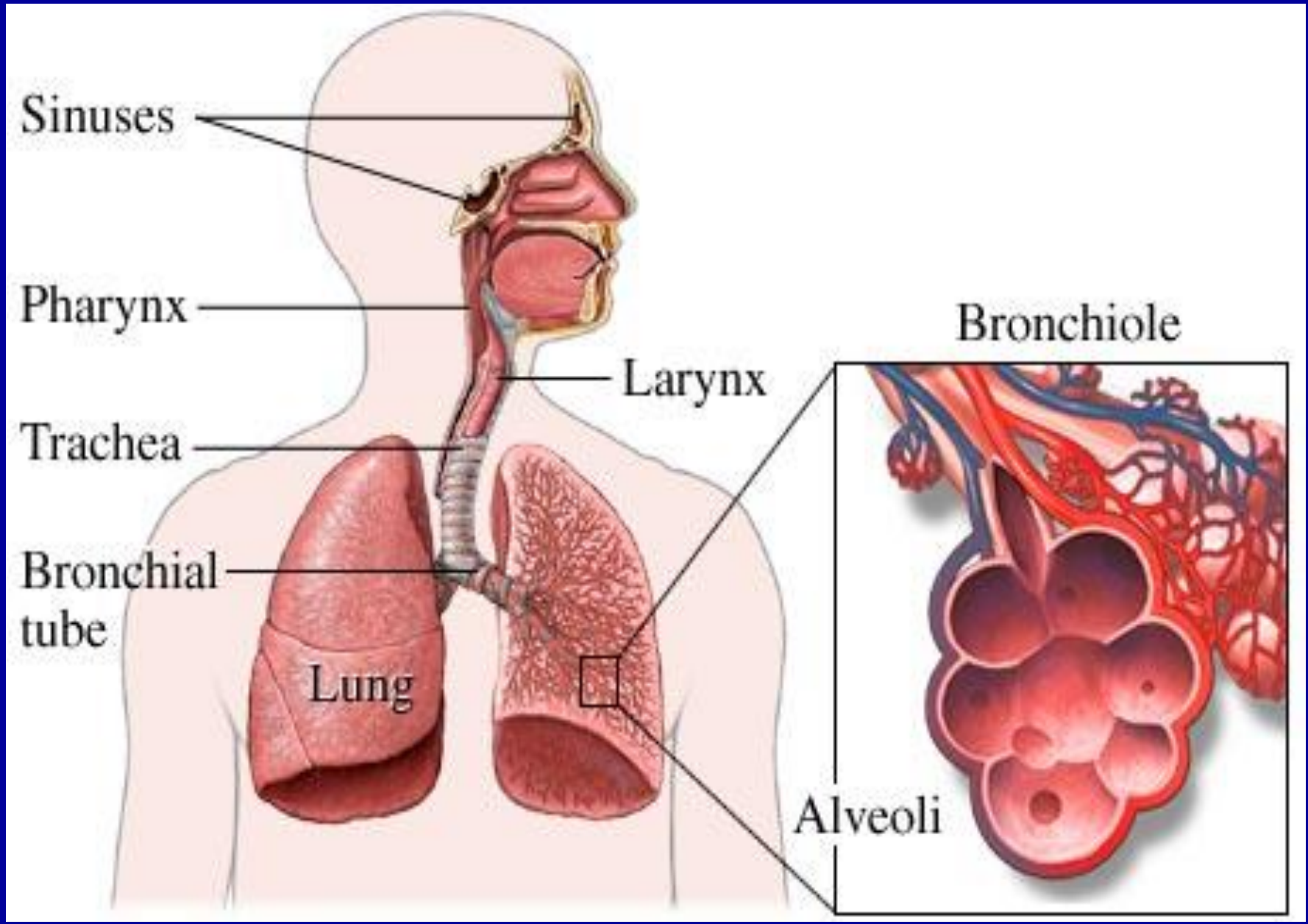
At rest, a person breathes about 14 to 16 times per minute. After exercise it could increase to over 60 times per minute.

New babies at rest breathe between 40 and 50 times per minute. By age five it decreases to around 25 times per minute.

The lungs are the only organ in the body that can float on water.

