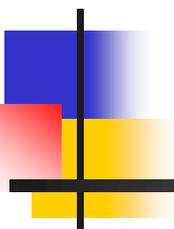
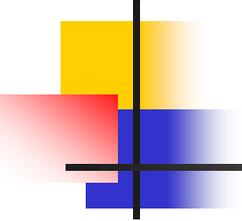


# Special circulations, Coronary, Pulmonary...



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Faisal I. Mohammed, MD,PhD

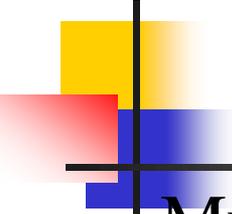


# Objectives

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

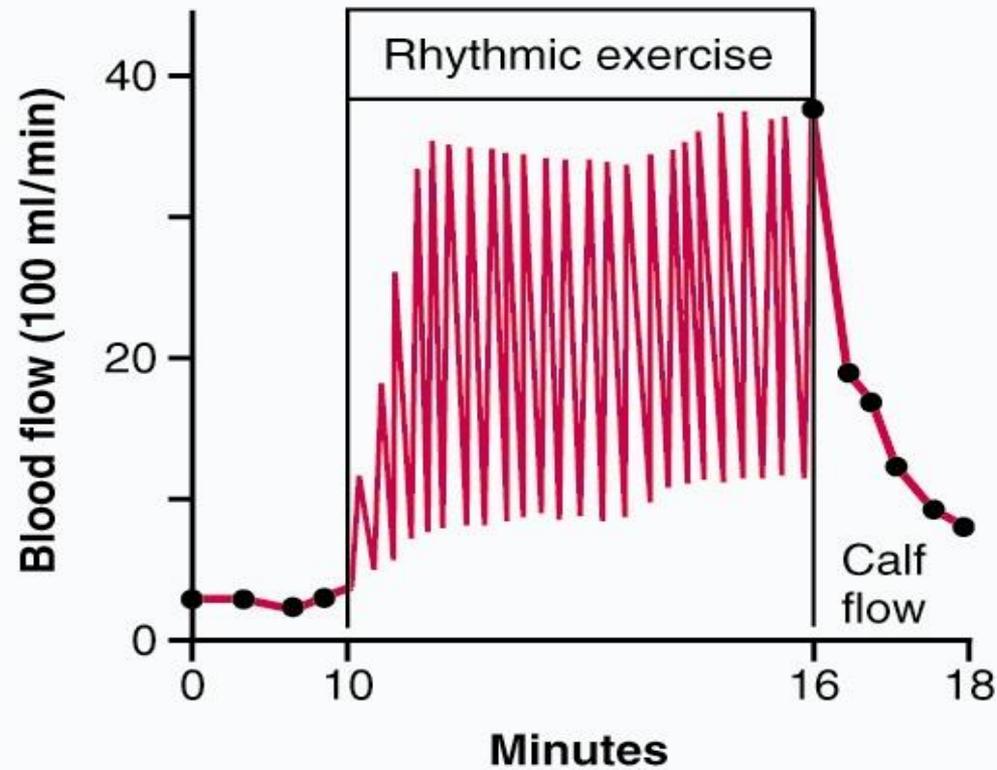
# Blood Flow: Skeletal Muscle Regulation



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

# Exercise and Muscle Blood Flow



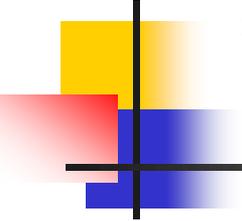


# Muscle Blood Flow During Exercise

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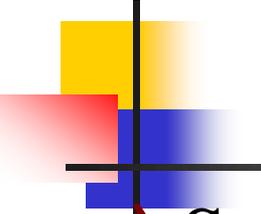
- ❖ Can 20 fold during exercise.
- ❖ Muscle makes up a large portion of body mass that has great effect on Cardiac output.
- ❖ Resting blood flow = 3 to 4 ml/min/100 gm muscle.
- ❖ Oxygen delivery can be increased by increasing the extraction ratio from 25% up to 75%
- ❖ Capillary density 's markedly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

