General Biology 1
BIO1201 RM 1021
Syllabus & Textbook:
https://openlab.citytech.cuny.edu/oer-biology/lecture-schedule/

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Email: mgotesman@citytech.cuny.edu

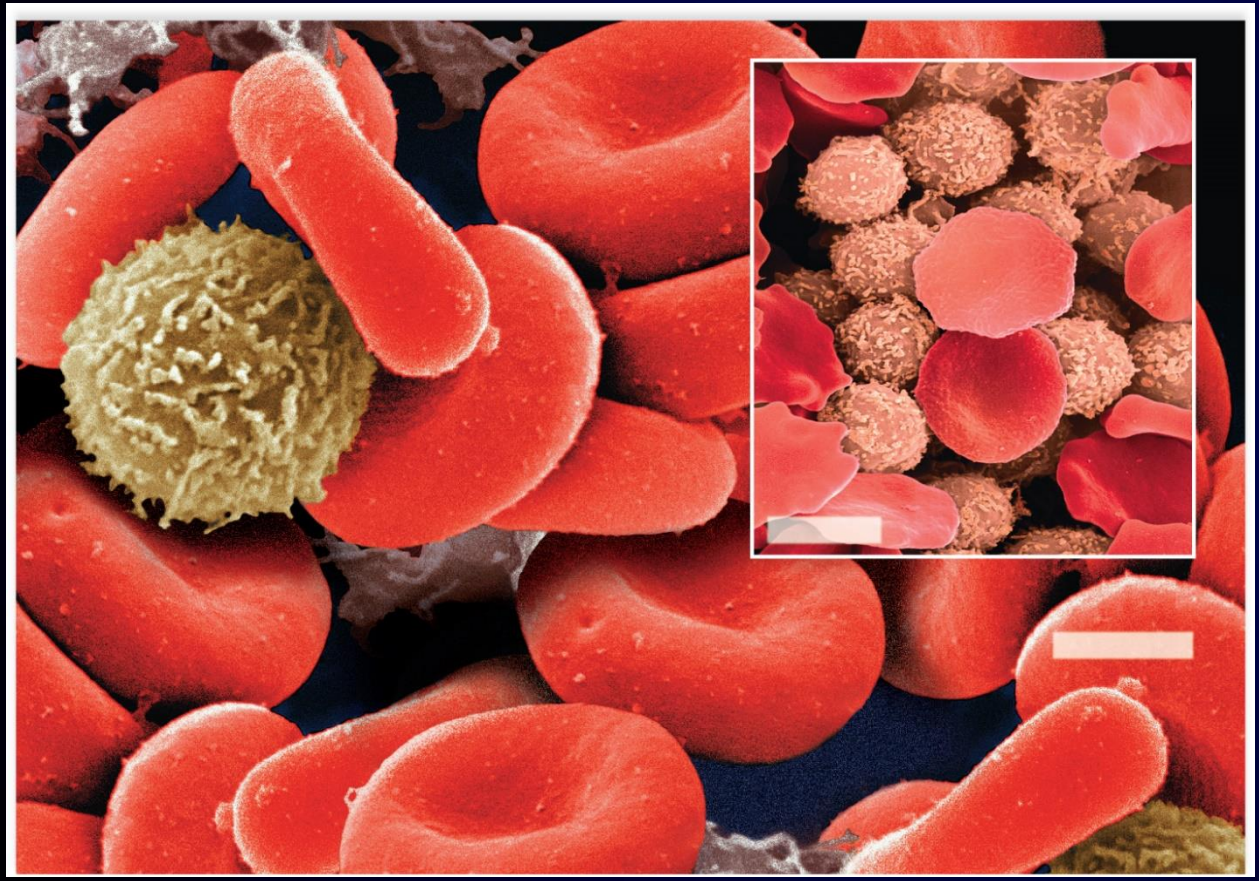
Grade Breakdown:

Lecture (60%)
Exams (4): 22.5% Each
Pop Quizzes (?): 10% Average

Lab (40%) – Lab Instructor

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

Circulation & Cardiovascular Systems



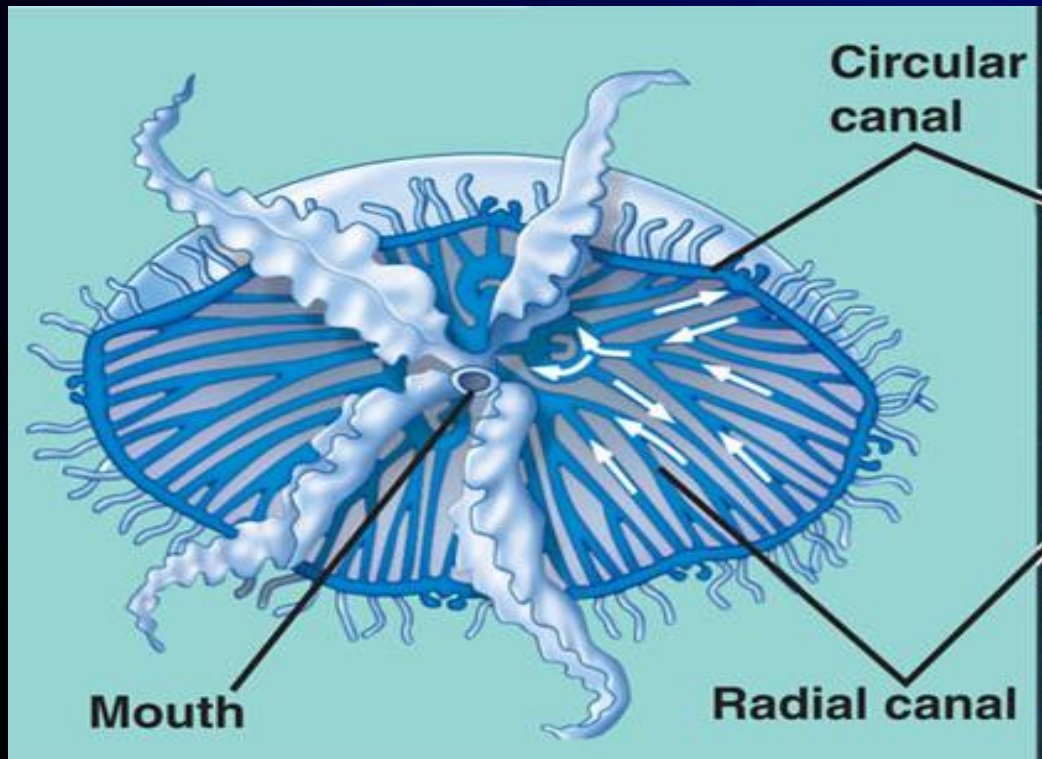
Chap 32: pp. 593-612

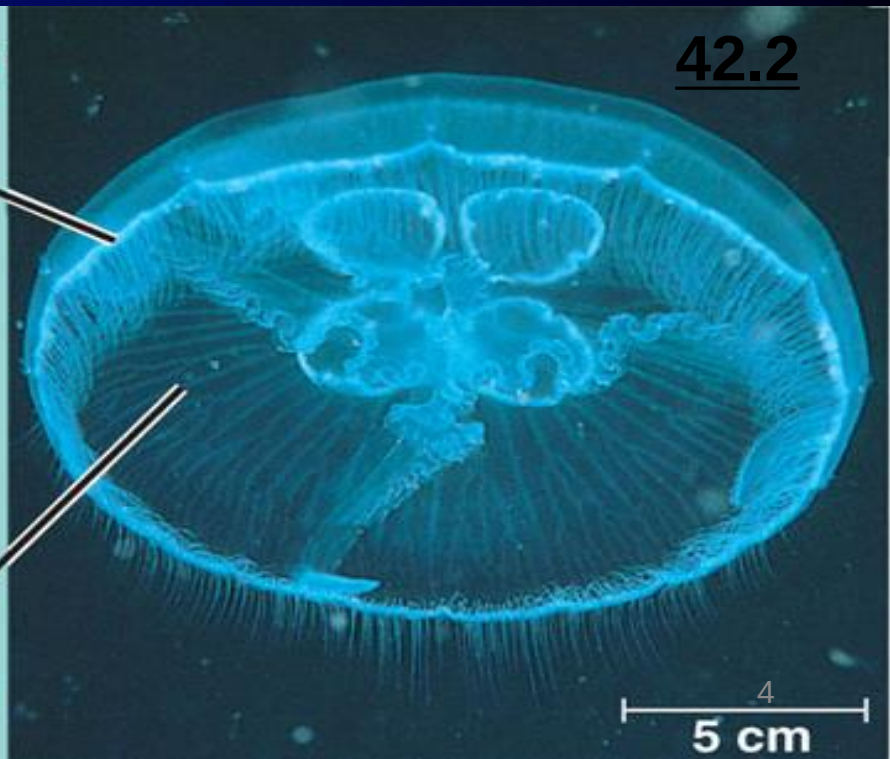
Bringing the outside in

- Two components of the circulatory system:
  - Close contact with outside environment (gills, lungs)
  - Close contact with all tissues everywhere
- In unicellular organisms, these exchanges occur directly with the environment
- Diffusion is only sufficient over a very short distance so for most cells making up multicellular organisms, direct exchange with the environment is not possible
- Thus, cells cannot be more than a few cells away from the bloodstream!
- Thus, circulation must branch into tiny vessels

Bringing the outside in (cont.)

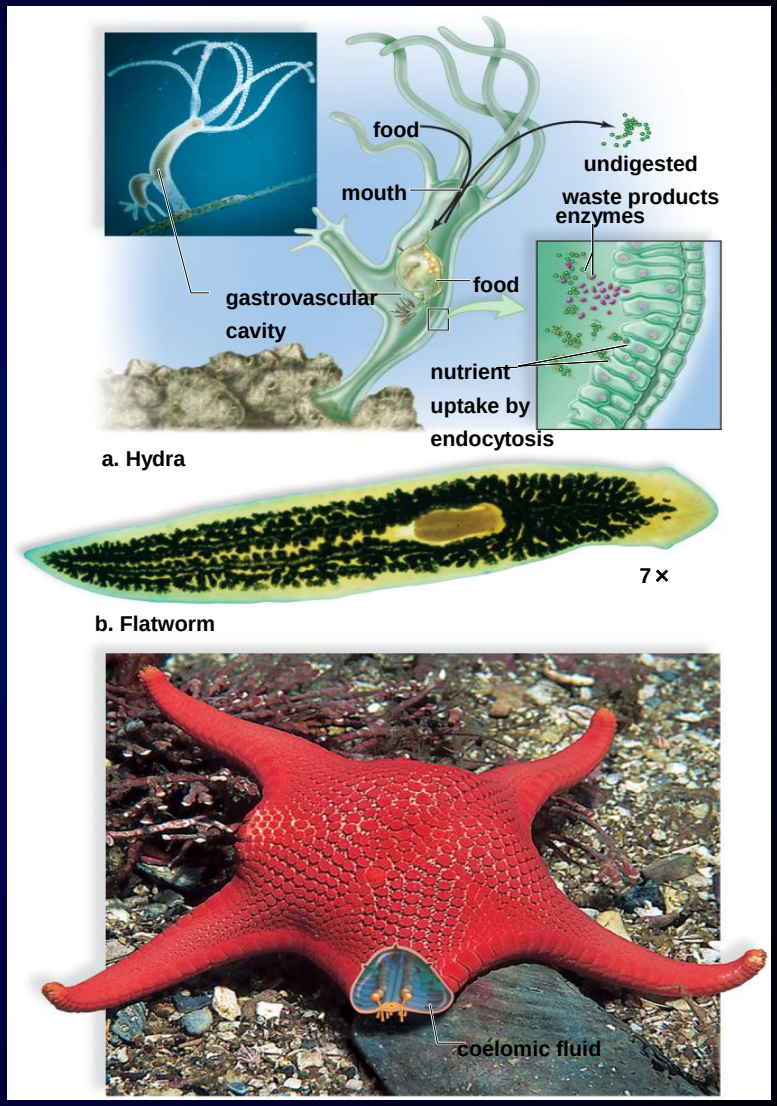
- The simplest circulatory system, the **gastrovascular cavity** combines the digest. and circ. systems, directly circulating the unfiltered outside environment throughout the body (e.g. jellyfish)





