Special circulations, Coronary, Pulmonary…

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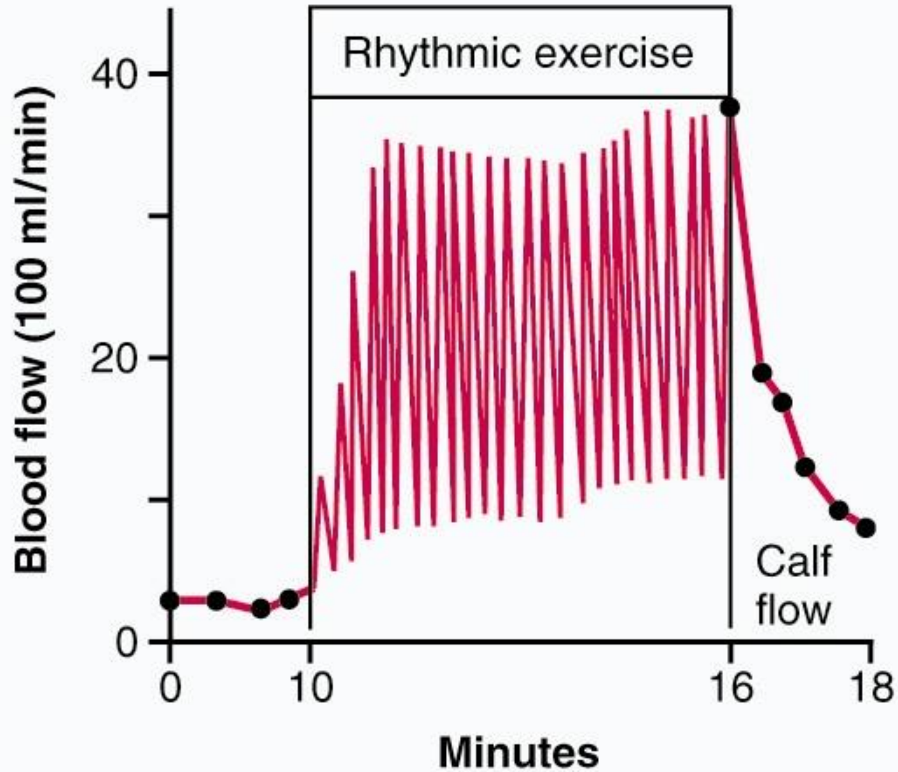
Objectives

- Describe the control of blood flow to different circulations (Skeletal muscles, pulmonary and coronary)
- Point out special hemodynamic characteristic pertinent to each circulation discussed

Blood Flow: Skeletal Muscle Regulation

- Muscle blood flow can increase tenfold or more during physical activity as vasodilation occurs
  - Low levels of epinephrine bind to β receptors
  - Cholinergic receptors are occupied
- Intense exercise or sympathetic nervous system activation result in high levels of epinephrine
  - High levels of epinephrine bind to α receptors and cause vasoconstriction
    - This is a protective response to prevent muscle oxygen demands from exceeding cardiac pumping ability

Exercise and Muscle Blood Flow



Muscle Blood Flow During Exercise

- Can 20 fold during exercise.
- Muscle makes up a large portion of body mass Þ great effect on Cardiac output.
- Resting blood flow = 3 to 4 ml/min/100 gm muscle.
- Oxygen delivery can be increased by increasing the extraction ratio from 25% up t0 75%
- Capillary density ’s markedly.
- Most blood flow occurs between contractions.

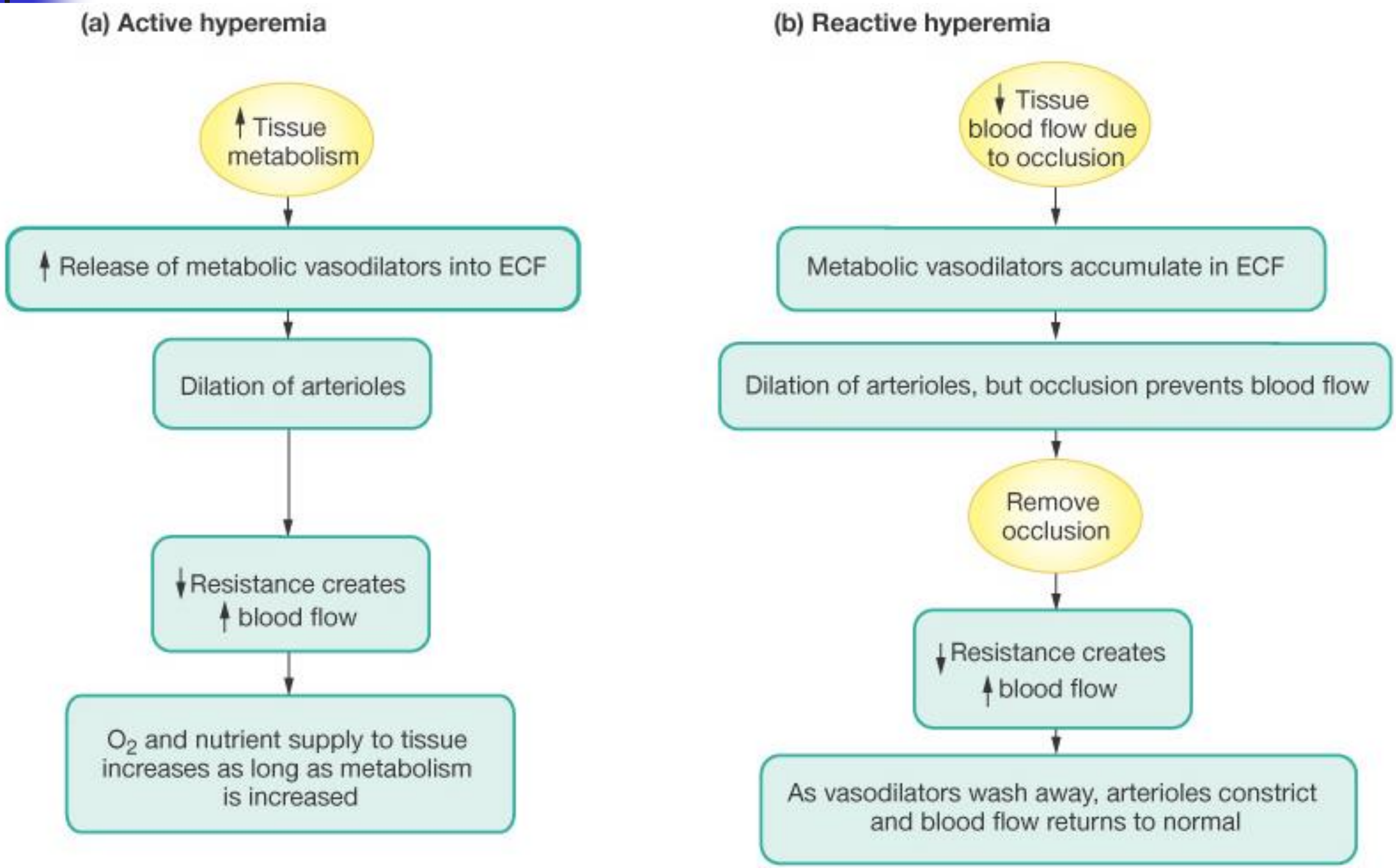
Local Regulation of Muscle Blood Flow during Exercise