# Local Regulation of Muscle Blood Flow during Exercise



---

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



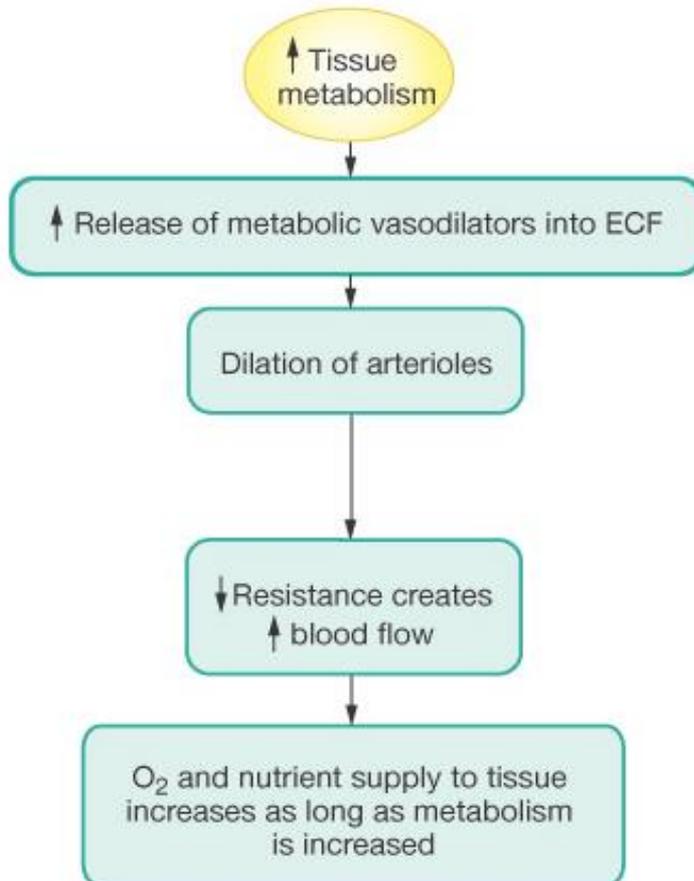
# Nervous Regulation

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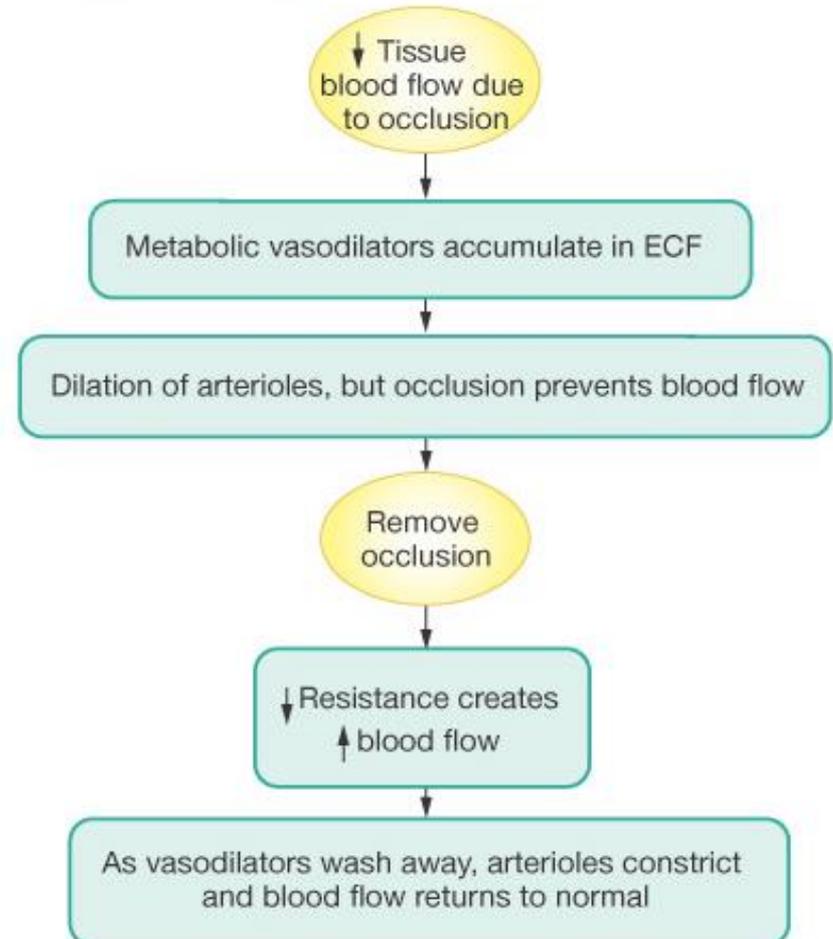
- Sympathetic release of norepinephrine (mainly  $\alpha$ ).
- Adrenals release epinephrine ( $\beta$  and  $\alpha$ ) norepinephrine ( $\alpha$  + a little  $\beta$ ).
- ☞  $\beta$  receptors  $\Rightarrow$  vasodilation mainly in muscle and the liver.
- ☞  $\alpha$  receptors  $\Rightarrow$  vasoconstriction in kidney and gut.