Transport in Invertebrates

- Small aquatic animals with no circulatory system
  - May rely on external water in gastrovascular cavity to service cells (flat worm acoelomate).
- Roundworms and other pseudocoelomates
  - Use a fluid-filled body cavity as a means of transporting substances
  - Fluid-filled cavity can also act as a hydrostatic skeleton



Aquatic Organisms Without a Circulatory System

Open vs. Closed Circulatory Systems

- **Open circulatory system**: (most invertebrates)
  - vessels have openings
  - The interstitial fluid itself is circulated through the body (no real "blood"). I.F. = **hemolymph**

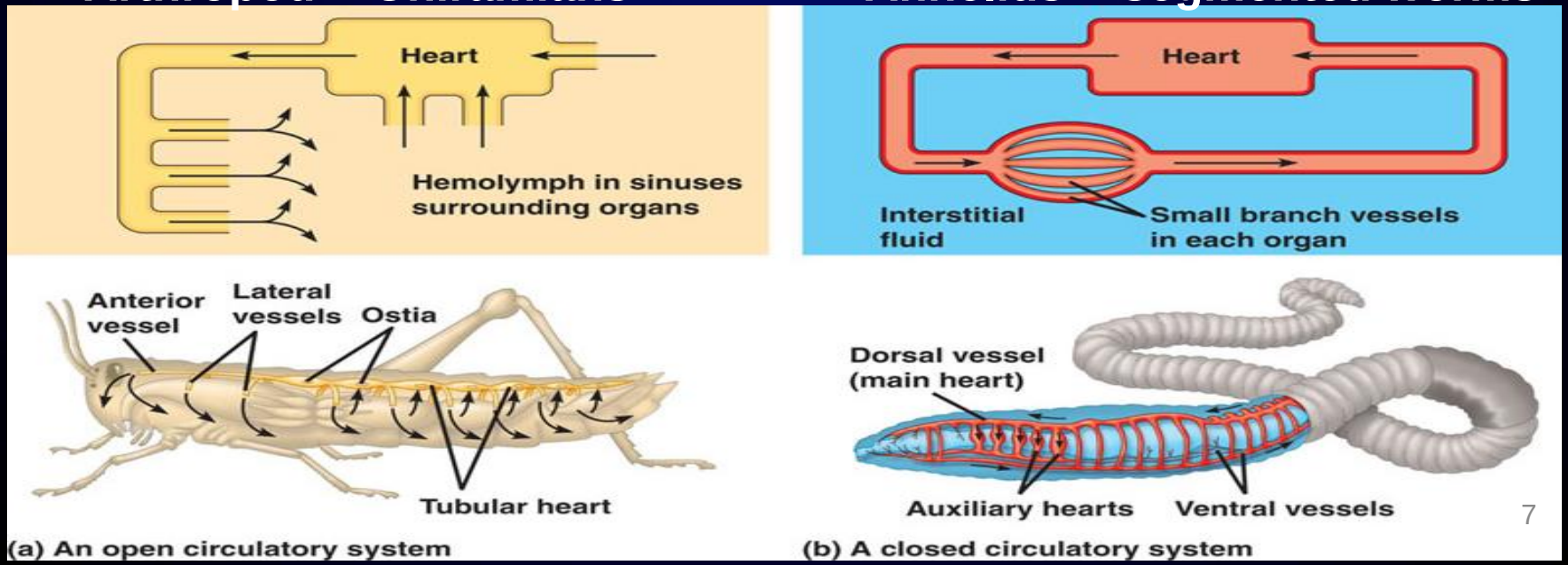
- **Closed circulatory system**: (all vertebrates, a few invertebrates ex **Annelids**)
  - **Blood** and interstitial fluid exchange material through diffusion, but do not mix
  - Blood is restricted to vessels

Open vs. Closed Circulatory Systems

- Both systems have three basic components:
  - A circulatory fluid (blood or hemolymph)
  - A set of tubes (blood vessels)
  - A muscular pump (the heart)

- Open is far less costly to pump, build, and maintain
- Closed is more efficient and allows larger animals

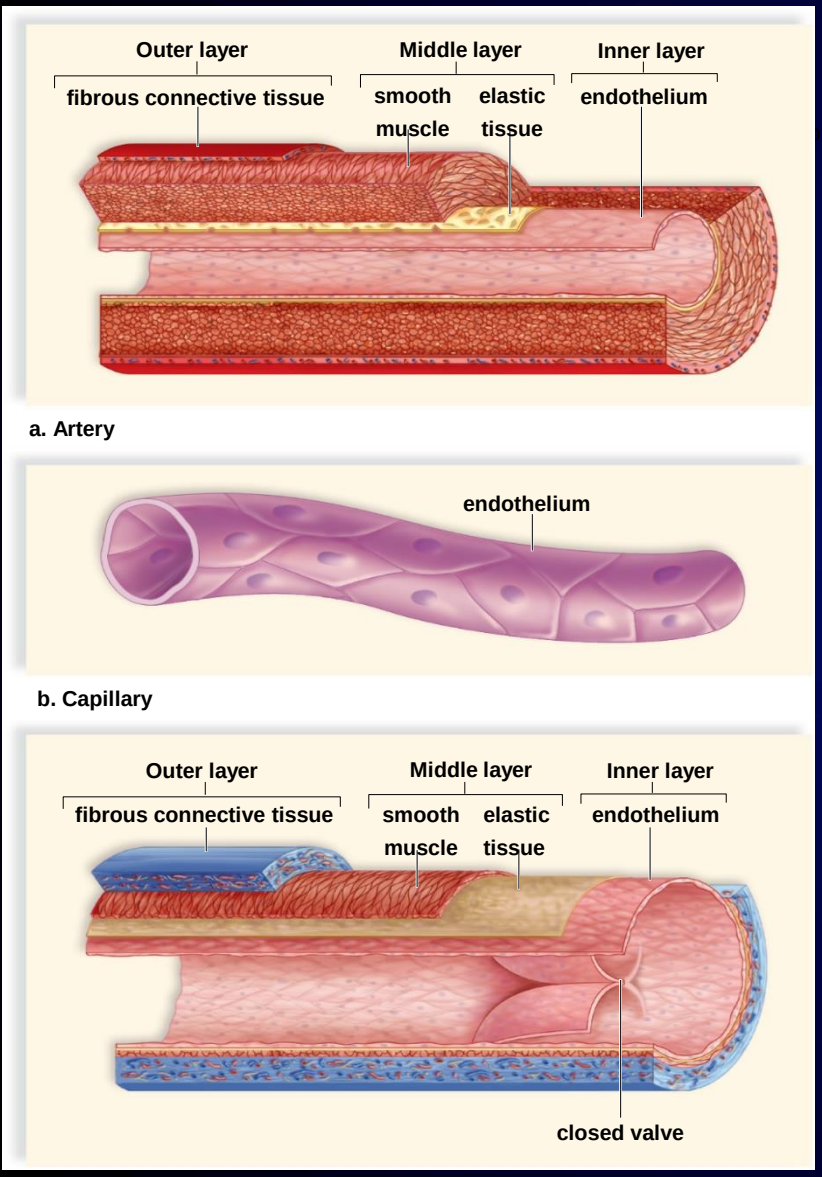
Arthropod -- Uniramians **Annelids -- segmented worms**

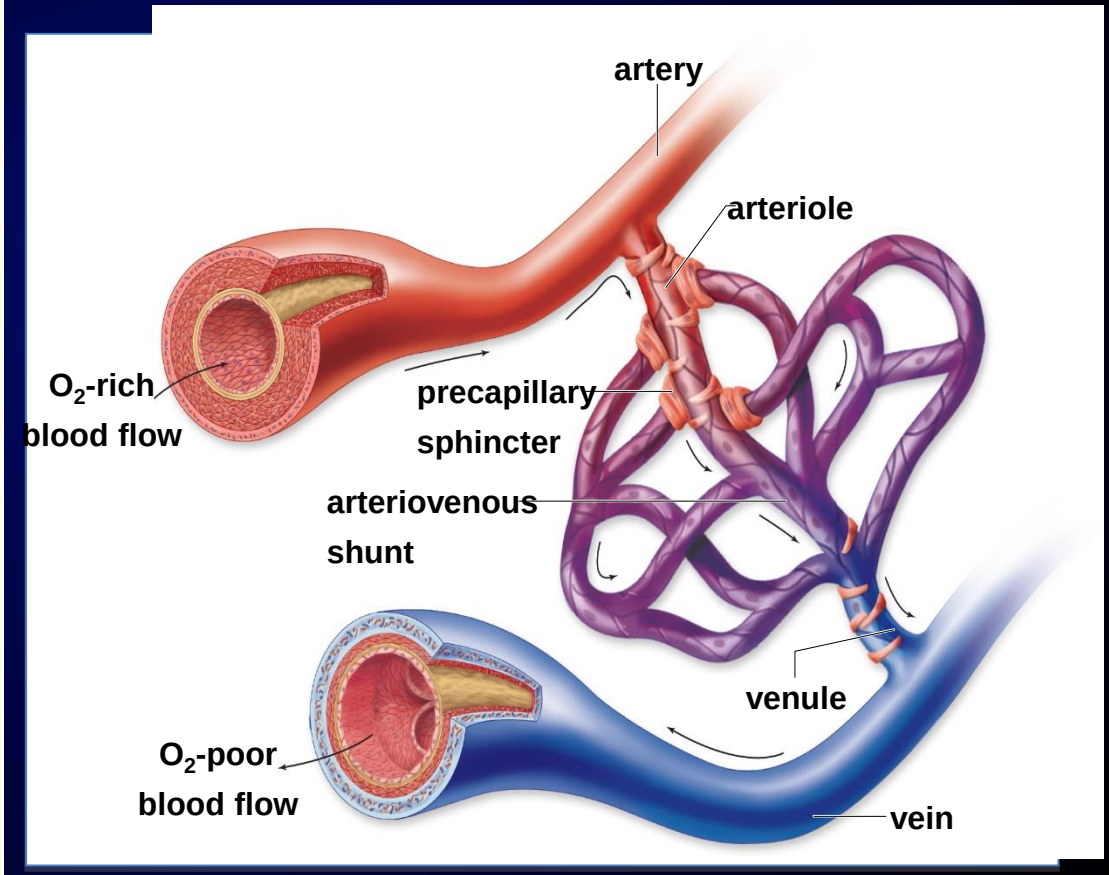


Transport in the Vertebrates

- All vertebrates have a closed cardiovascular system
- Vertebrate heart:
  - Atrial chamber(s) of heart receive blood from general circulation
  - Ventricle chamber(s) of heart pump blood out through blood vessels
- Vertebrate vessels:
  - Arteries - Carry blood away from heart
  - Arterioles – Lead to capillaries
  - Capillaries - Exchange materials with tissue fluid
  - Venules - Lead to veins
  - Veins - Return blood to heart