- ↓ O_2 during exercise affects vascular smooth muscle directly ⇒ vasodilation.
- Vasodilators (which ones?)
  1. K^+
  2. Adenosine
  3. Osmolality
  4. EDRF (nitric oxide)

Nervous Regulation

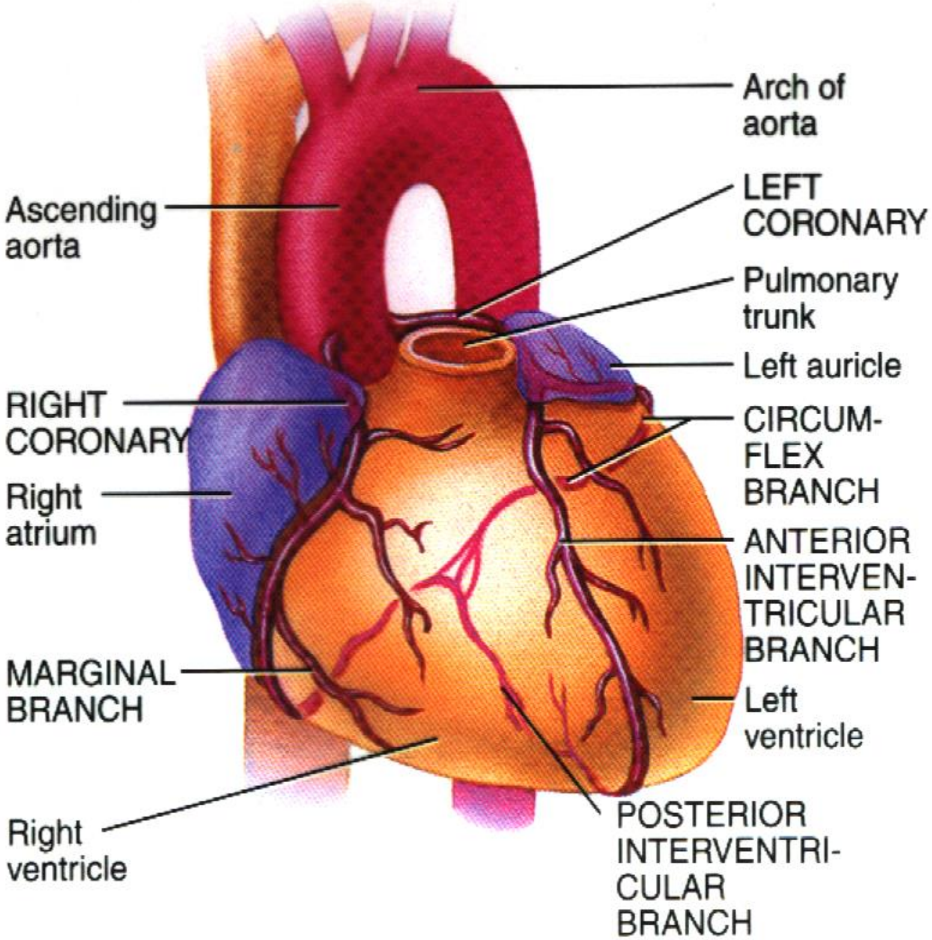
- Sympathetic release of norepinephrine (mainly α).
- Adrenals release epinephrine (β and α) norepinephrine (α + a little β).
  - β receptors ⇒ vasodilation mainly in muscle and the liver.
  - α receptors ⇒ vasoconstriction in kidney and gut.

Arteriole Resistance: Control of Local Blood Flow

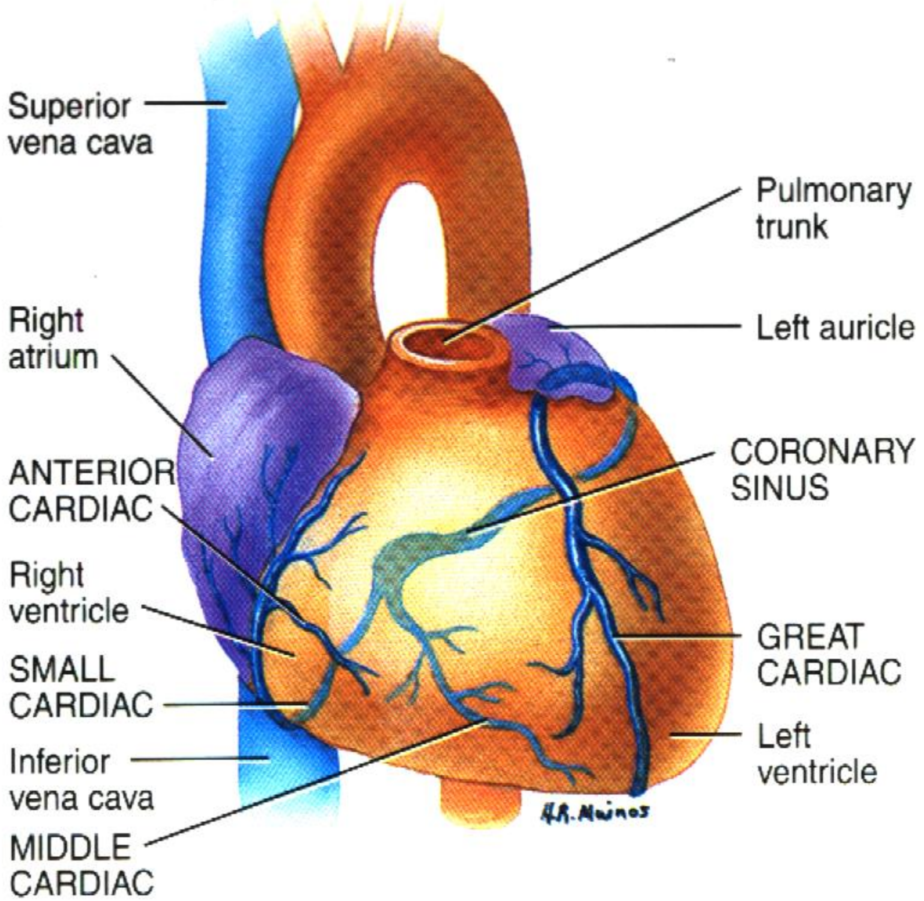


Blood Flow: Heart

- Small vessel coronary circulation is influenced by:
  - Aortic pressure
  - The pumping activity of the ventricles
- During ventricular systole:
  - Coronary vessels compress
  - Myocardial blood flow ceases
  - Stored myoglobin supplies sufficient oxygen
- During ventricular diastole, oxygen and nutrients are carried to the heart
- Extraction ratio is maximum (75%) during rest so an increase demand for oxygen means an increase blood flow