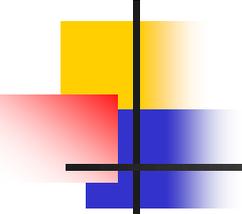
# Arteriole Resistance: Control of Local Blood Flow

(a) Active hyperemia



(b) Reactive hyperemia

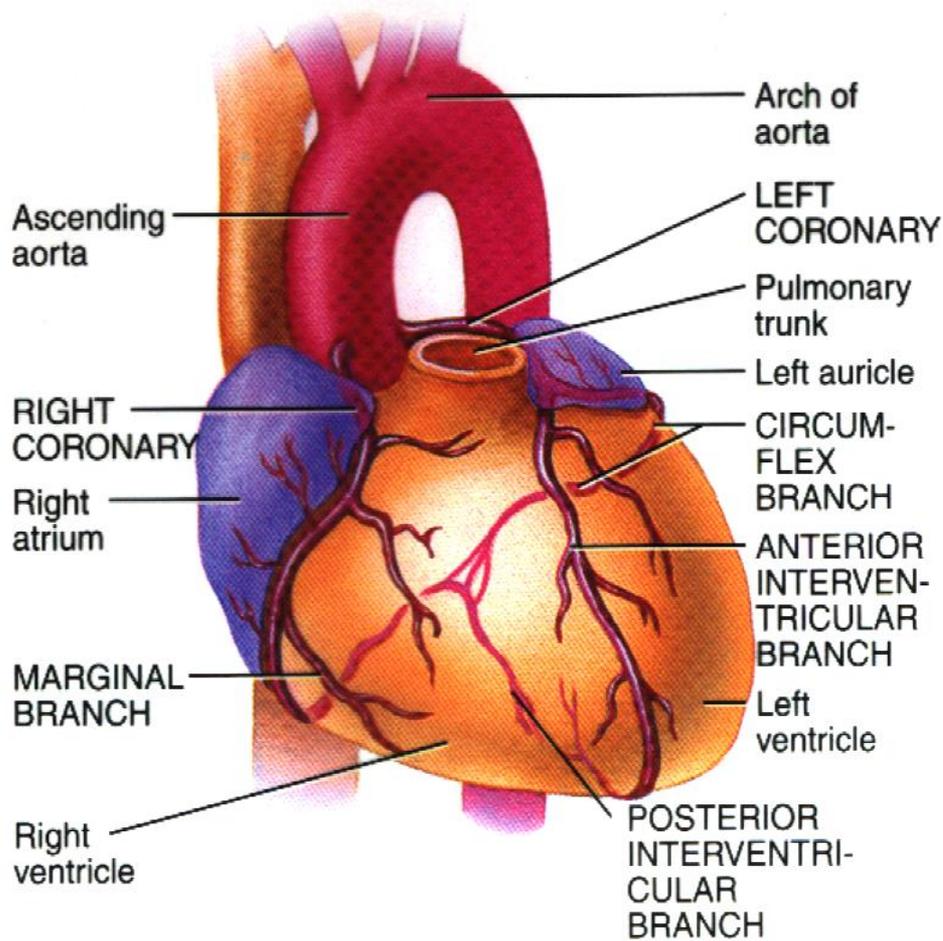