Transport in Vertebrates





Anatomy of a Capillary Bed

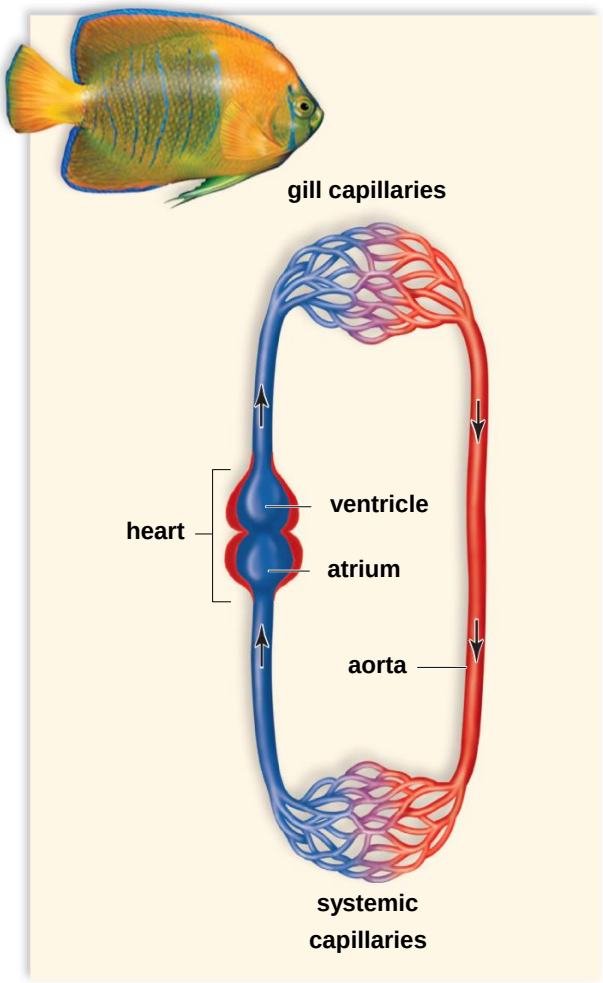
The Vertebrate Cardiovascular System

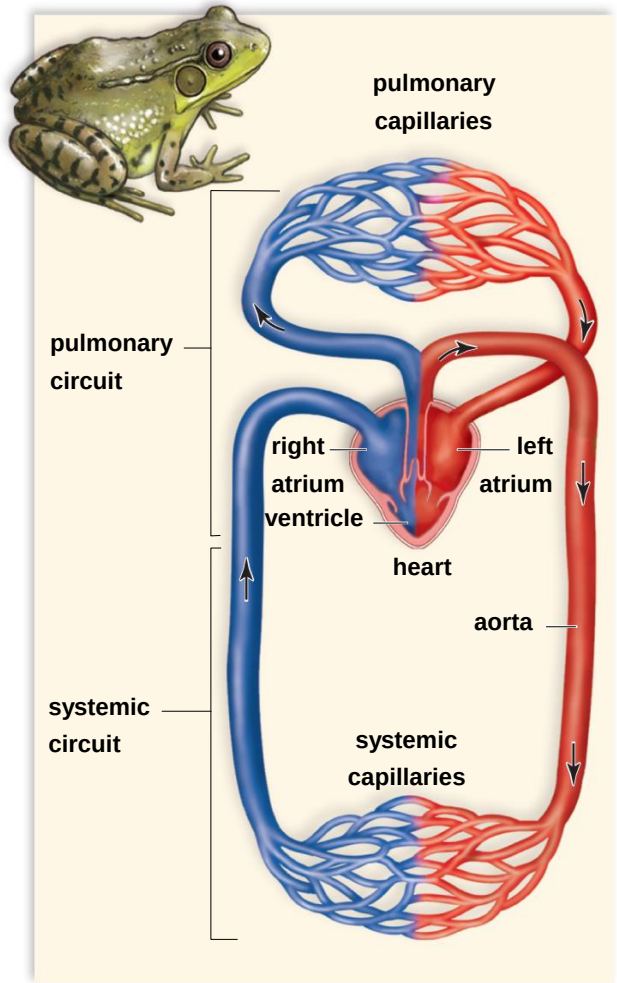
- **Capillaries** are the tiny vessels with walls that are one-cell thick.
  - All gas & nutrient exchange between blood and internal fluids occurs in **capillary "beds"**
  - cap. beds in Lungs (or gills) pick up O_2 and release CO_2
  - cap. beds in the GI pick up nutrients
  - cap. beds in kidney allow excretion of urea and other wastes
  - cap. beds in all tissues deliver O_2 and nutrients, pick up wastes and CO_2
  - cap. beds in glands, liver, etc., pick up hormones or other secretions

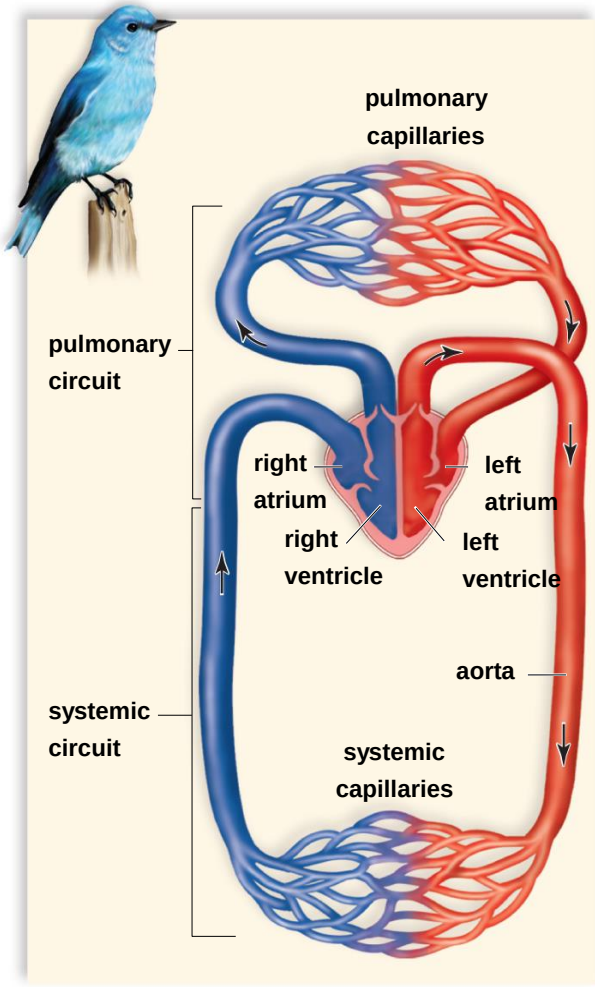
Comparison of Circulatory Pathways

- Fish - Blood flows in single loop
  - Single atrium and single ventricle
- Amphibians - Blood flows in double loop
  - Two atria with single ventricle
    - Left Atrium feeds body
    - Right Atrium to pulmonary loop
- Other vertebrates - Blood flows in a double loop
  - Heart divided by septum into separate sides

Comparison of Circulatory Circuits in Vertebrates







https://study.com/academy/lesson/three-chambered-heart-definition-anatomy-quiz.html

Comparison of Circulatory Pathways

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  - Heart divided by septum into separate sides

Question

Which of the following are the only vertebrates in which blood flows directly from respiratory organs to body tissues without first returning to the heart?

A) amphibians

B) birds

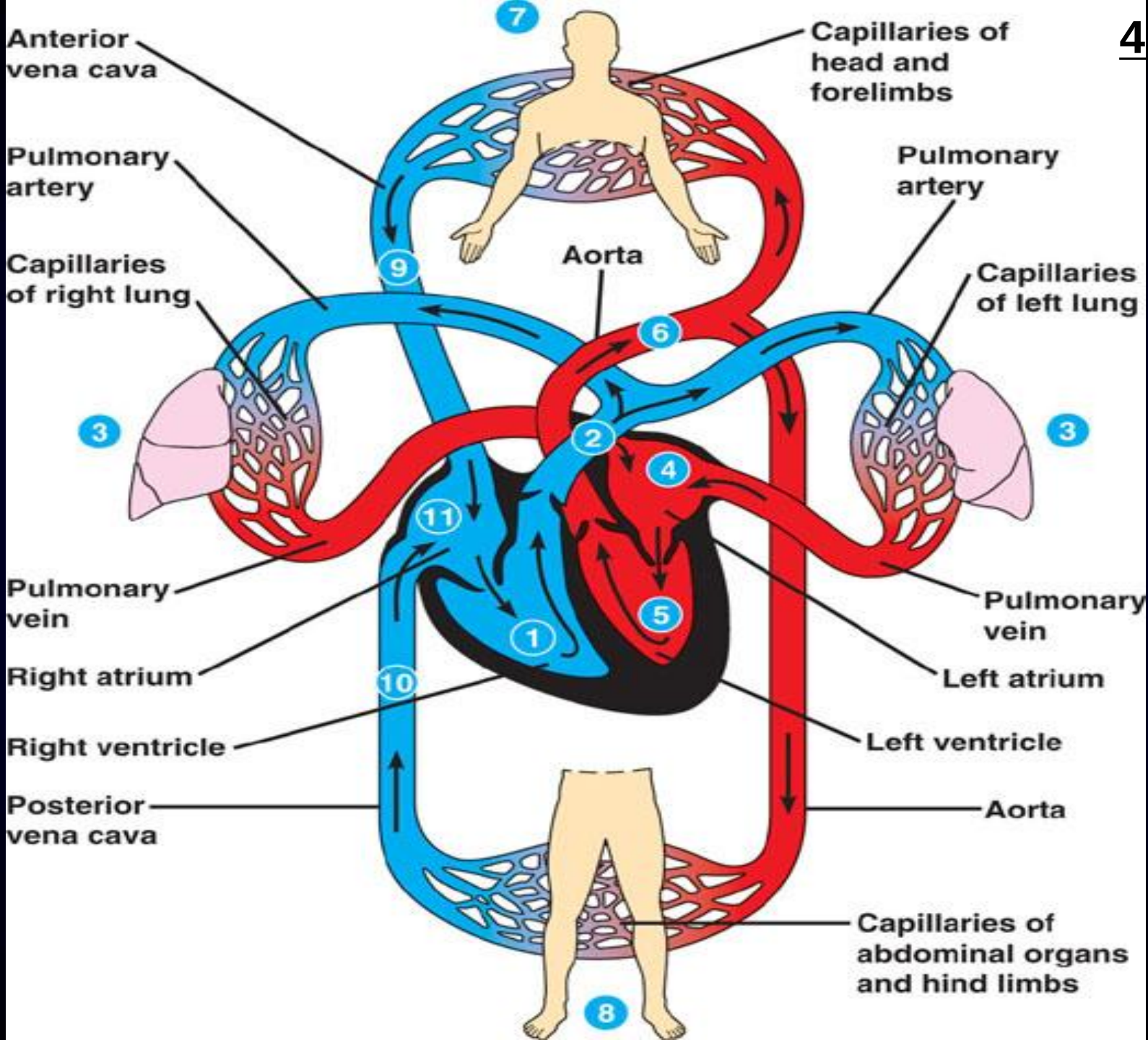
C) fishes

D) Mammals

Transport in Humans

- Human Heart
  - Fist-sized
  - Cone-shaped
  - Very muscular organ (special cardiac fibers)
  - Lies within a fluid-filled sac (the pericardium)
  - Septum separates heart into left & right halves

- Each half has two chambers
  - Upper two chambers are the atria
    - Thin-walled
    - Receive blood from circulation
  - Lower two chambers are the ventricles
    - Thick-walled
    - Pump blood away from heart


Anterior vena cava
Capillaries of head and forelimbs
Pulmonary artery
Pulmonary artery
Capillaries of right lung
Aorta
Capillaries of left lung
Pulmonary vein
Pulmonary vein
Right atrium
Left atrium
Right ventricle
Left ventricle
Posterior vena cava
Aorta
Capillaries of abdominal organs and hind limbs
1
2
3
3
4
5
6
7
8
9
10
11