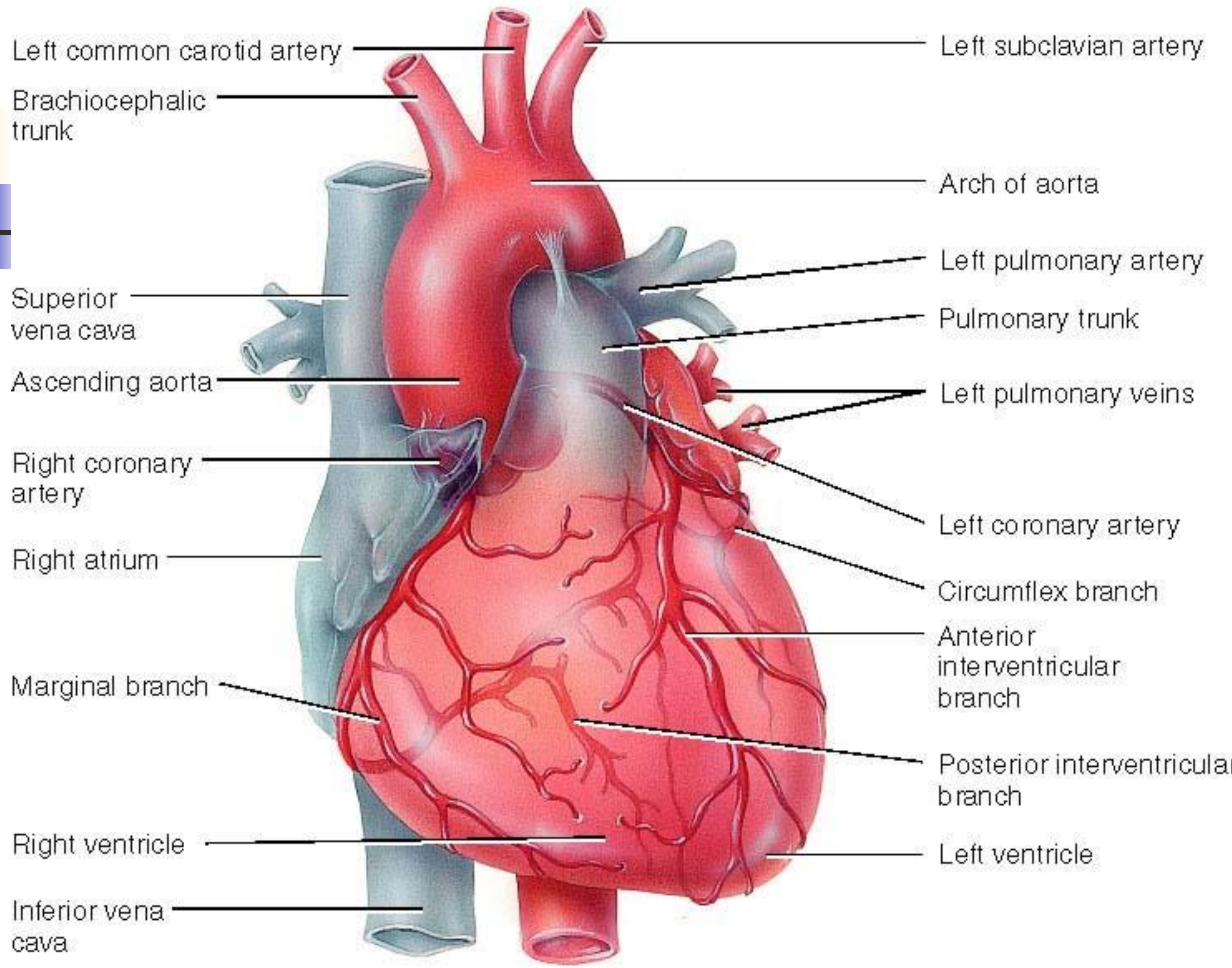


(a) Anterior view of coronary arteries

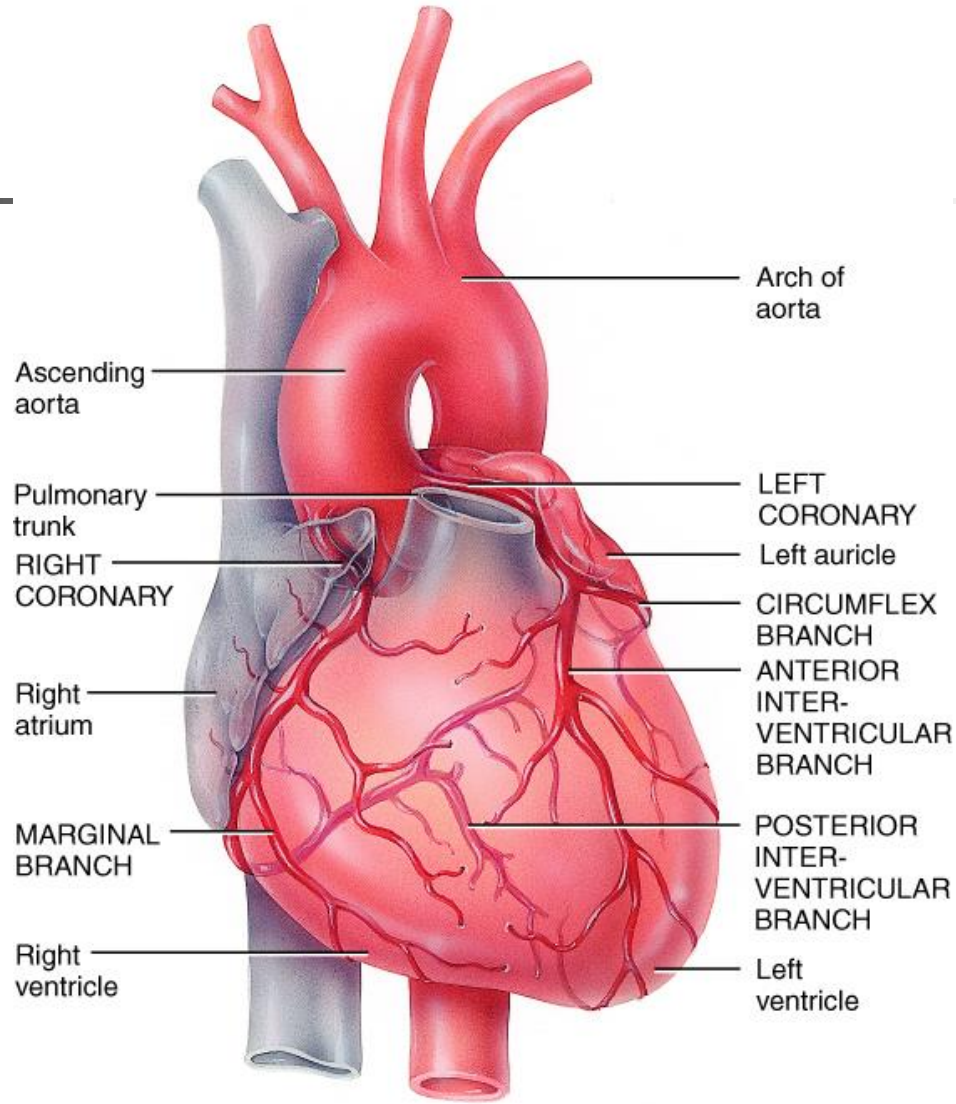


(b) Anterior view of coronary veins

CORONARY CIRCULATION


Left common carotid artery
Brachiocephalic trunk
Superior vena cava
Ascending aorta
Right coronary artery
Right atrium
Marginal branch
Right ventricle
Inferior vena cava
Left subclavian artery
Arch of aorta
Left pulmonary artery
Pulmonary trunk
Left pulmonary veins
Left coronary artery
Circumflex branch
Anterior interventricular branch
Posterior interventricular branch
Left ventricle