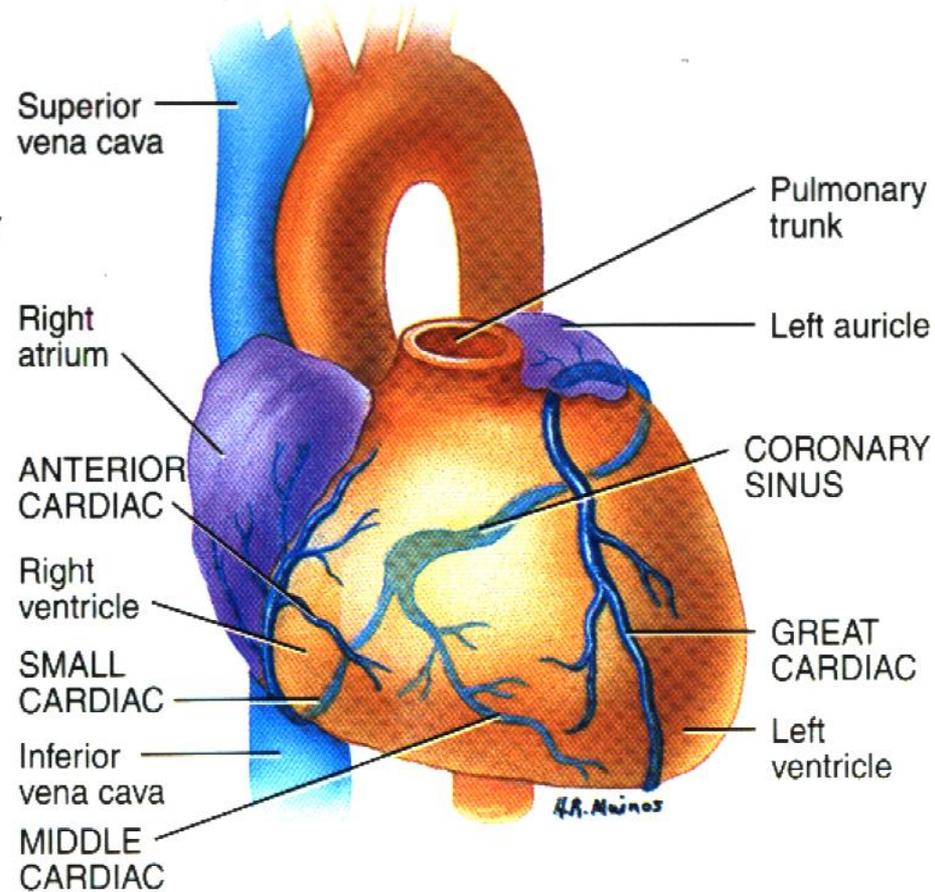
# Blood Flow: Heart

---

- 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

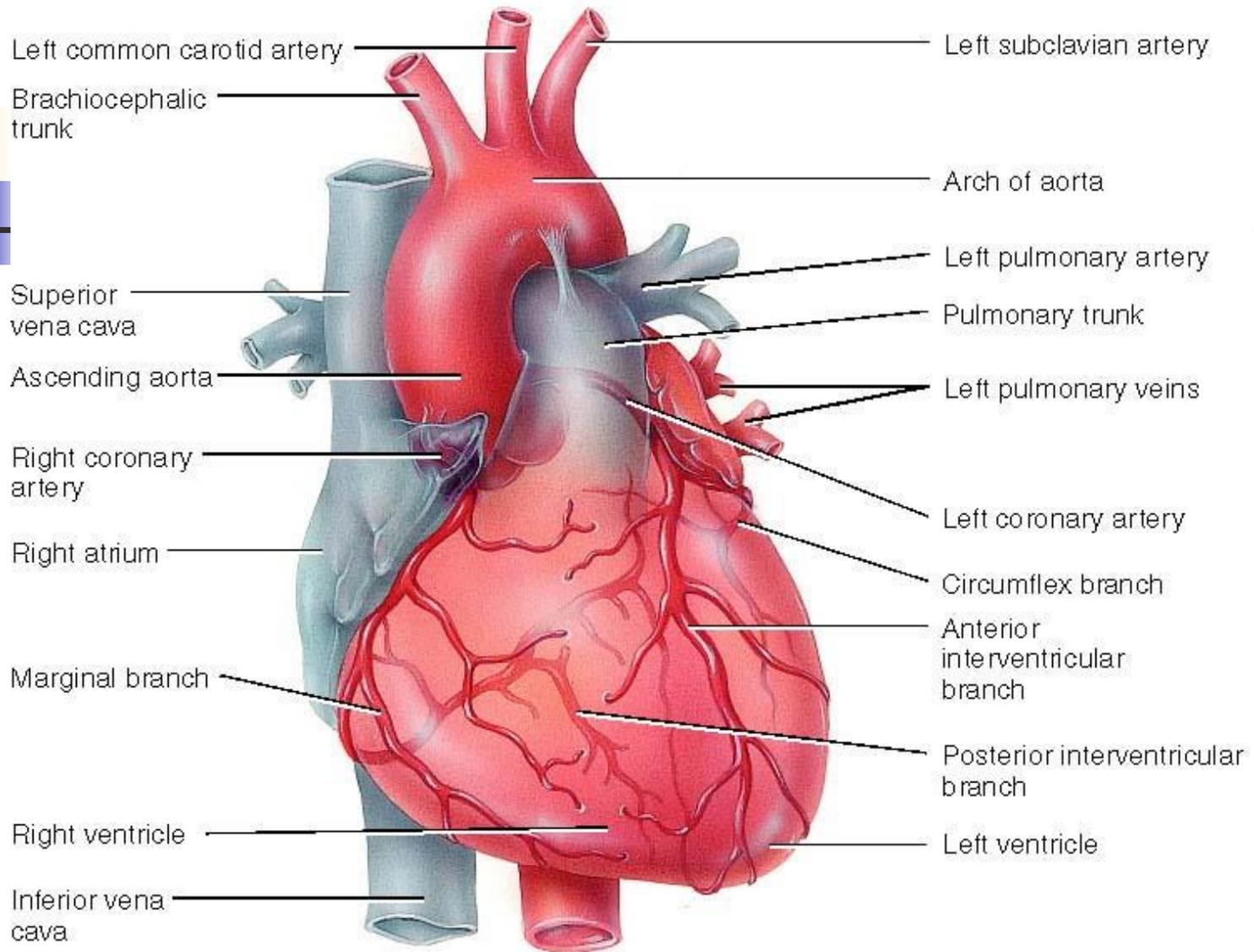
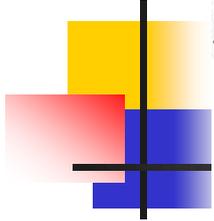