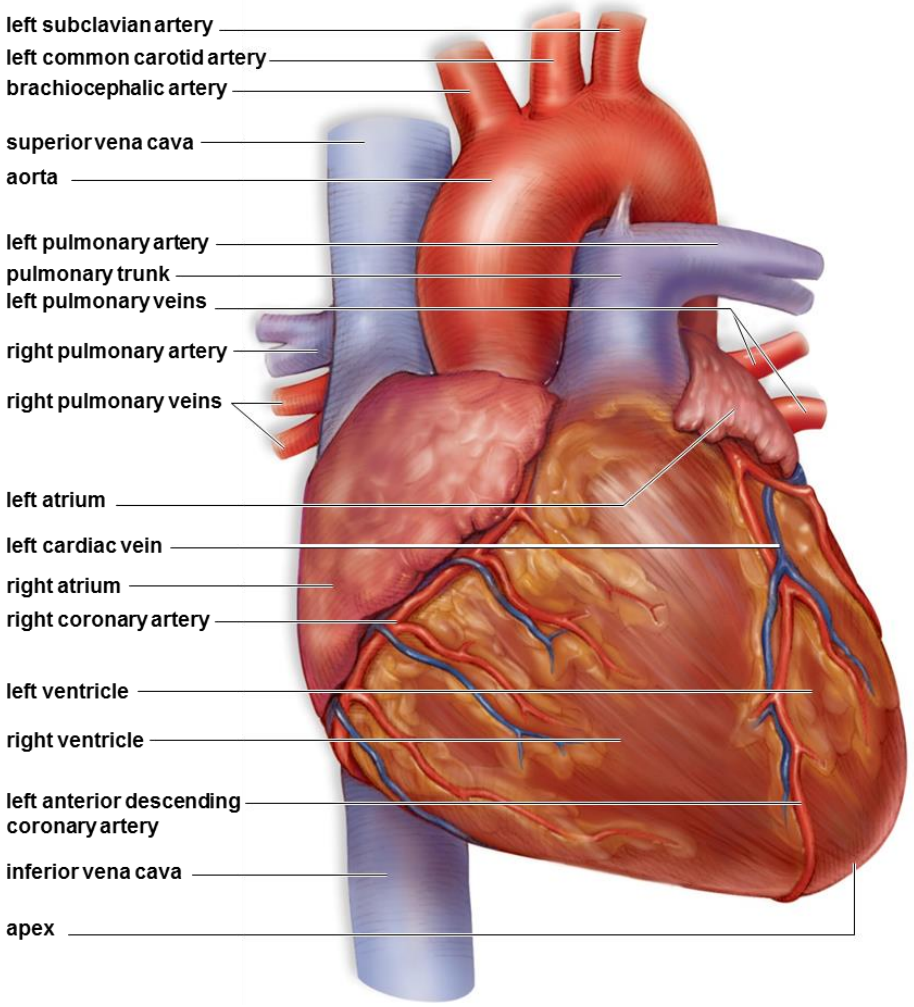
Blood flow through the heart

Inferior and superior vena cava (1) dump blood into the right atrium (2)

Right ventricle (3)

2 pulmonary arteries (4) that lead to the lungs (5) where blood becomes oxygenated

Pulmonary veins (6) bring blood from the lungs back to the left atrium (7) Left ventricle (8) is large and muscular to pump blood into the aorta (9) and to the rest of the body through arteries (10)



Eventually blood will be pumped back to each vena cava (1)

https://www.youtube.com/watch?v=BEWjOCVEN7M

Transport in Humans

- Blood returning to heart from systemic circuit
  - Enters right atrium
  - Right atrium pumps through tricuspid valve to right ventricle
  - Right ventricle pumps blood through pulmonary valve to the pulmonary circuit
- Blood returning to heart from pulmonary circuit
  - Enters left atrium
  - Left atrium pumps through mitral valve to left ventricle
  - Left ventricle pumps blood through aortic valve to the systemic circuit
- Oxygen-poor blood never mixes with oxygen-rich blood (in humans)

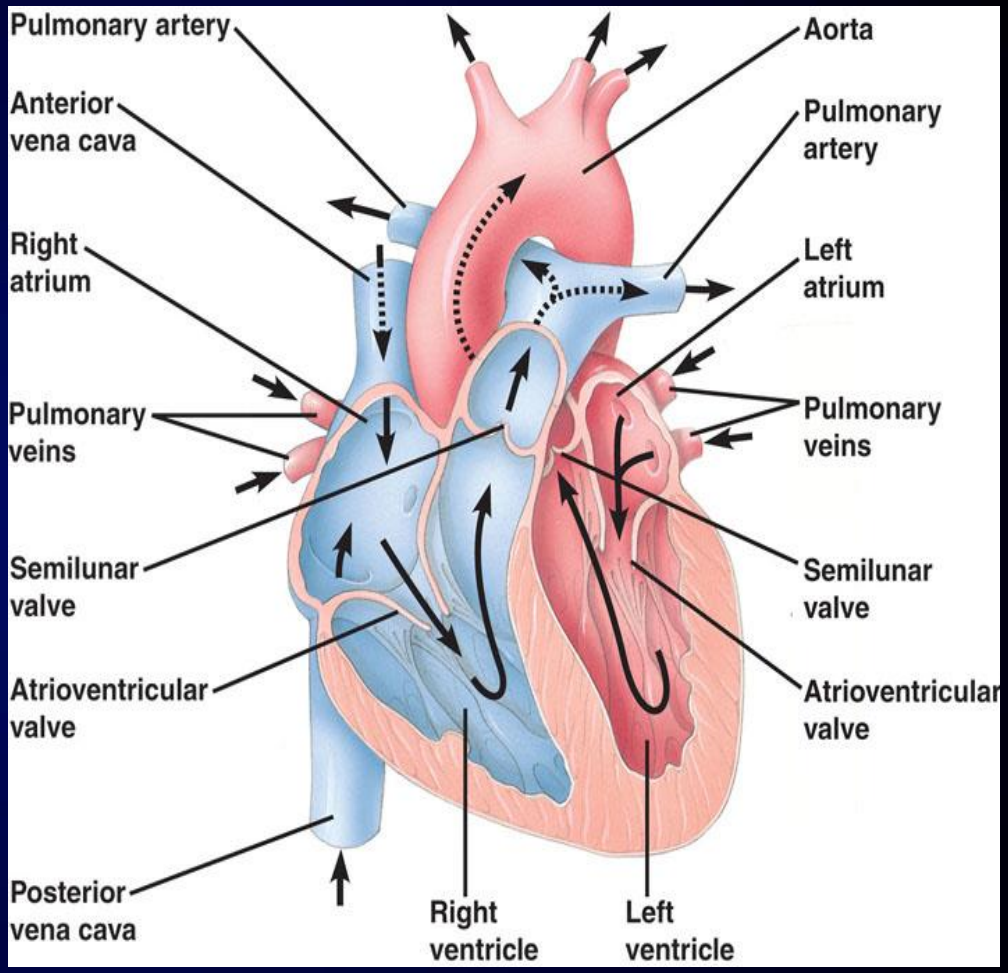
https://www.youtube.com/watch?v=5tUWOF6wEnk

Heartbeat

- Systole - Contraction of heart chambers
- Diastole - Relaxation of heart chambers
- Pulse - Two-part pumping action that takes about a second
  - Blood collects in atria, the atria contract
    - Pushes blood through tricuspid and mitral valves into the resting lower ventricles
    - This phase (the longer of the two) is called the diastole
  - Second part begins when ventricles fill
    - Ventricles contract
    - This is called systole
  - After blood moves into the pulmonary artery and aorta, the ventricles relax

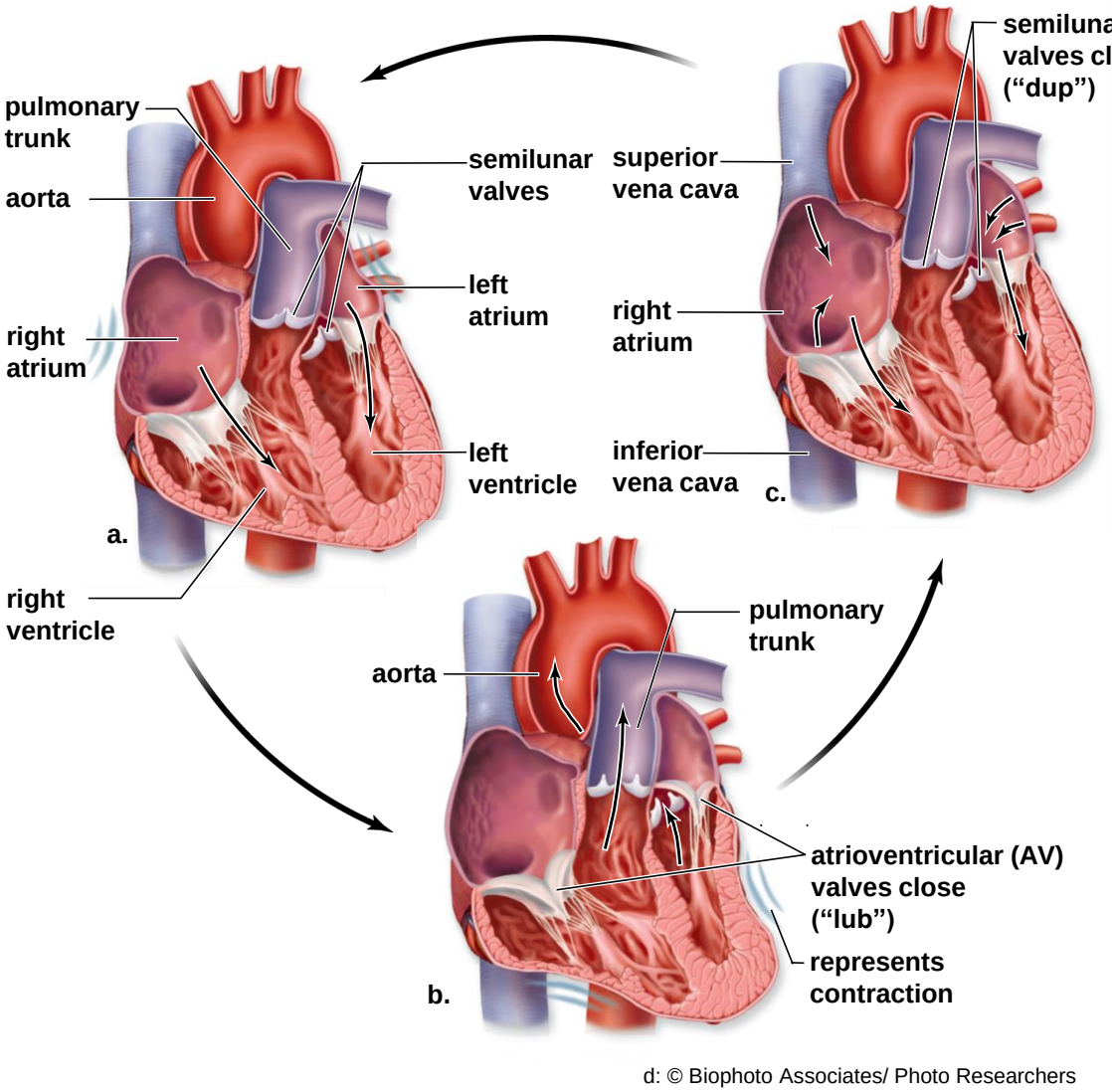
Heartbeat

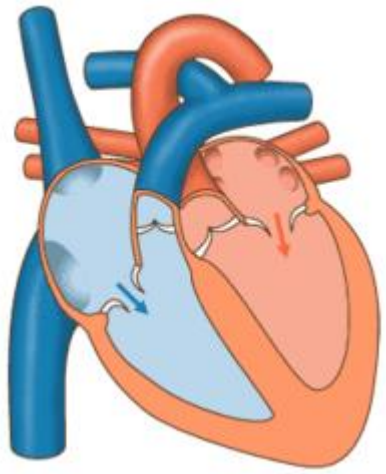
- **Systole** – the contraction phase of the cardiac cycle
- **Diastole** – the filling phase
- **Valves** ensure one-way flow of blood (make heart sounds!)
  - **AV valves** (b/w the A and V), snap shut when the V's contract
  - **Semilunar valves** (b/w RV & PA, and b/w LV & aorta) snap shut after contraction is complete

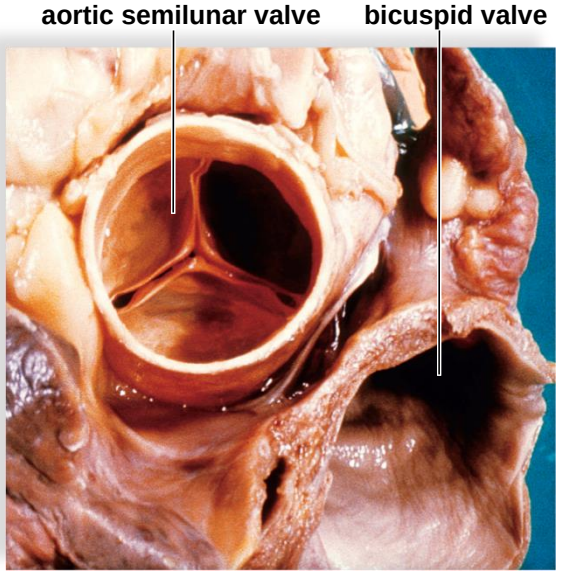


•The two semilunar (SL) valves, the aortic valve and the pulmonary valve, which are in the arteries leaving the heart.