21.19



(a) Anterior view of coronary arteries

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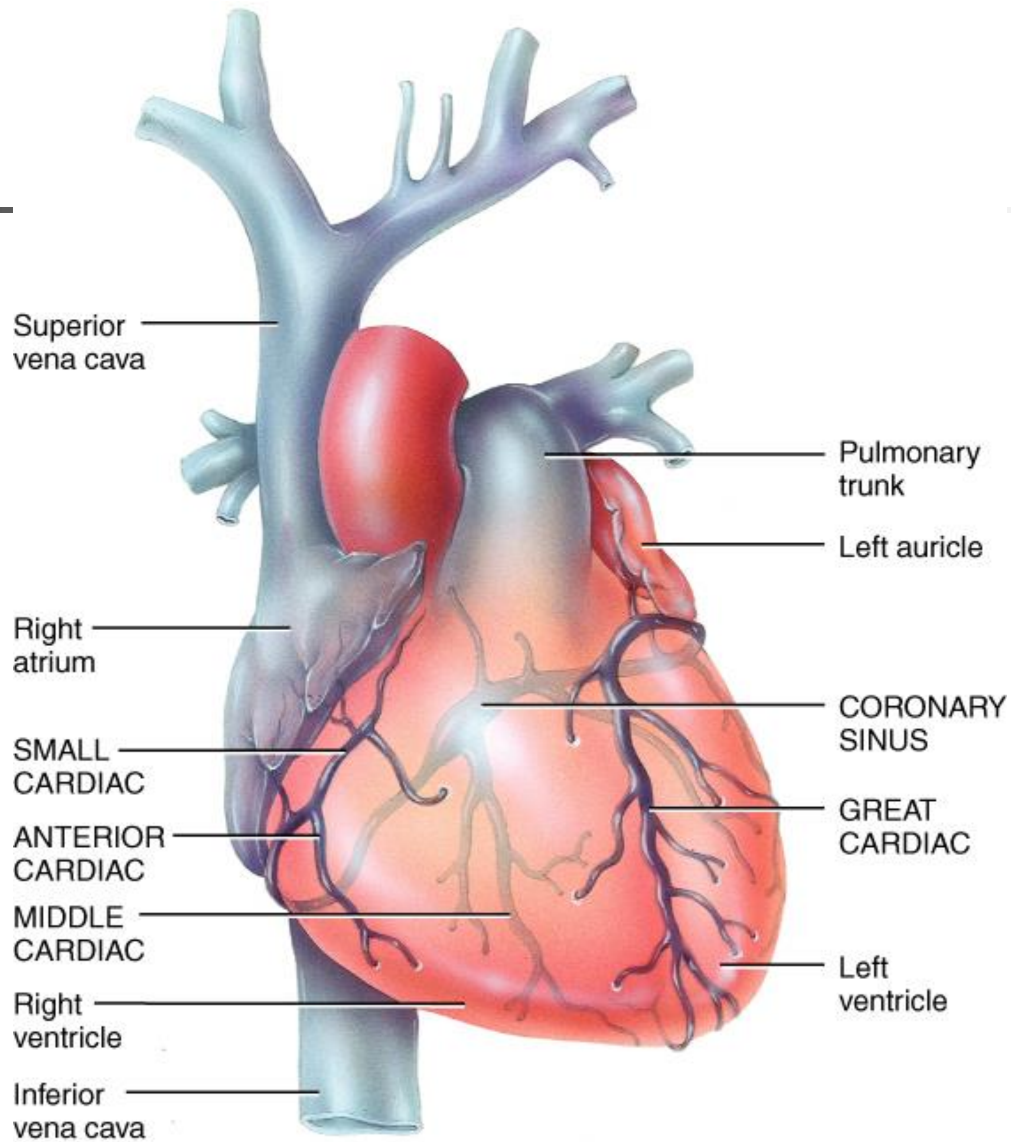

(b) Anterior view of coronary veins

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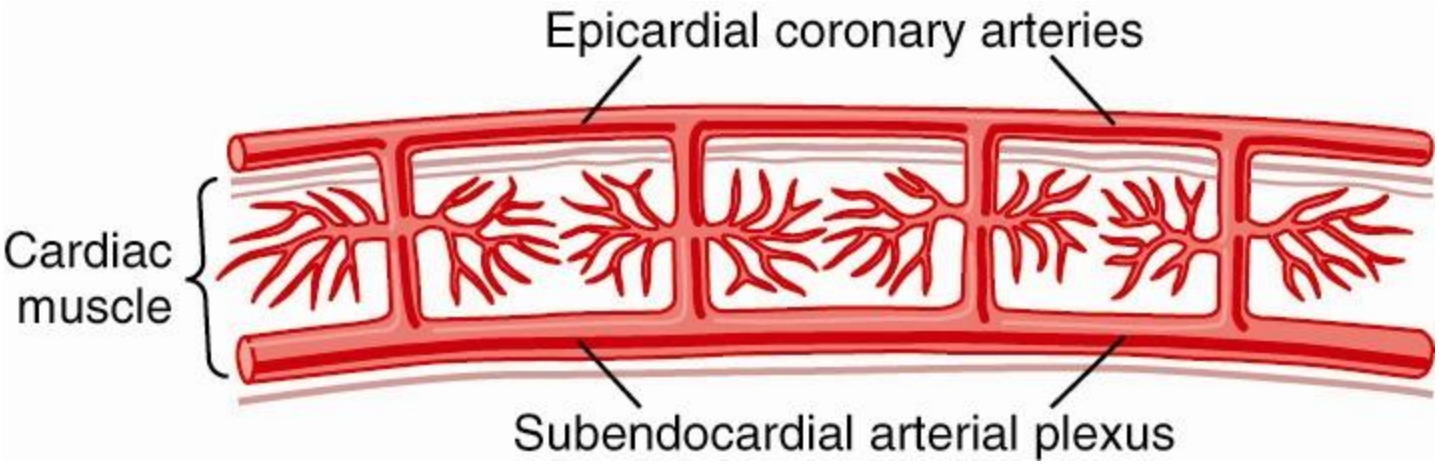
Epicardial and Subendocardial Vasculature