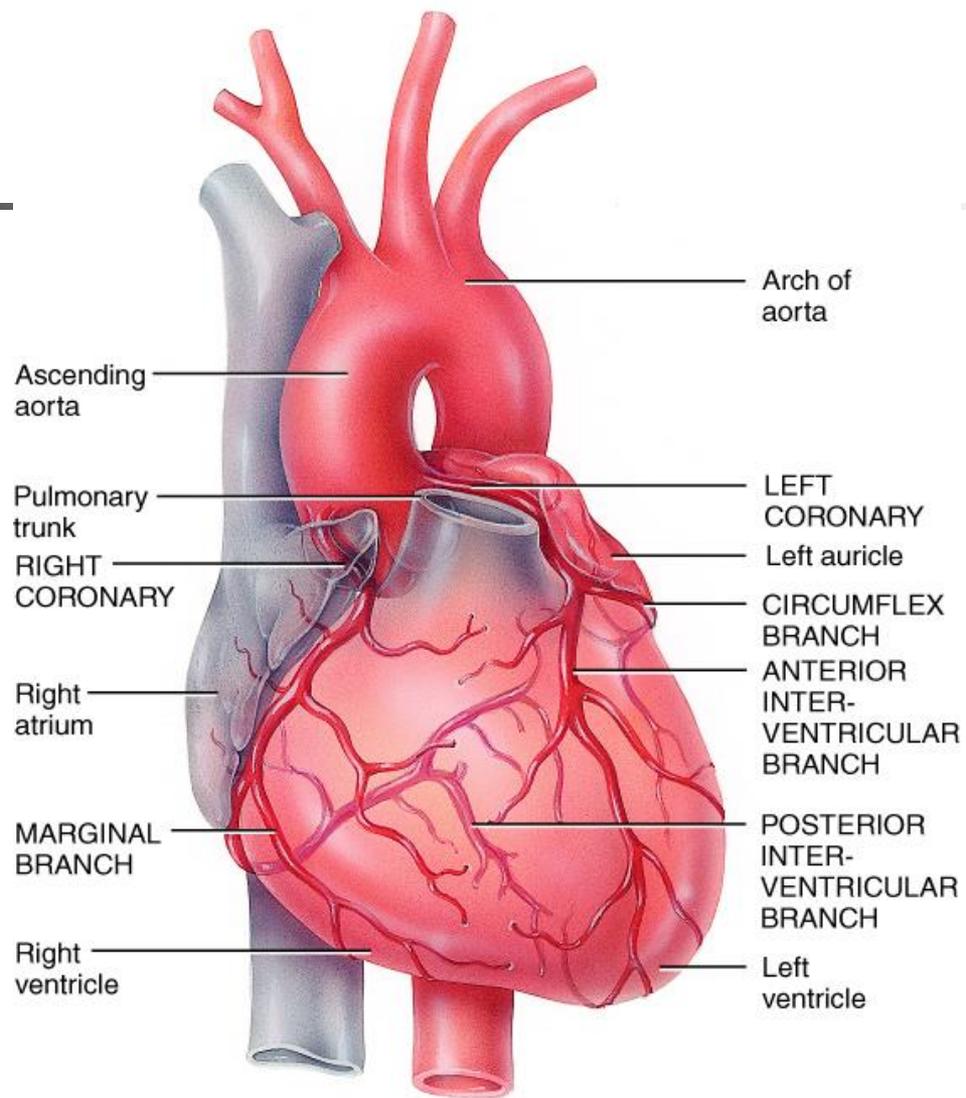
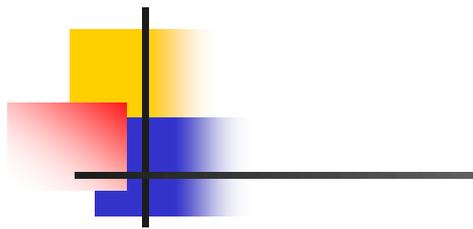
(a) Anterior view of coronary arteries