What is the cardiac cycle?







d: © Biophoto Associates/ Photo Researchers

d.

Figure 5.5 The stages of the cardiac cycle.

Question

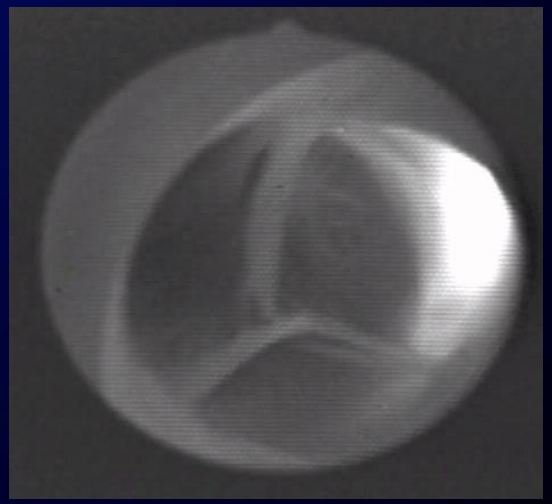
Rheumatic fever is a bacterial disease that can result in degeneration of heart valves. That would cause

A. backfire of blood from ventricle to an atrium.

B. slower heartbeat.

C. uncoordinated attraction of ventricles.

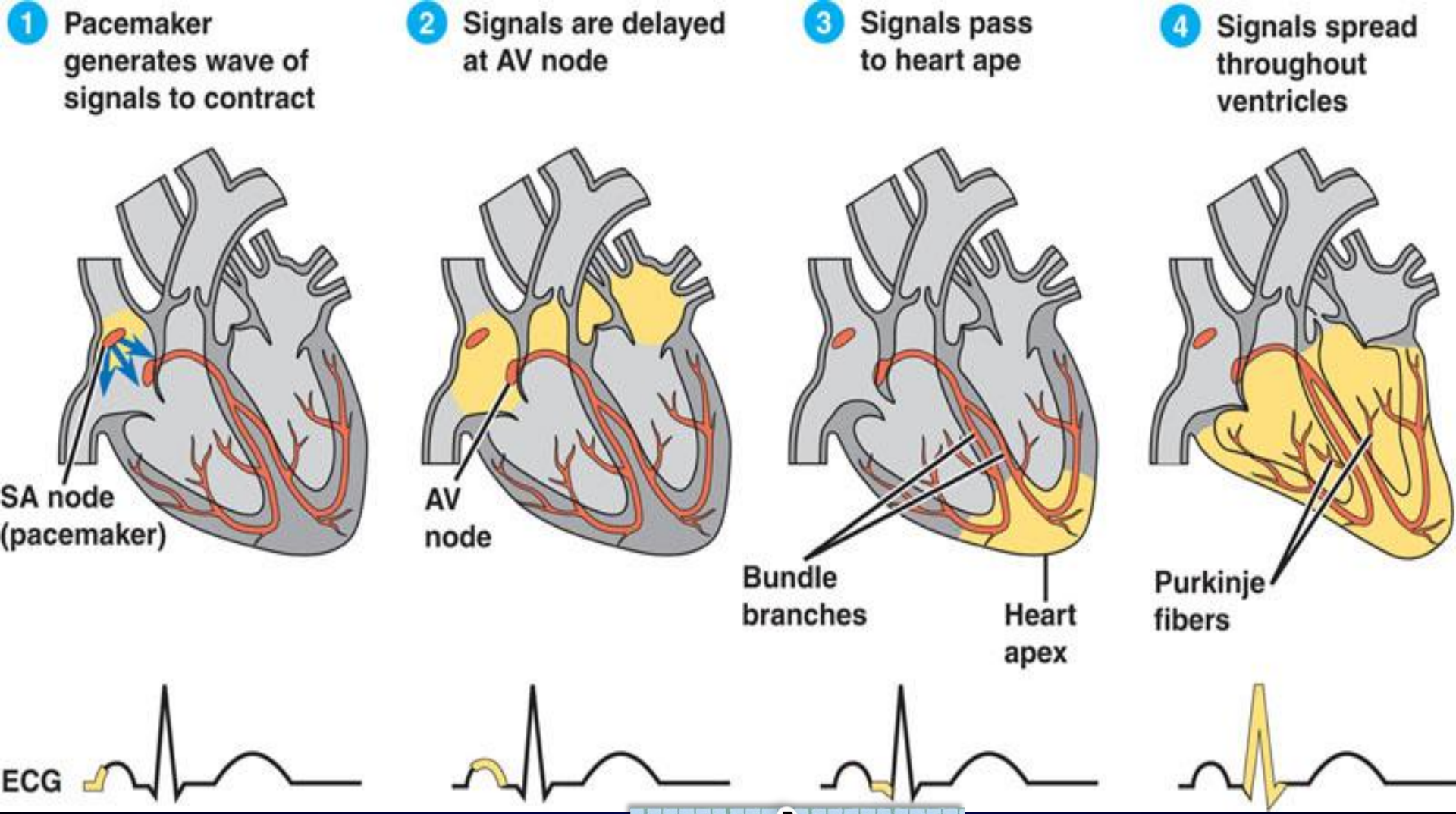
D. faster heart beat.



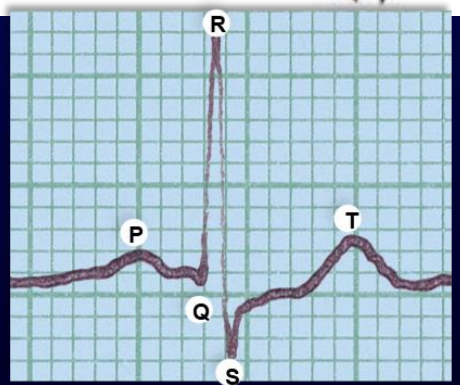
https://en.wikipedia.org/wiki/Aortic_valve#/media/File:Aortic_valve.gif

Heartbeat – Electrical Control

- Rhythmic contraction due to cardiac conduction system
  - Sinoatrial node (SA) keeps the heartbeat regular
  - Atrioventricular node (AV) signals ventricles to contract - Purkinje Fibers
- Electrocardiogram (ECG)
- A recording of electrical changes that occurring in myocardium during cardiac cycle
  - When SA node triggers an impulse, the atrial fibers produce an electrical charge (P wave)



SA (sinoatrial) node
AV (atrioventricular) node



Blood Pressure

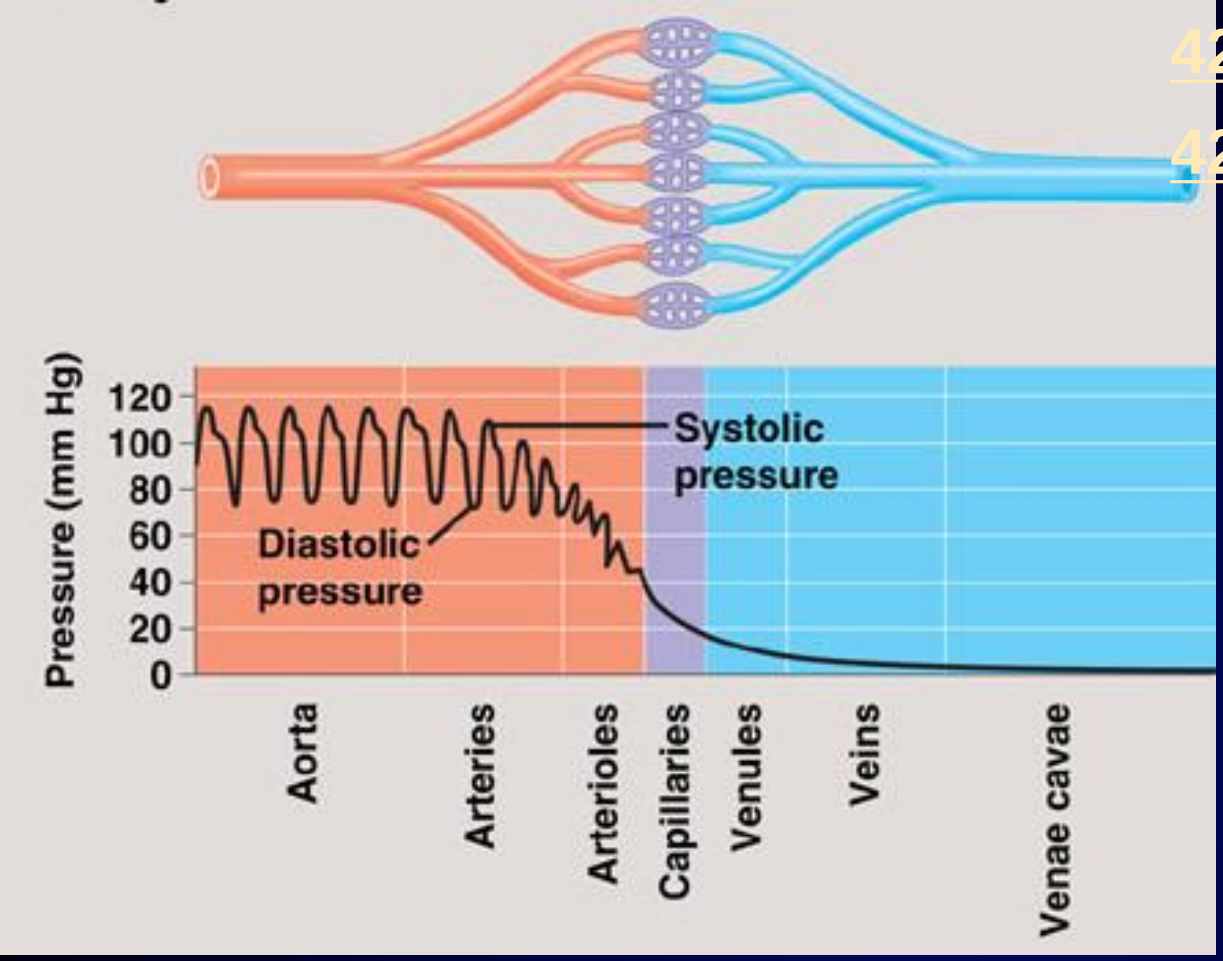
- The beat of the heart supplies pressure that keeps blood moving in the arteries
  - Systolic Pressure results from blood forced into the arteries during ventricular systole
  - Diastolic Pressure is the pressure in the arteries during during ventricular diastole
- Skeletal muscle contraction pushes blood in the veins toward the heart
- Blood pressure
  - Normally measured with a sphygmomanometer on the brachial artery
  - Expressed in the form: Systolic “over” Diastolic