Cellular respiration:

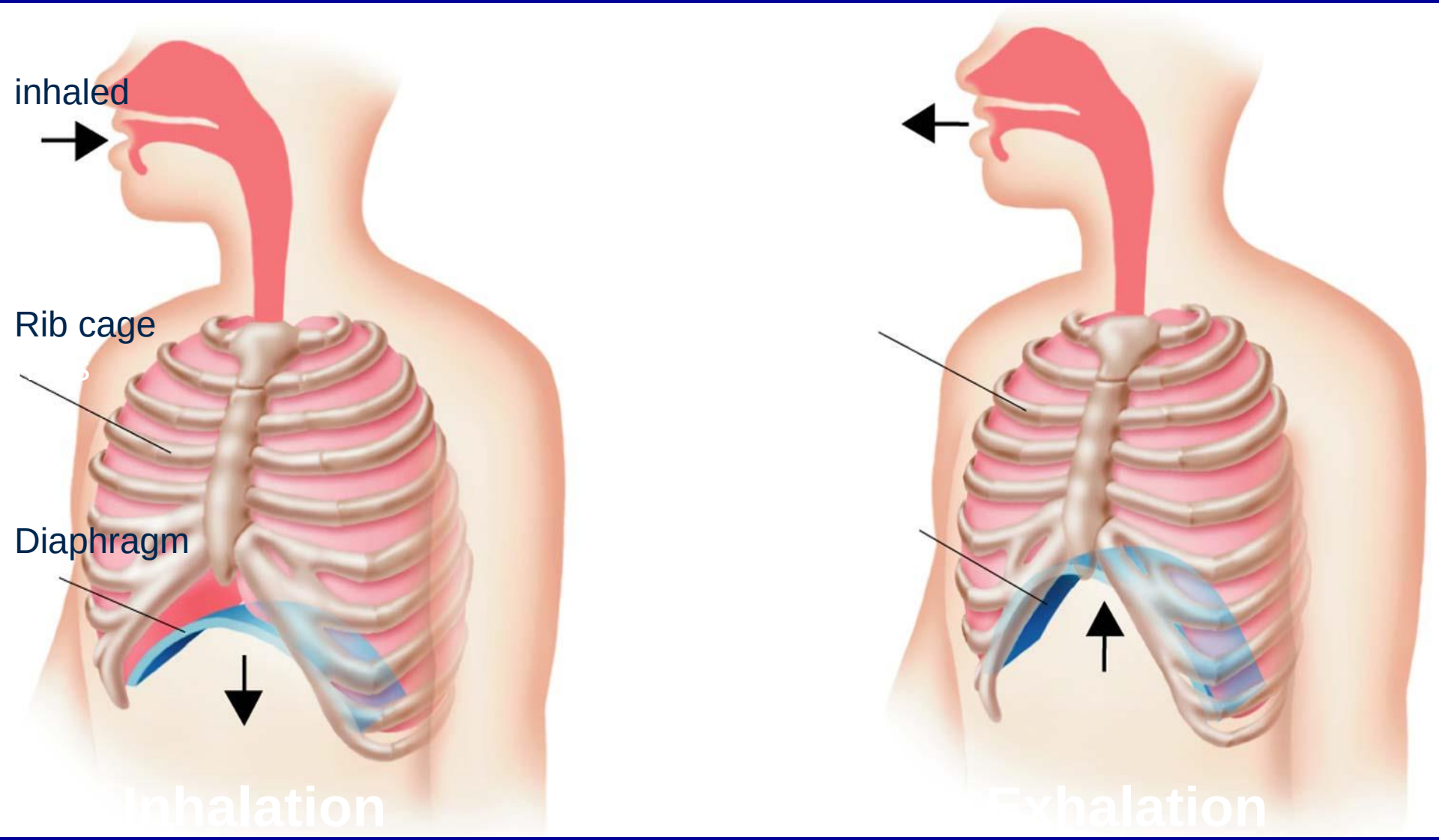
$C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O + energy$


Sinuses
Pharynx
Larynx
Trachea
Bronchial tube
Lung
Bronchiole
Alveoli

B. Trachea- Sturdy Tube (cartilage rings) moves air between Throat (pharynx) and Lungs

C. Bronchi/Bronchial/Bronchioles
Tubes that branch off of Trachea and lead to Alveoli (Air Sacs)

D. Alveoli-Air sacs that we inhale air into - blood capillaries surround these - O2 and CO2 exchange between blood and air sacs


inhaled
Rib cage
Diaphragm
Inhalation
Exhalation

IX. Human Excretory System

A. Eliminates waste products
   1. CO_2 – removed by the lungs
   2. Water – removed by skin & kidneys
   3. Salts – removed by skin & kidneys
   4. Ammonia – converted by liver into urea, which is then removed from the blood by the kidneys