(b) Anterior view of coronary veins

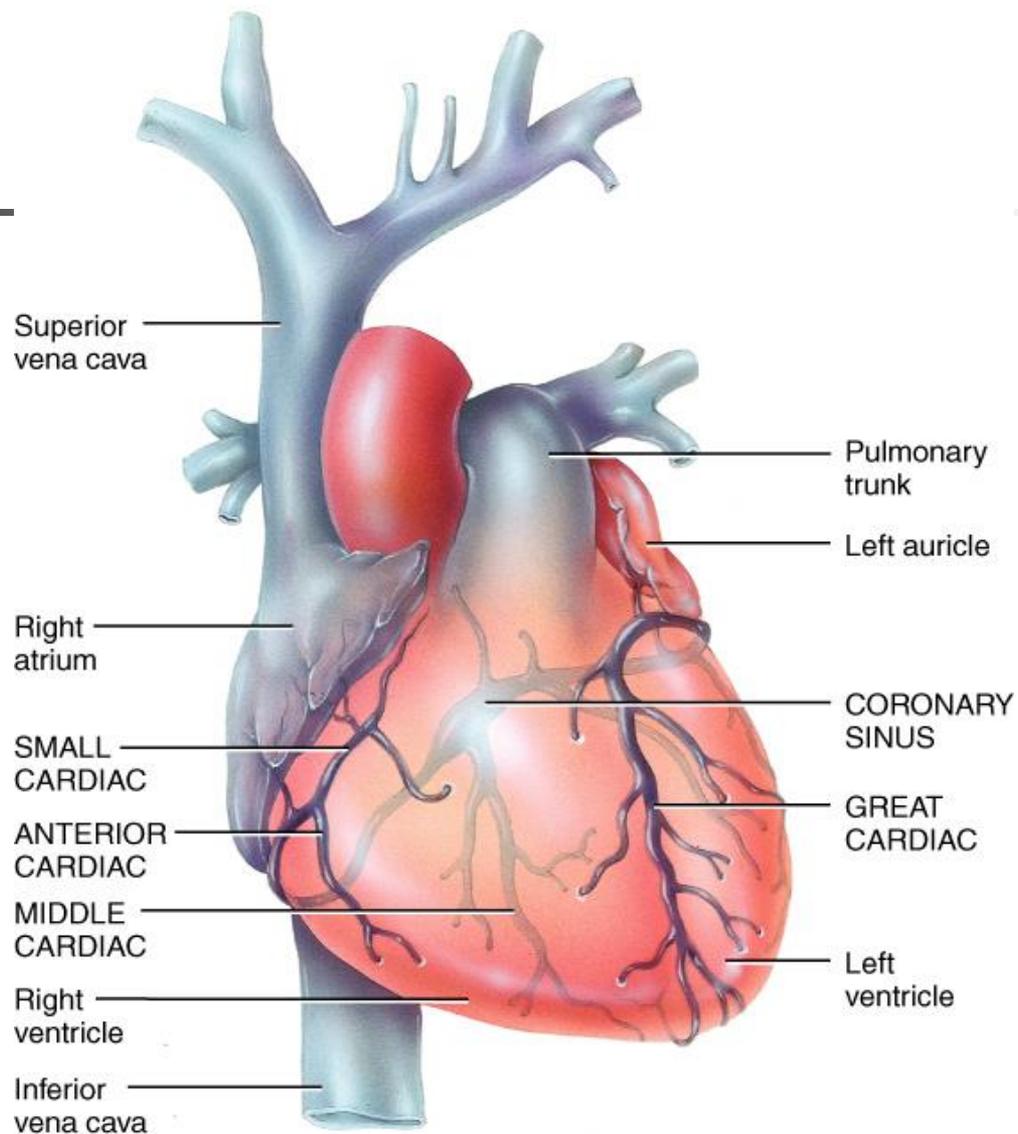
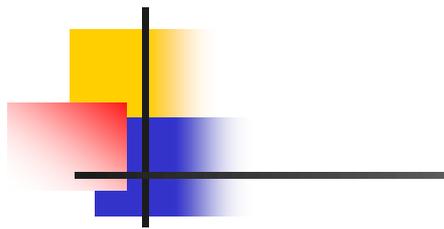
# CORONARY CIRCULATION