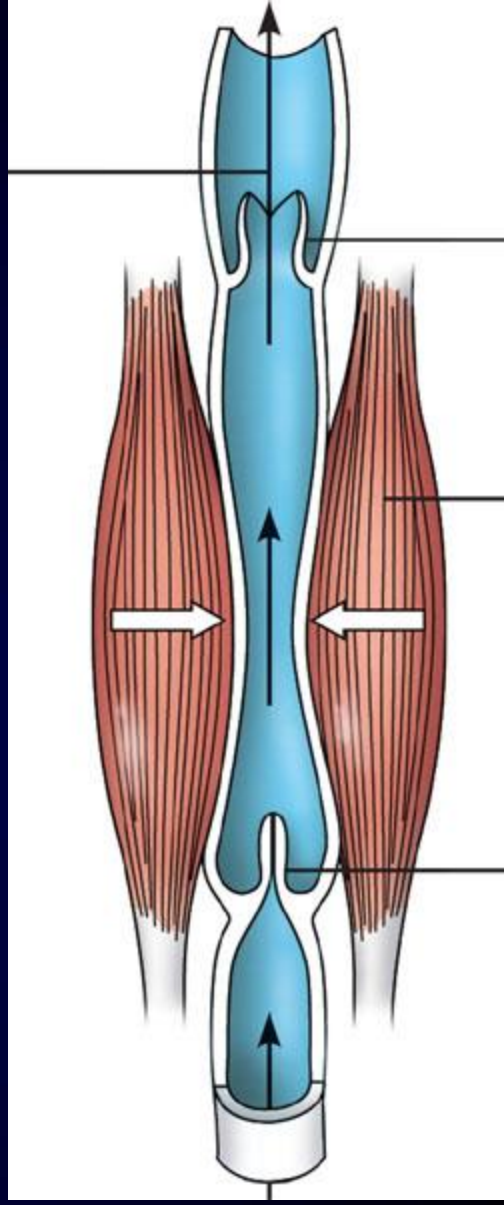
Blood Flow & Blood Pressure

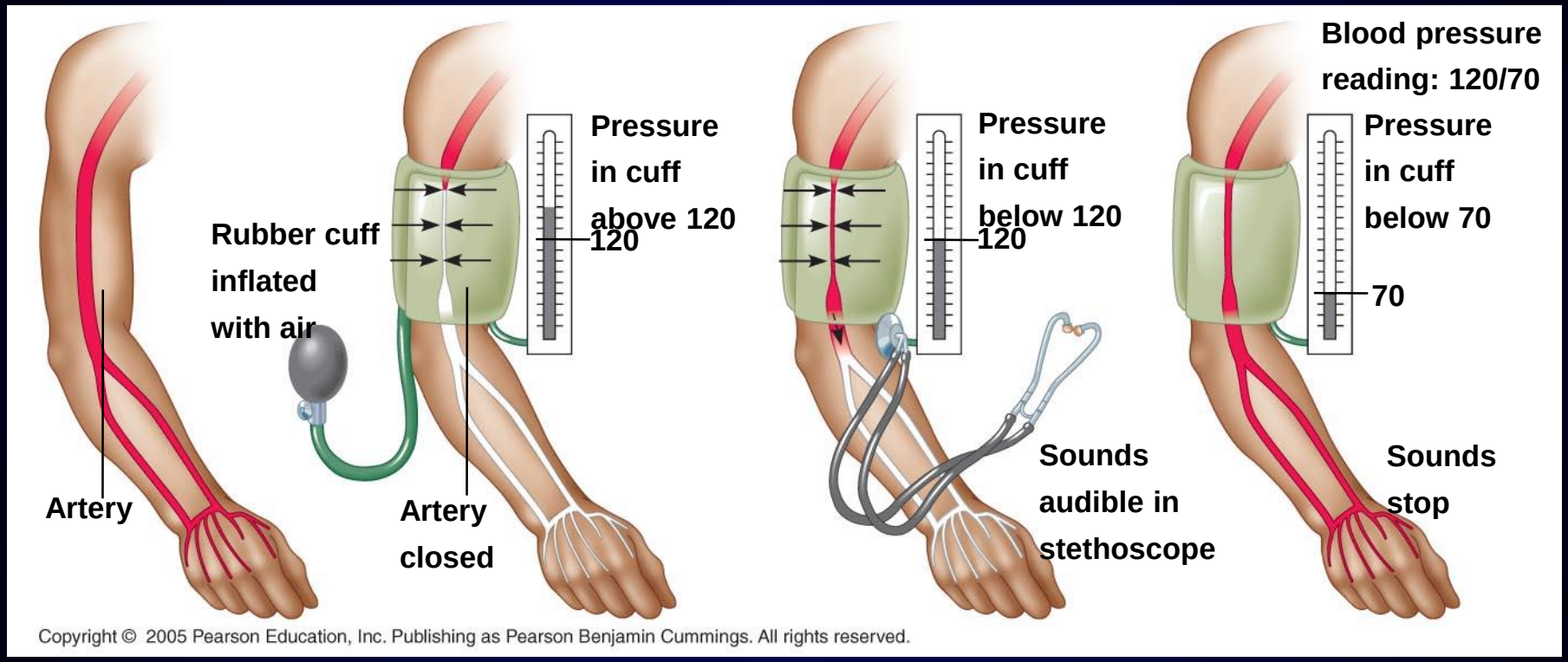
- As with any fluid, blood flows from high to low pressure (P)
  - (valves in heart ensure proper direction!)
- The heart pressurizes in bursts (contractions!)
  - These bursts are "smoothed" out by the elastic recoil of the great arteries
- The highest systemic BP is during ventricular contraction (**systolic**)
  - Lowest BP is during cardiac rest/filling (**diastolic**)
- P is so low in veins that they have valves to prevent backflow
- "Skeletal muscle pump" also helps return B to the heart
  - Many veins run right through muscle layers, so that regular movements by the animal will "squeeze" blood back to heart

42.11

42.10


Pressure (mm Hg)
120
100
80
60
40
20
0
Systolic pressure
Diastolic pressure
Aorta
Arteries
Arterioles
Capillaries
Venules
Veins
Venae cavae

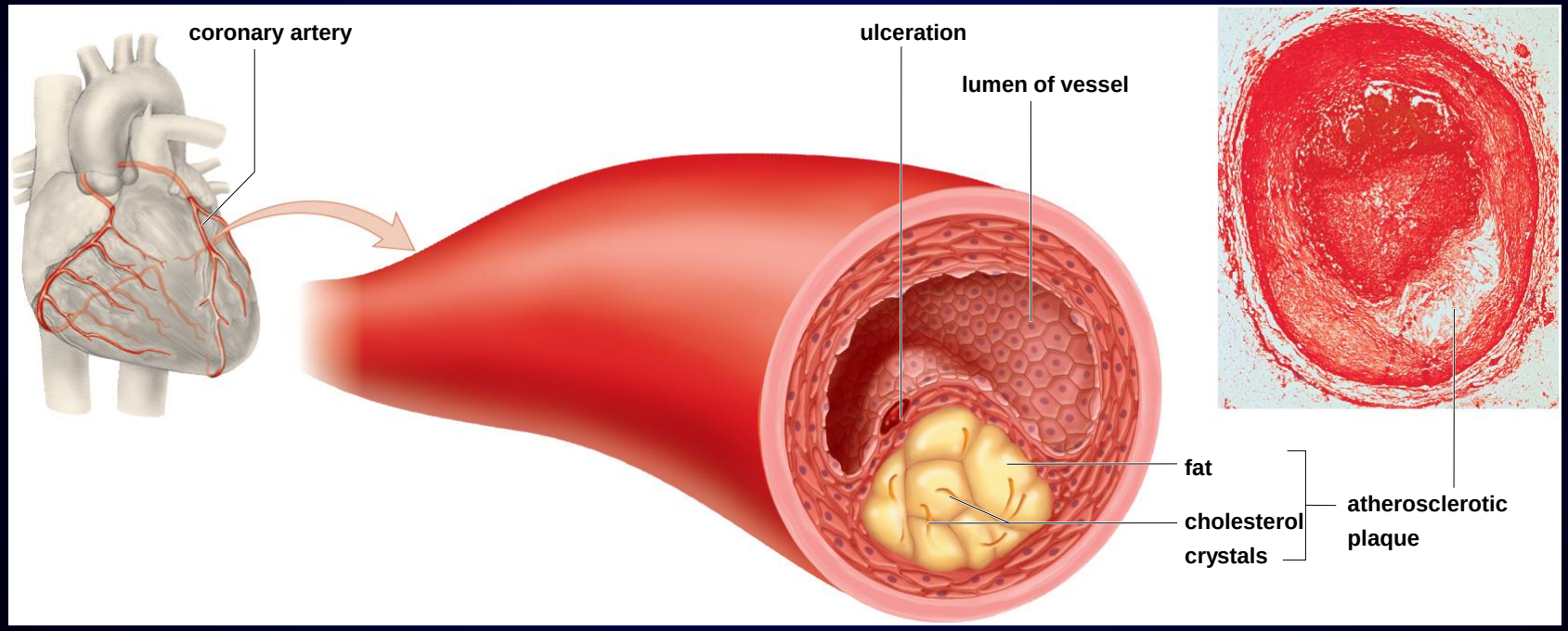




Cardiovascular Disorders

- Hypertension - High blood pressure
- Atherosclerosis - Accumulation of fatty materials in inner linings of arteries
- Stroke - Cranial arteriole bursts or is blocked by an embolus
- Heart attack – (Myocardial infarction) Coronary artery becomes partially blocked
- Angina pectoris – Painful squeezing sensation from myocardial oxygen insufficiency

Coronary Arteries and Plaque



Blood: Homeostasis Functions

- Transports substances to and from capillaries for exchange with tissue fluid
- Guards against pathogen invasion
- Regulates body temperature
- Buffers body pH
- Maintain osmotic pressure
- Clots prevent blood/fluid loss

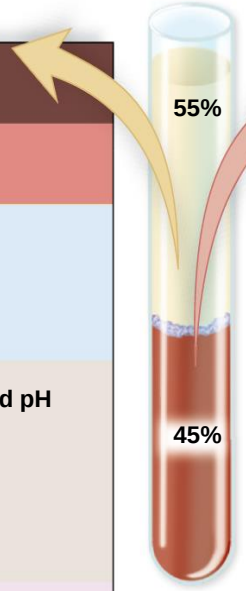
Red & White Blood Cells

- Red blood cells:
  - Small, biconcave disks
  - Manufactured continuously in bone marrow of skull, ribs, vertebrae, and ends of long bones
  - Lack a nucleus and contain hemoglobin
    - Hemoglobin contains
      - Four globin protein chains
      - Each associated with an iron-containing heme
- White Blood Cells
  - Most types larger than red blood cells
  - Contain a nucleus and lack hemoglobin
  - Important in inflammatory response
    - Neutrophils enter tissue fluid and phagocytize foreign material
    - Lymphocytes (T Cells) attack infected cells
    - Antigens cause body to produce antibodies