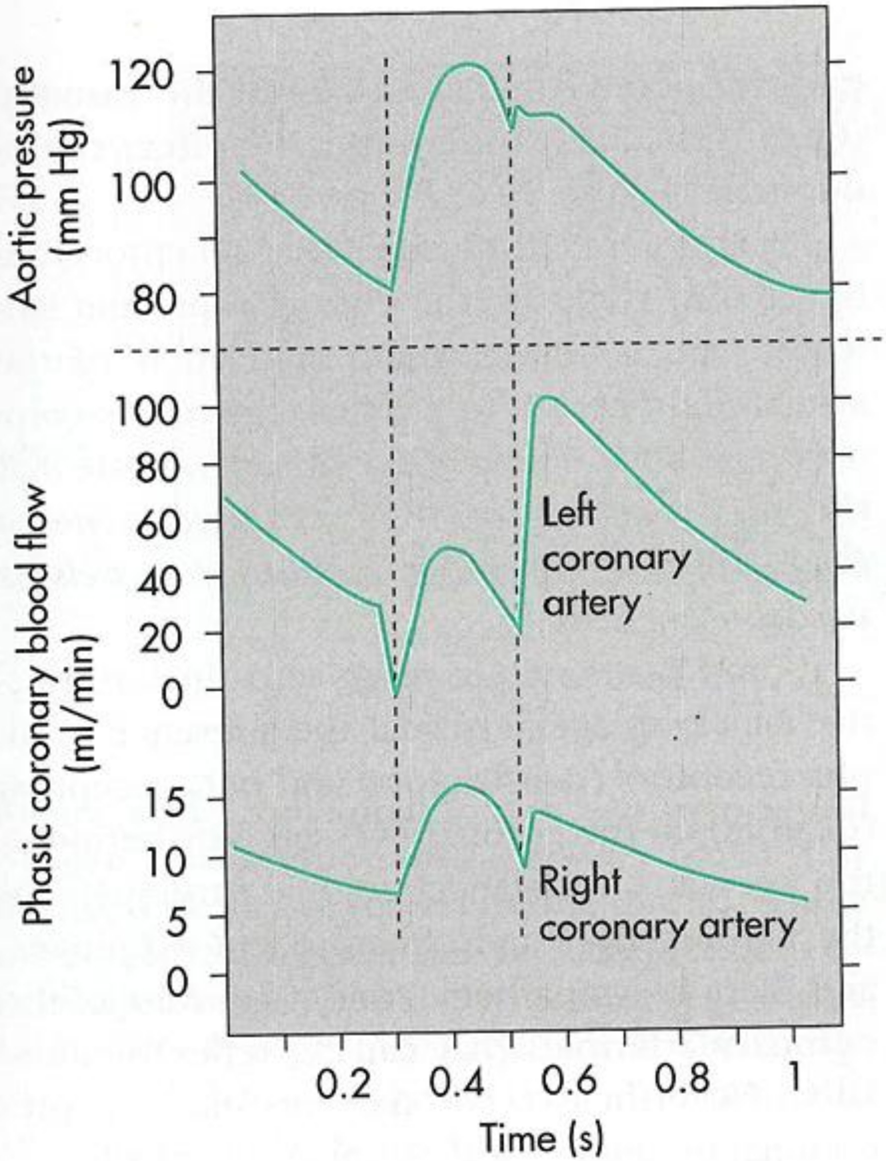
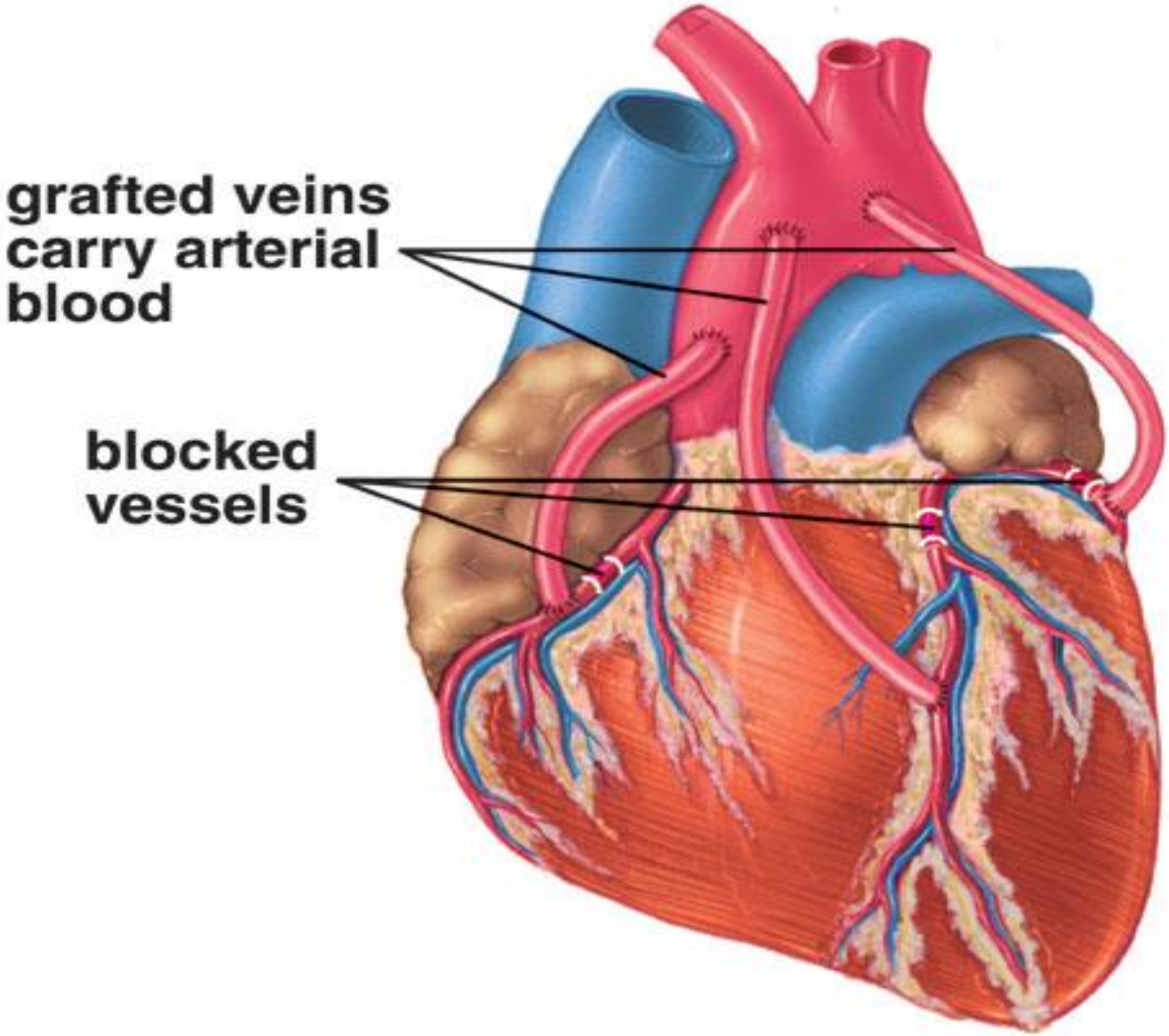
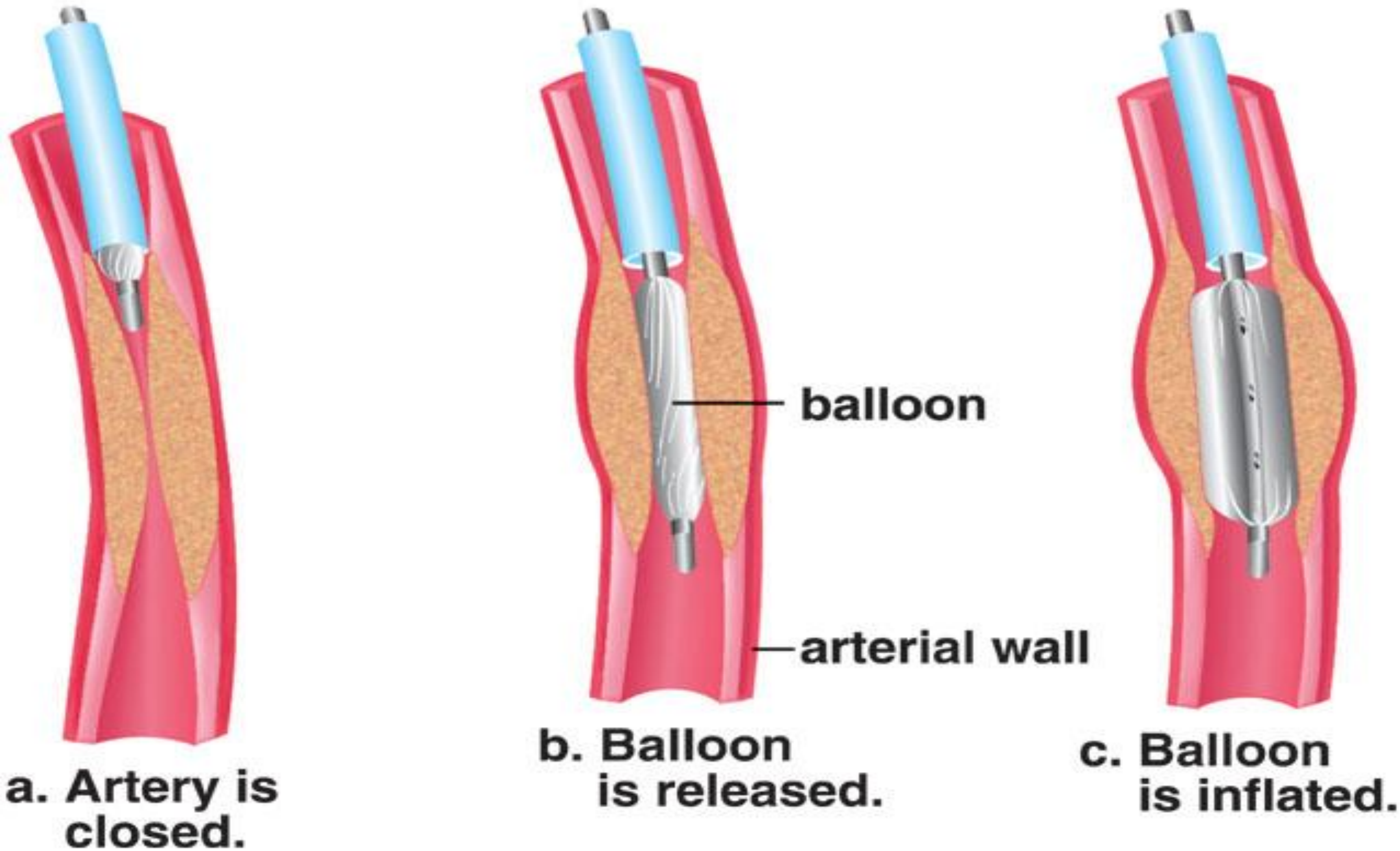