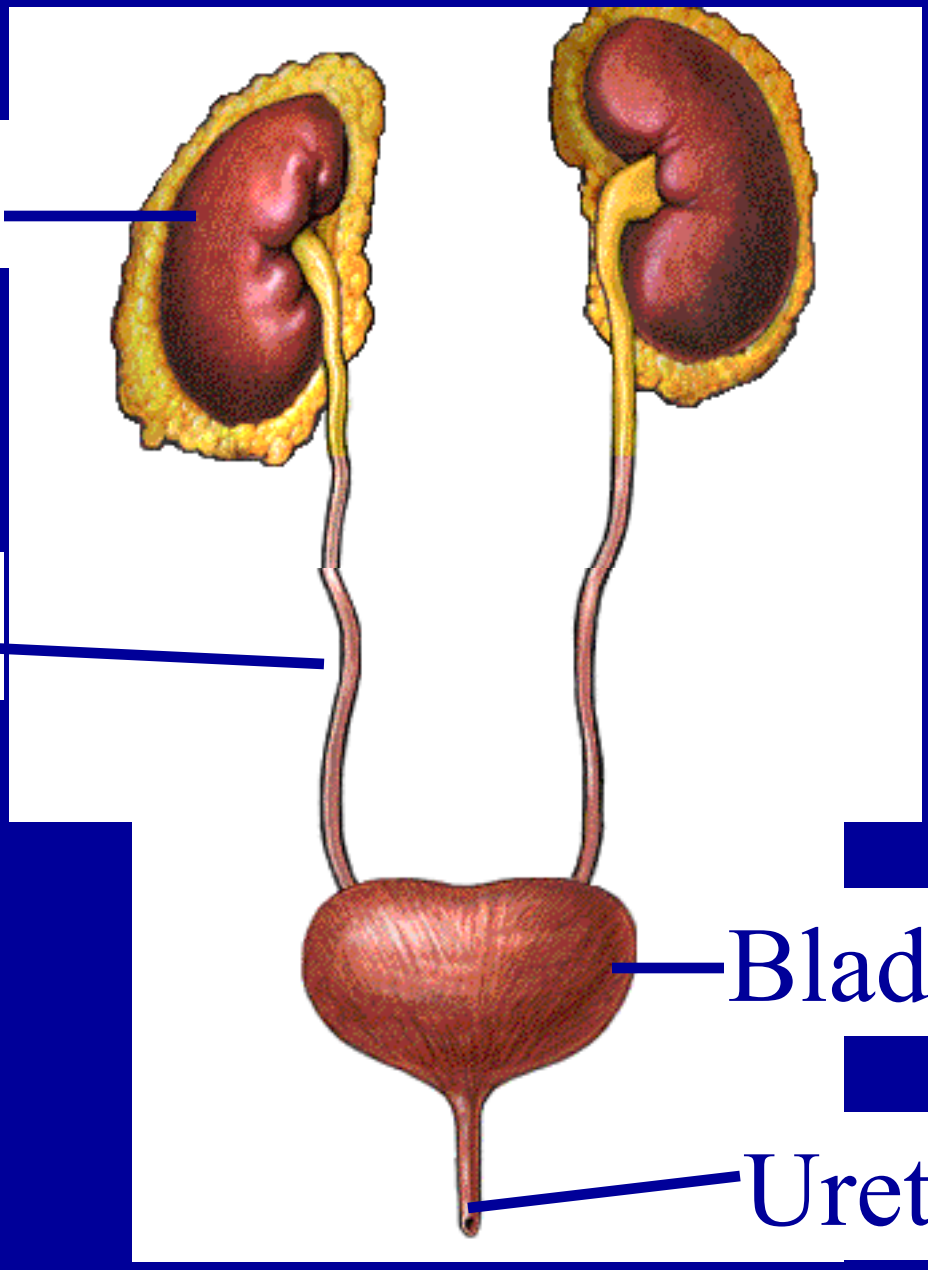
B. Maintains homeostasis: regulates the amount of water and other substances in the blood to keep internal body conditions ideal

Interesting facts:

- **your kidneys filter the entire volume of blood in your body every 45 minutes (about 5 liters), using about 25% of your body's total oxygen intake to fuel the filtration process**

- Largest known kidney stone weighed 1.36 kg (about 3 pounds)

- On Dec. 23, 1954, doctors in Boston gave a kidney to a seriously ill, 23-year-old man in the first successful long-term transplant of a human organ.


Kidney
Ureter
Bladder
Urethra

C. Urinary system

1. Kidney- Filters metabolic wastes from blood - this wastes becomes Urine
2. Ureters: drain urine from kidney to bladder
3. Bladder: muscular sac that expands to store urine
4. Urethra: drains urine from bladder out of body