Composition of Blood

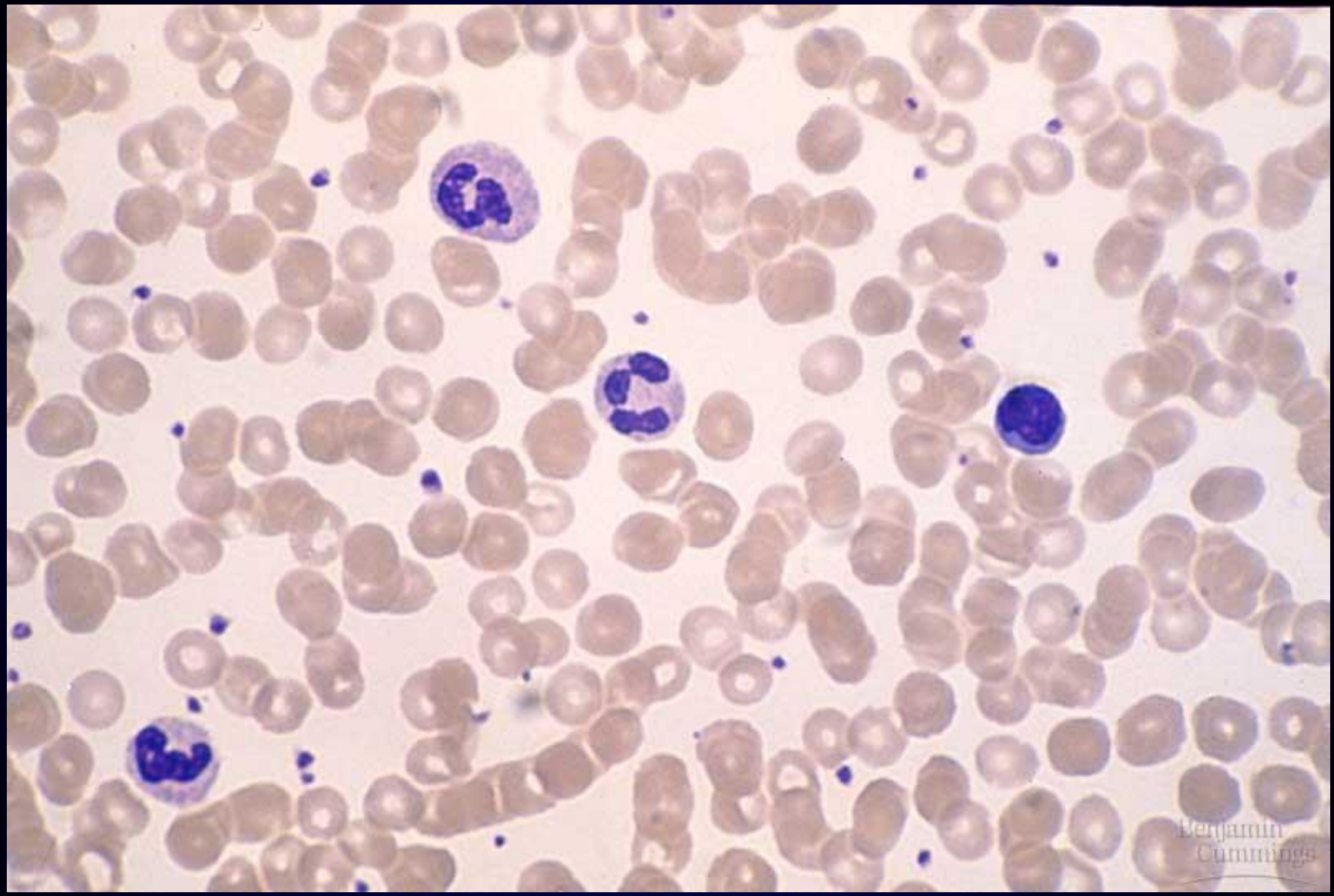
Plasma

Type	Function
Water (90–92% of plasma)	Maintains blood volume; transports molecules
Plasma proteins (7–8% of plasma)	Maintain blood osmotic pressure and pH
Globulins	Transport; fight infection
Fibrinogen	Blood clotting
Salts (less than 1% of plasma)	Maintain blood osmotic pressure and pH; aid metabolism
Gases (O_2 and CO_2)	Cellular respiration
Nutrients (lipids, glucose, and amino acids)	Food for cells
Wastes (urea and uric acid)	End product of metabolism; excretion by kidneys
Hormones	Aid metabolism



Formed Elements

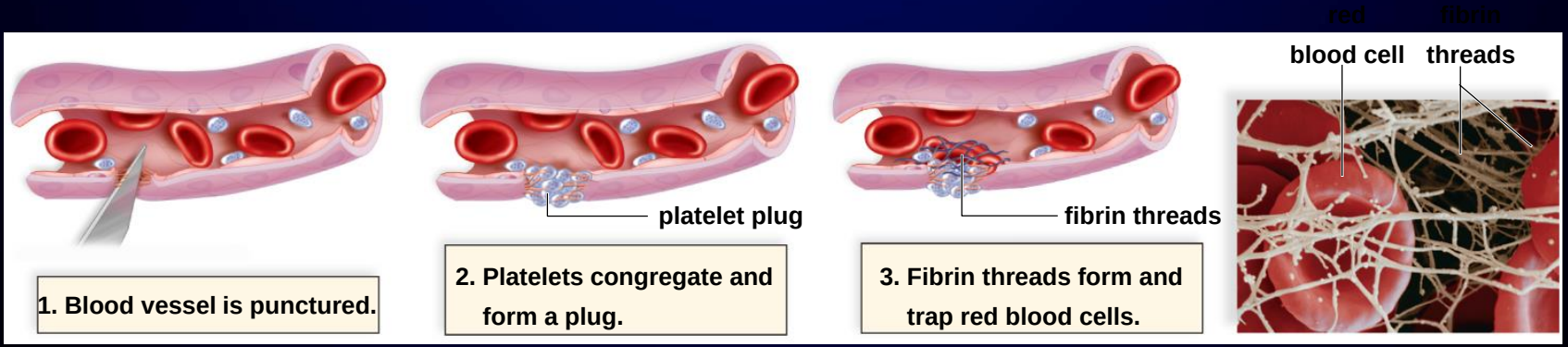
Type	Number (per mm 3 blood)
Red blood cells (erythrocytes) Transport O_2 and help transport CO_2	4 million–6 million
White blood cells (leukocytes) 5,000–1 1,000 Fight infection	
Neutrophils	40–70%
Lymphocytes	20–45%
Monocytes	4–8%
Eosinophils	1–4%
Basophils	0–1%
Platelets (thrombocytes) Aid clotting	150,000–300,000



Giemsa-stained Blood Smear

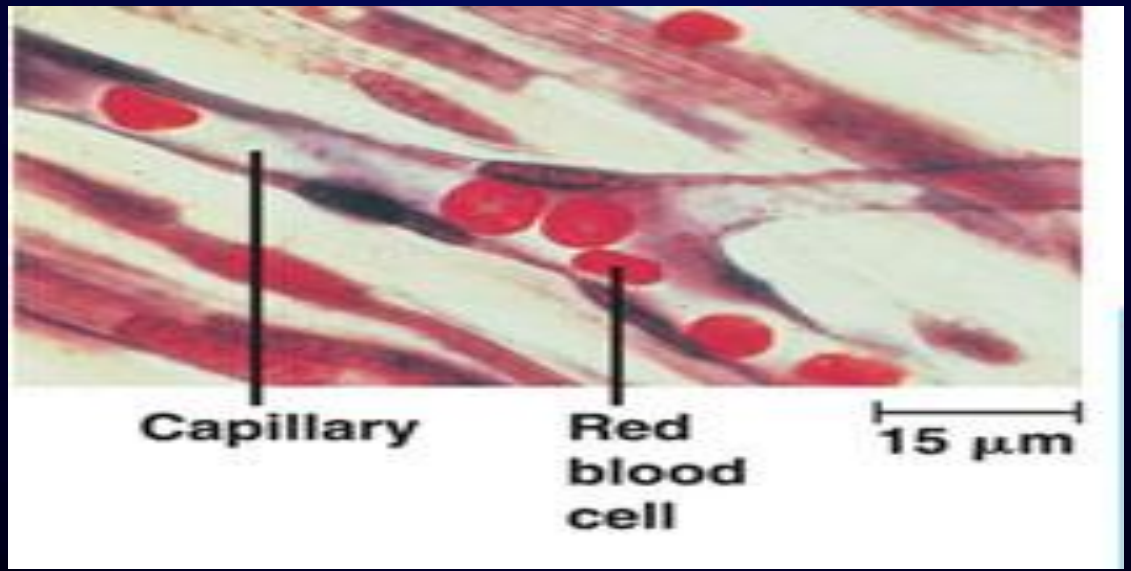
Platelets

- Platelets
  - Result from fragmentation of megakaryocytes
  - Involved in coagulation
- Blood clot consists of:
  - Platelets
  - Red blood cells
  - All entangled within fibrin threads