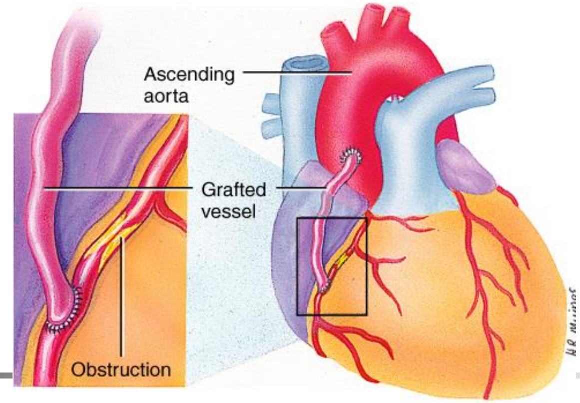
Figure 10-3 ■ Comparison of phasic coronary blood flow in the left and right coronary arteries.

Coronary bypass operation

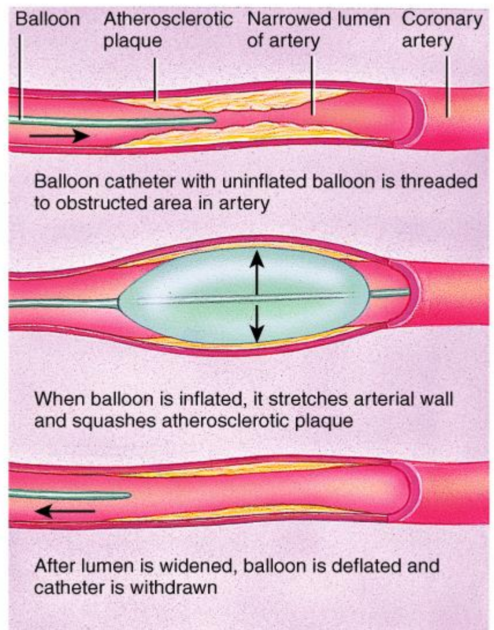


Angioplasty

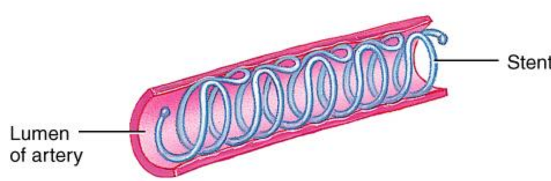




(a) Coronary artery bypass grafting (CABG)



(b) Percutaneous transluminal coronary angioplasty (PTCA)



(c) Stent in an artery

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Blood Flow: Brain

- Blood flow to the brain is constant, as neurons are intolerant of ischemia
- Metabolic controls – brain tissue is extremely sensitive to declines in pH, and increased carbon dioxide causes marked vasodilation
- Myogenic controls protect the brain from damaging changes in blood pressure
  - Decreases in MAP cause cerebral vessels to dilate to insure adequate perfusion
  - Increases in MAP cause cerebral vessels to constrict