(a) Anterior view of coronary arteries

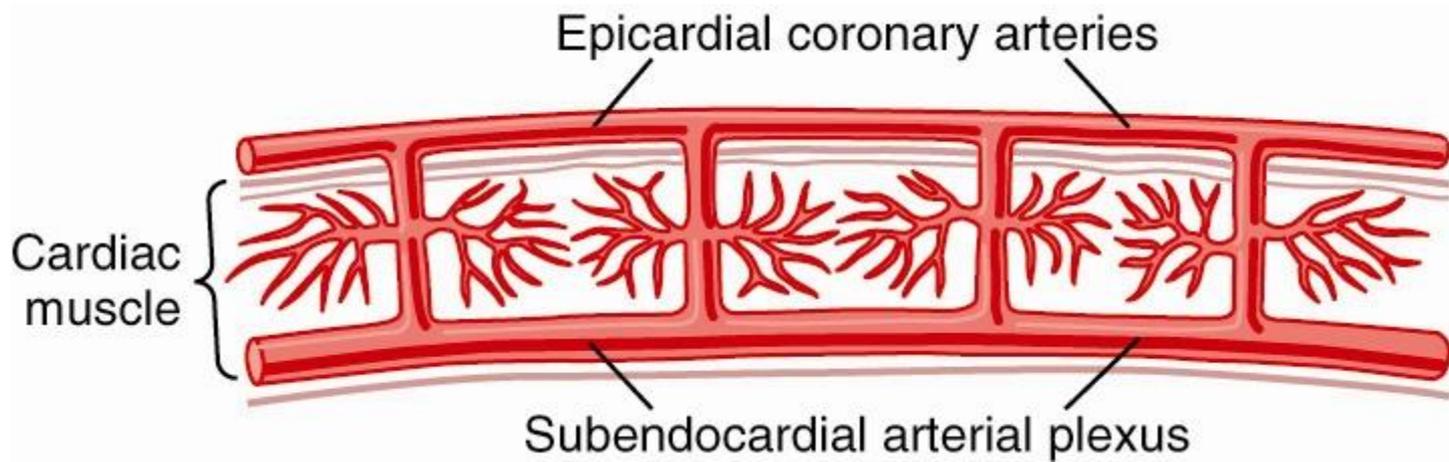
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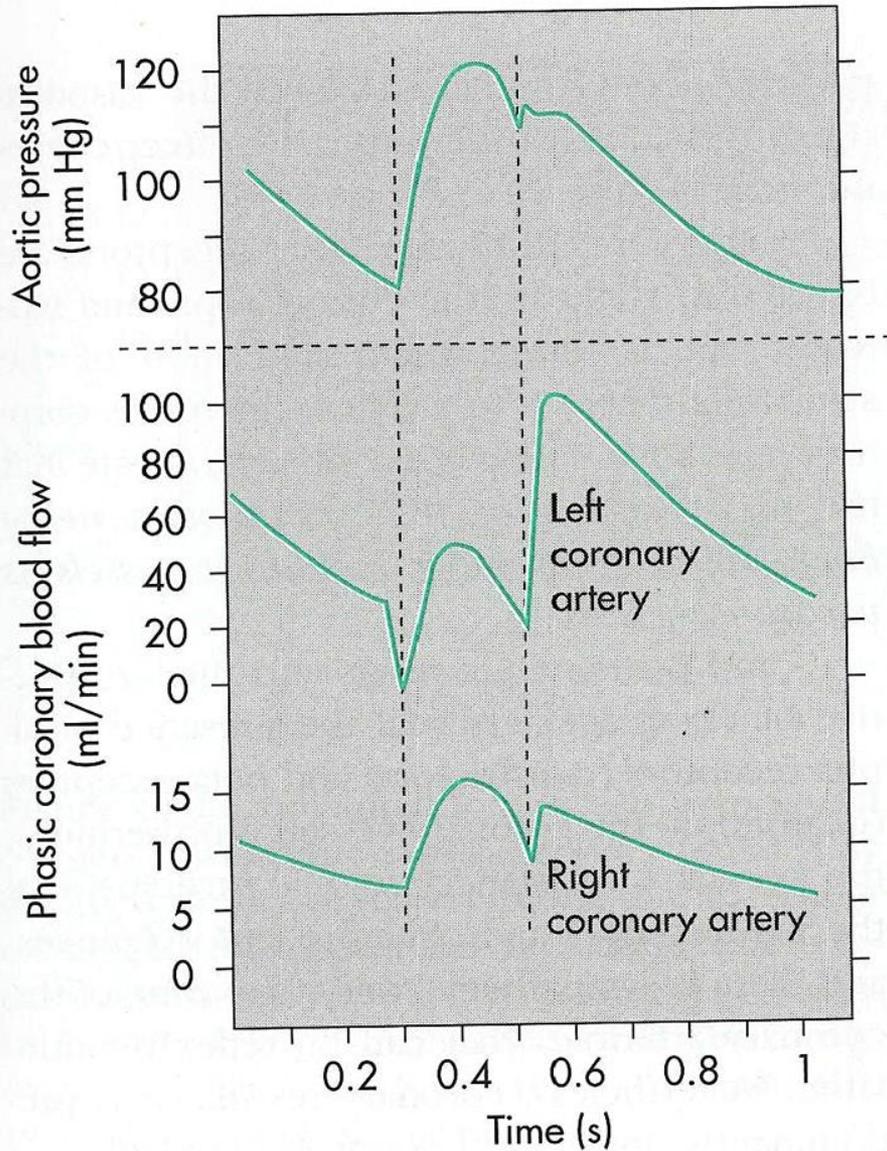