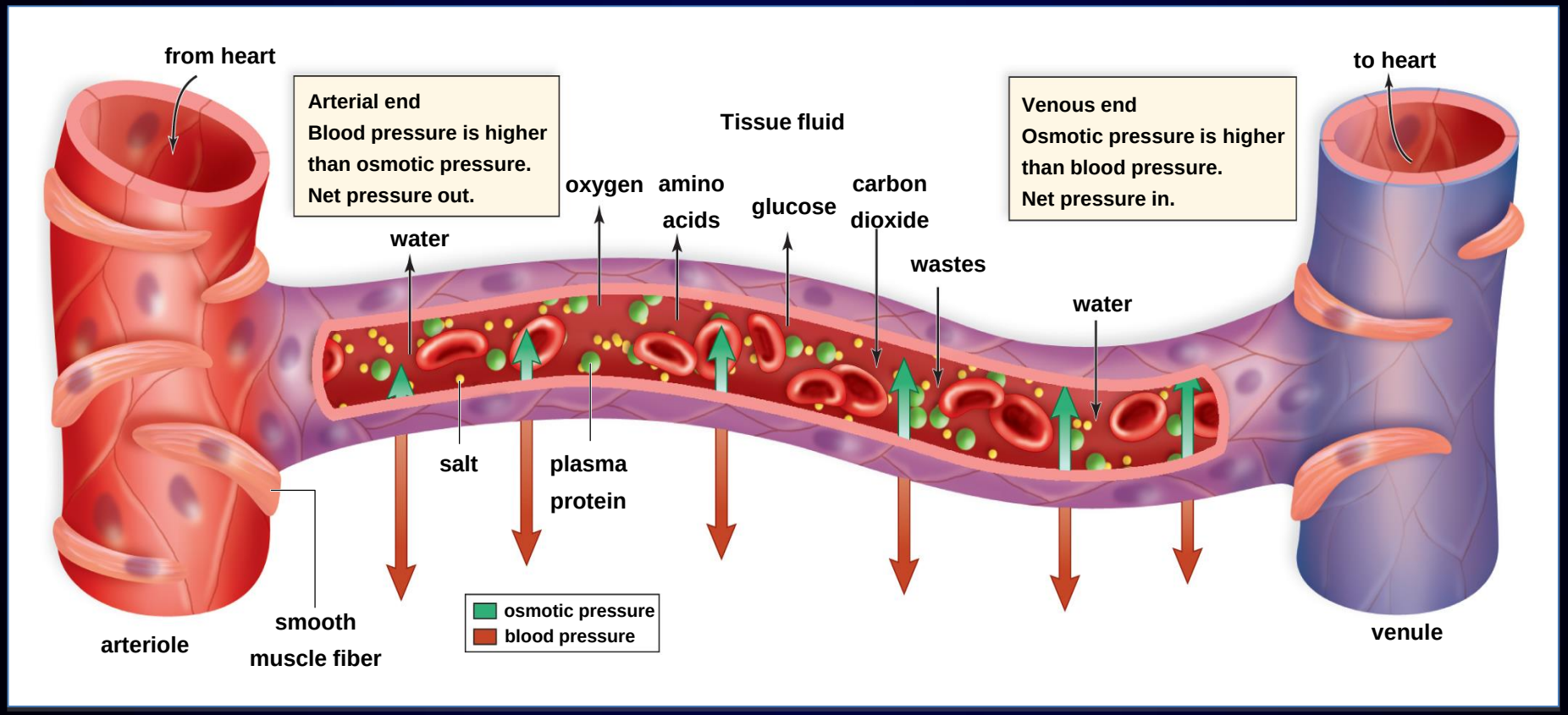


Capillary Exchange

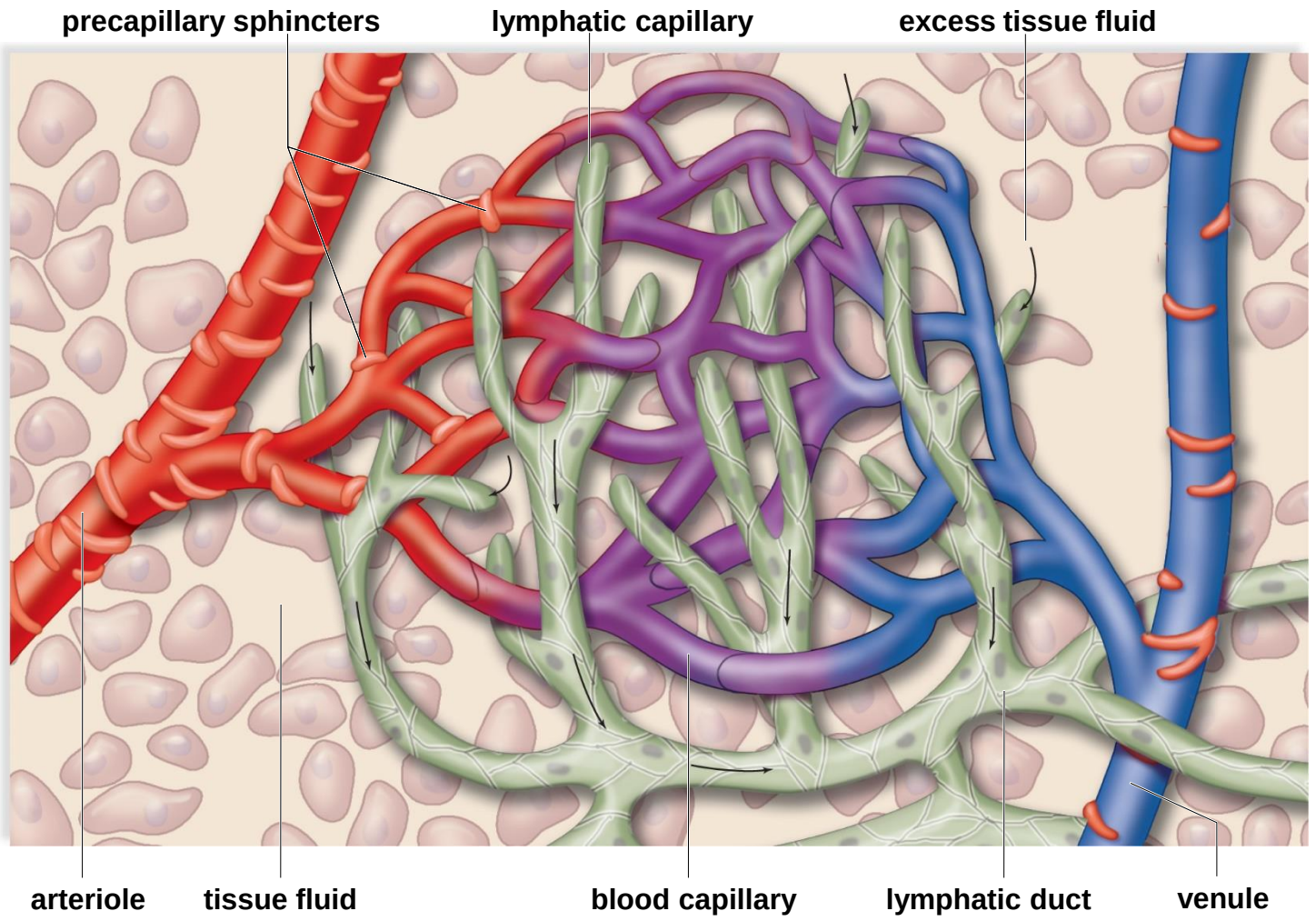
- Capillaries very narrow – Tiny RBCs must go through single file
- Wall of capillaries very thin to facilitate diffusion of nutrients, gases, and wastes
  - Oxygen and nutrients exit a capillary near the arterial end
  - Carbon dioxide and waste molecules enter a capillary near the venous end



Capillary Exchange



Capillary Bed

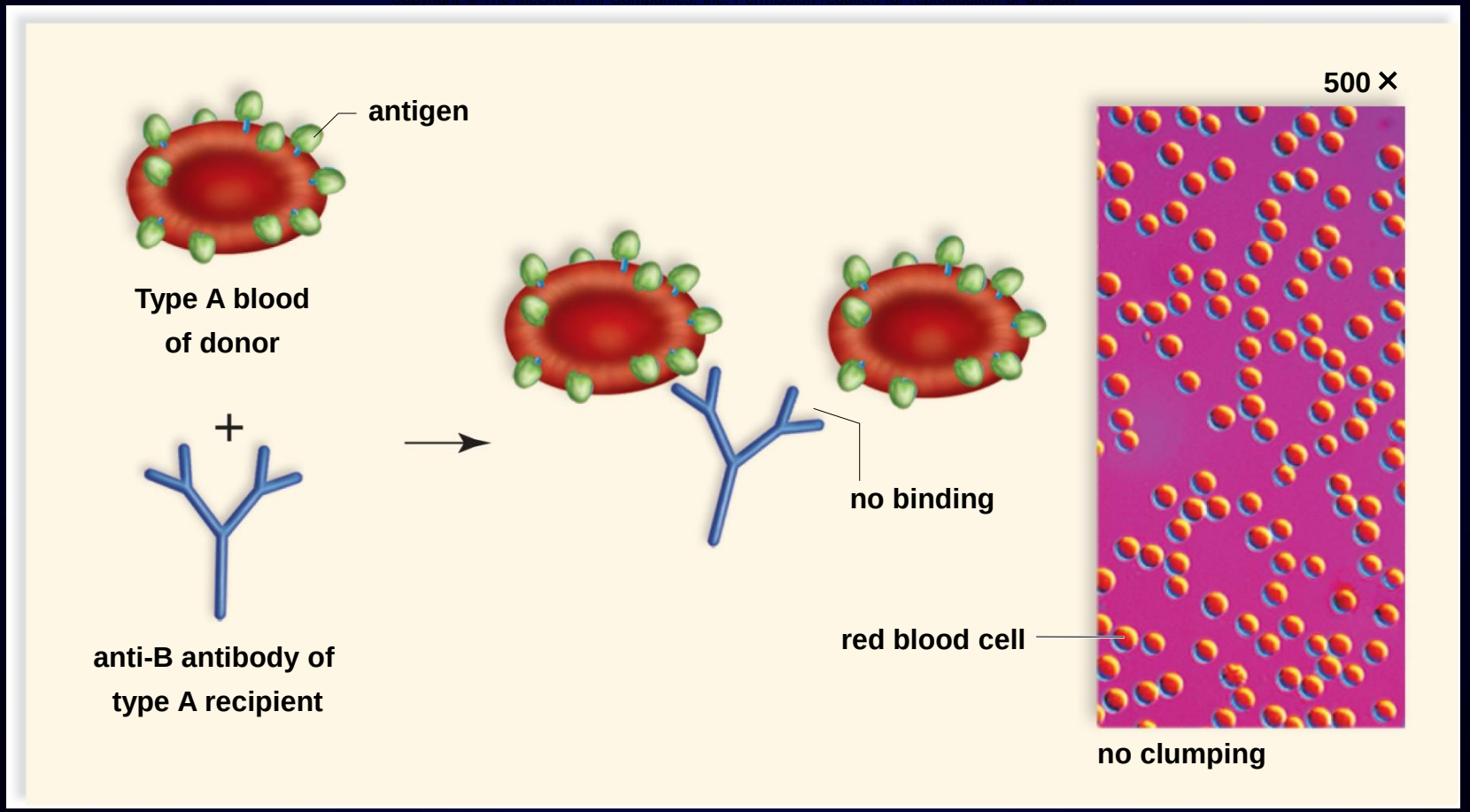


Blood Type

- Determined by the presence or absence of surface antigens (agglutinogens)
  - Antigens A, B and Rh (D)
- Antibodies in the plasma (agglutinins)
- Cross-reactions occur when antigens meet antibodies

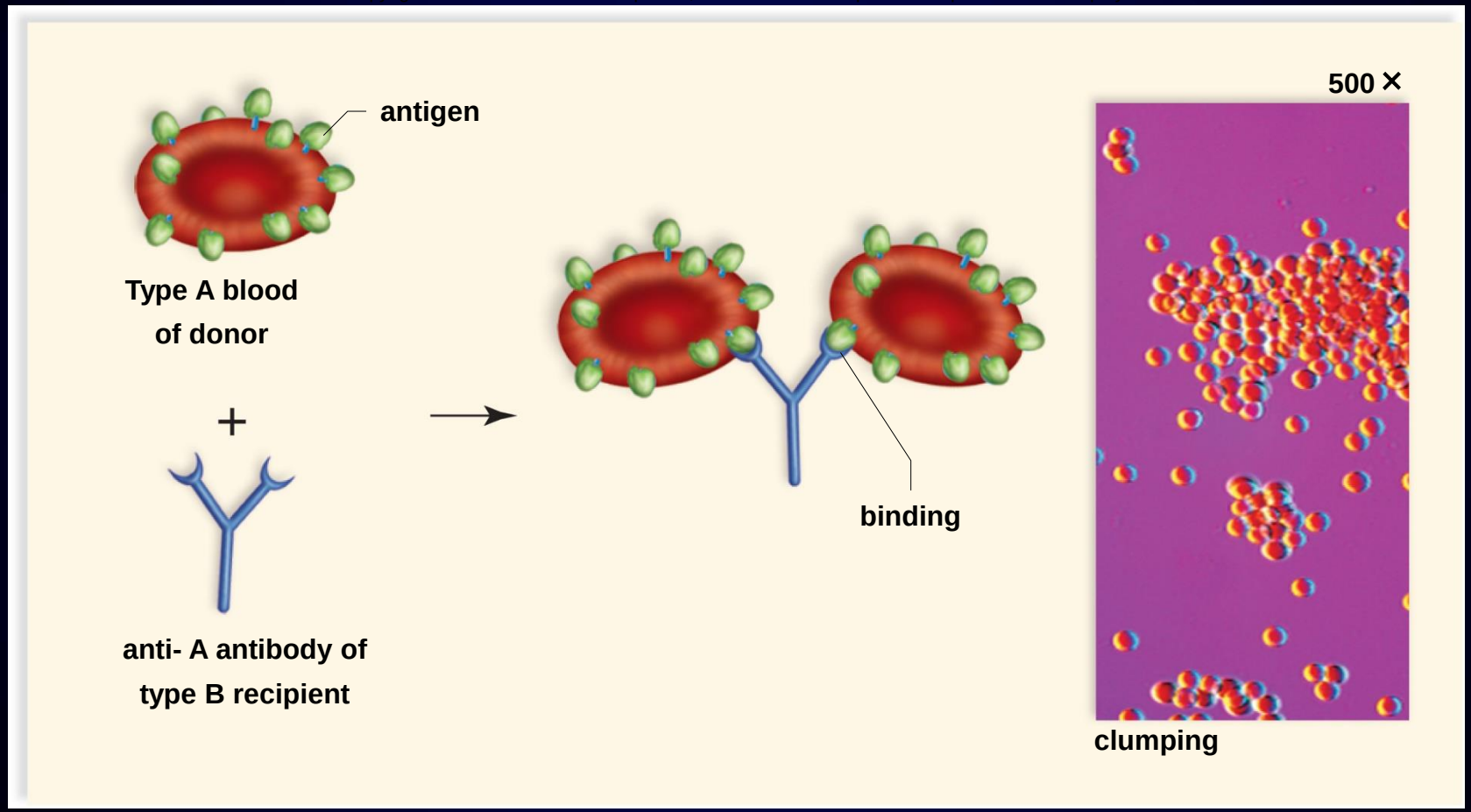
Blood Type	Antigen on Red Blood Cells	Antibody In Plasma
A	A	Anti-B
B	B	Anti-A
AB	A, B	None
O	None	Anti-A and anti-B

No Agglutination



No agglutination

Agglutination



Agglutination

Blood Type

- During pregnancy, if the mother is Rh negative and the father is Rh positive, the child may be Rh positive.
  - Rh-positive red blood cells may leak across the placenta
  - The mother will produce anti-Rh antibodies.
  - Antibodies may attack the embryo in a subsequent pregnancy

Points to ponder

- What are the functions of the cardiovascular system?
- What is the anatomy of the heart? Of blood vessels, such as veins and arteries?
- How is the heart beat regulated?
- What is blood pressure?
- What are common cardiovascular diseases and how might you prevent them?