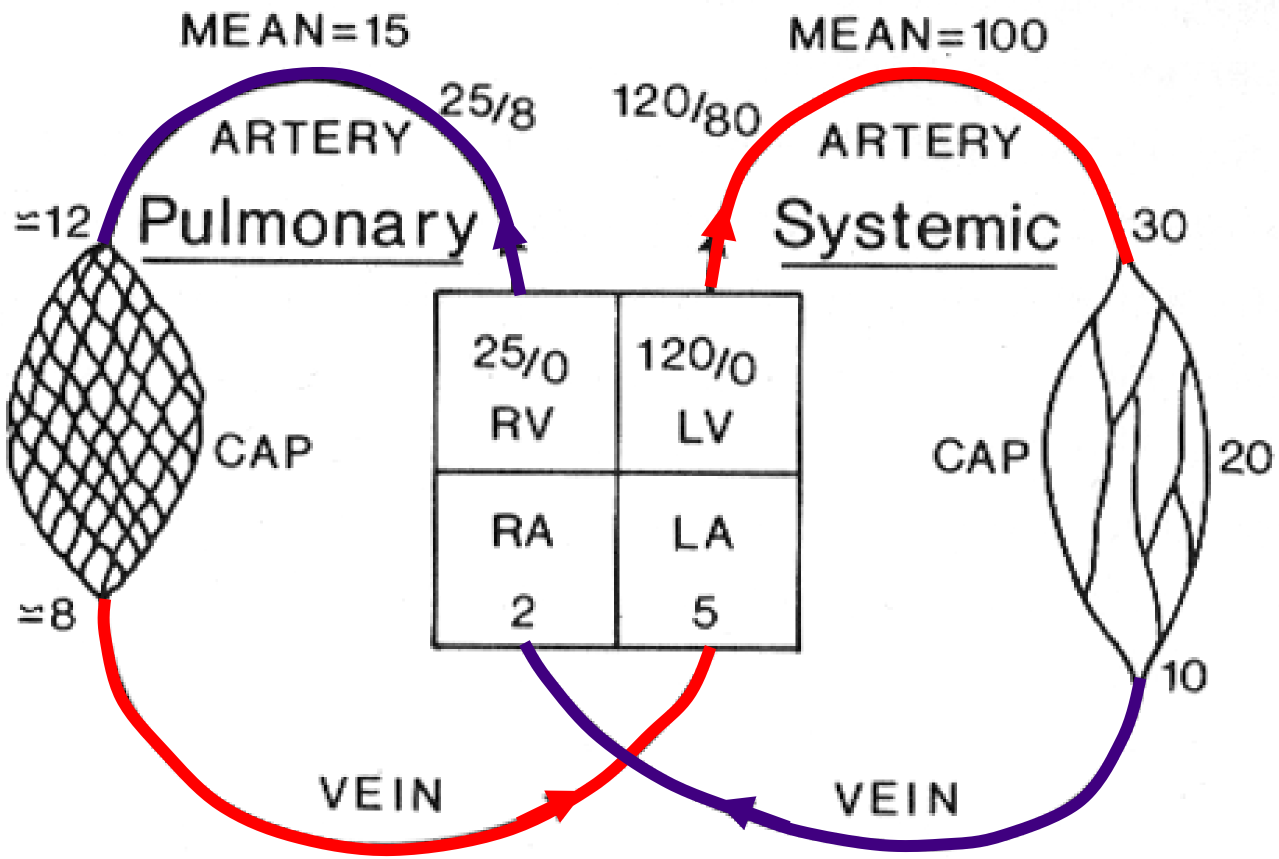
Blood Flow: Brain

- The brain can regulate is own blood flow in certain circumstances, such as ischemia caused by a tumor
- The brain is vulnerable under extreme systemic pressure changes
  - MAP below 60mm Hg can cause syncope (fainting)
  - MAP above 160 can result in cerebral edema

Blood Flow: Skin

- Blood flow through the skin:
  - Supplies nutrients to cells in response to oxygen need
  - Aids in body temperature regulation and provides a blood reservoir
- Blood flow to venous plexuses below the skin surface:
  - Varies from 50 ml/min to 2500 ml/min, depending upon body temperature
  - Is controlled by sympathetic nervous system reflexes initiated by temperature receptors and the central nervous system

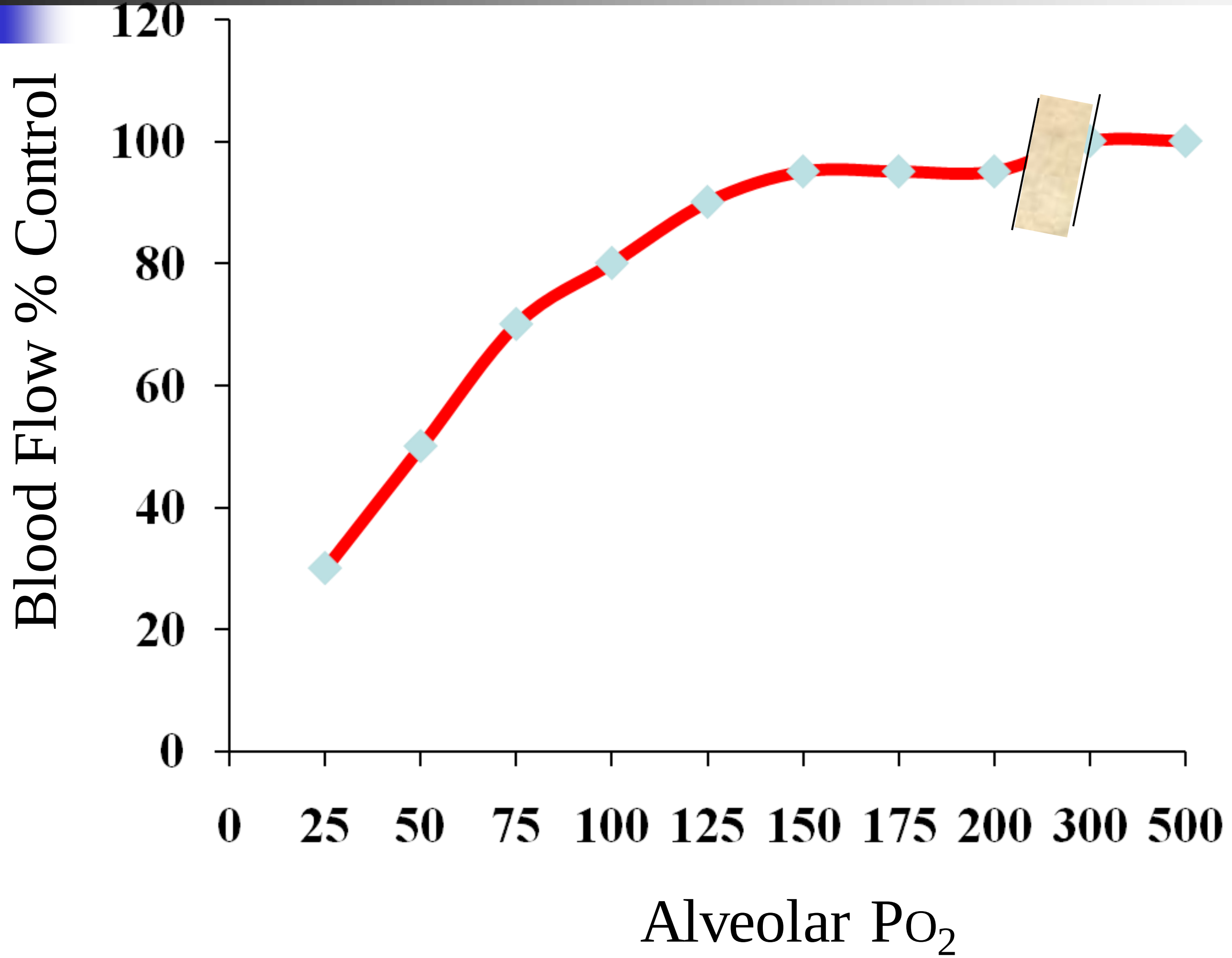
Characteristics of the Pulmonary Circulation



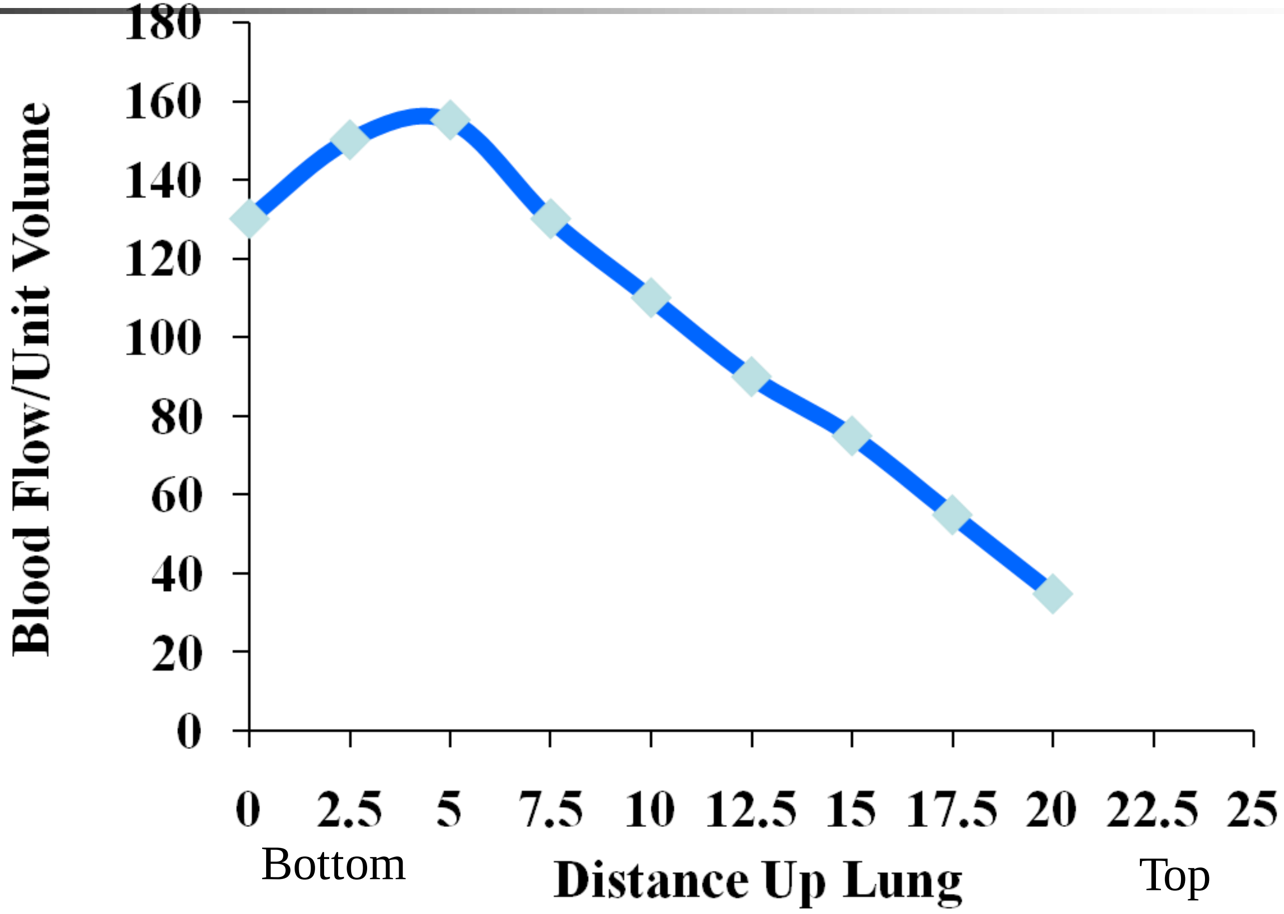
Blood Flow: Lungs

- Blood flow in the pulmonary circulation is unusual in that:
  - The pathway is short
  - Arteries/arterioles are more like veins/venules (thin-walled, with large lumens)
    - They have a much lower arterial pressure (24/8 mm Hg versus 120/80 mm Hg)
  - The autoregulatory mechanism is exactly opposite of that in most tissues
    - Low oxygen levels cause vasoconstriction; high levels promote vasodilation
    - This allows for proper oxygen loading in the lungs

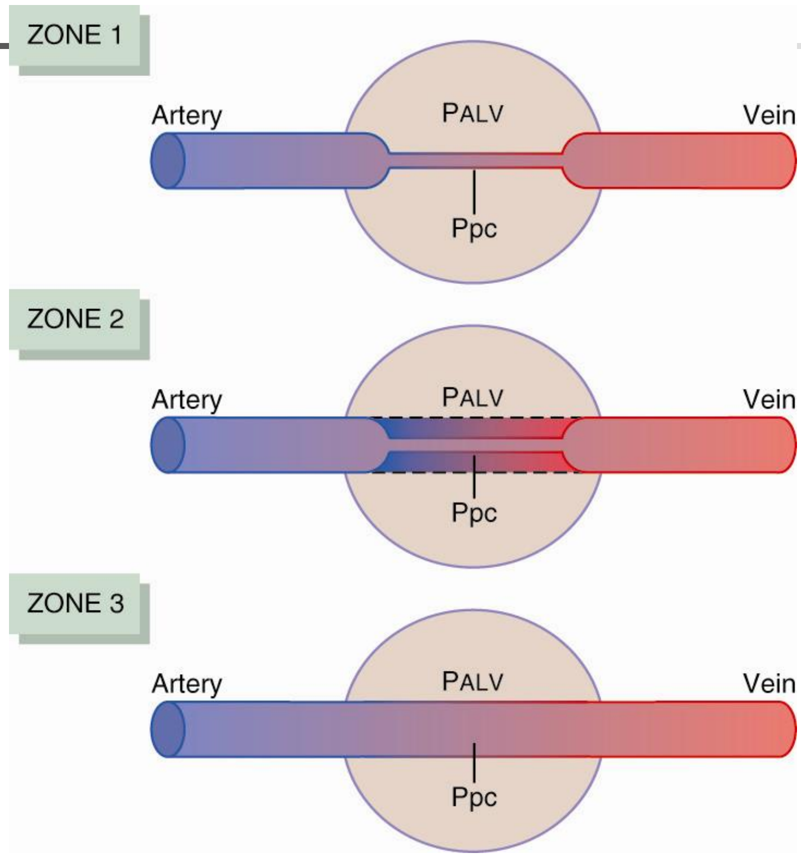
Effect of Po_2 on Blood Flow

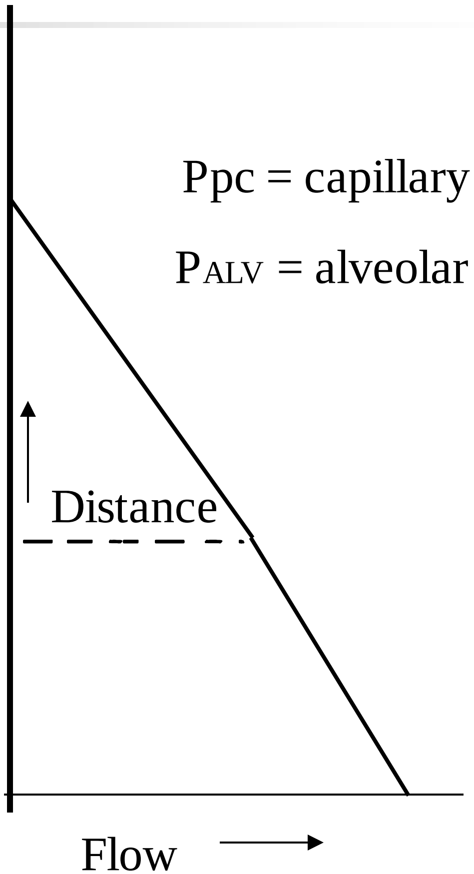


Distribution of Blood Flow



Hydrostatic Effects on Blood Flow





Ppc = capillary pressure

PALV = alveolar pressure

Thank You