(b) Anterior view of coronary veins

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# Epicardial and Subendocardial Vasculature

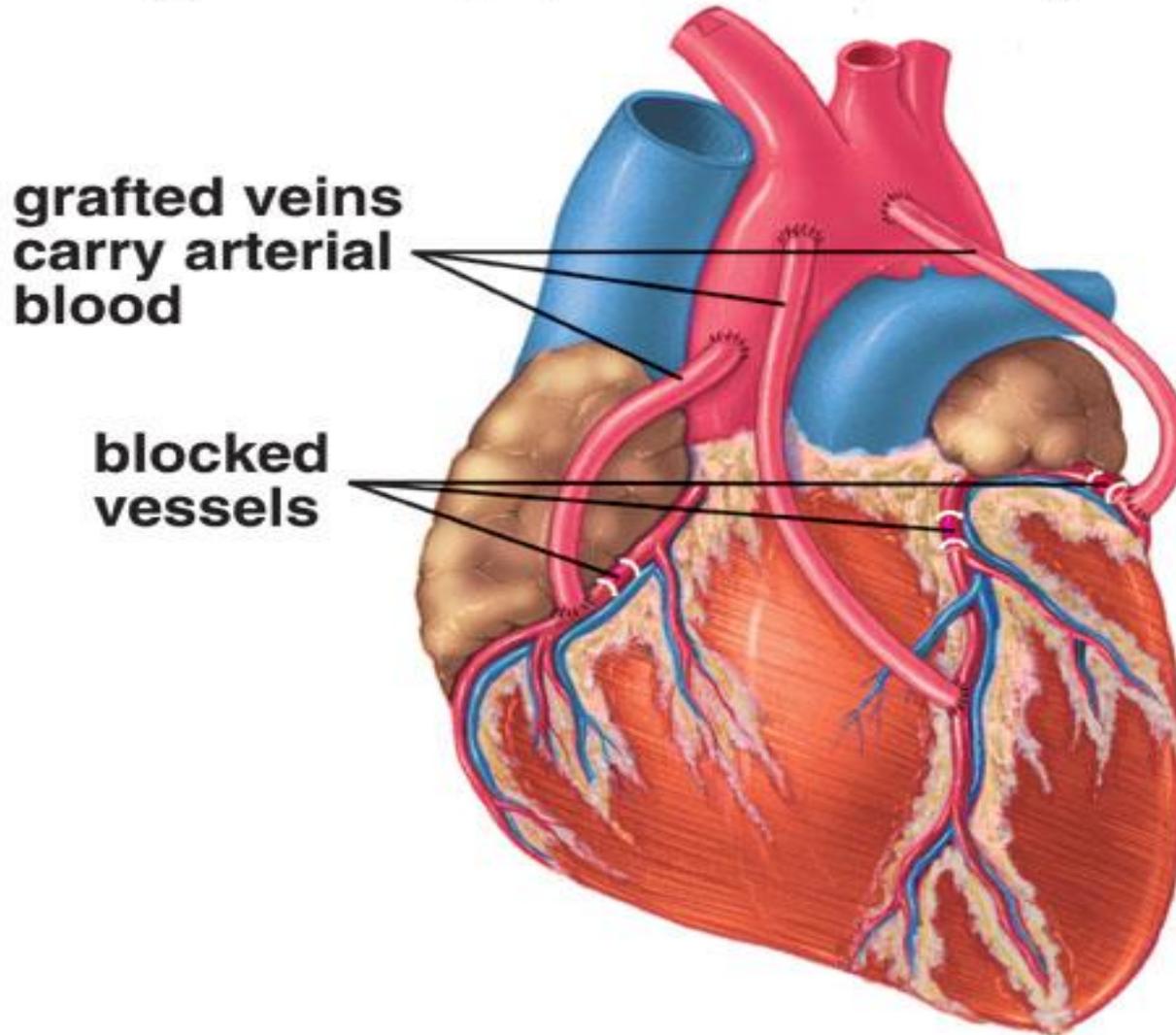




**Figure 10-3** ■ Comparison of phasic coronary blood flow in the left and right coronary arteries.

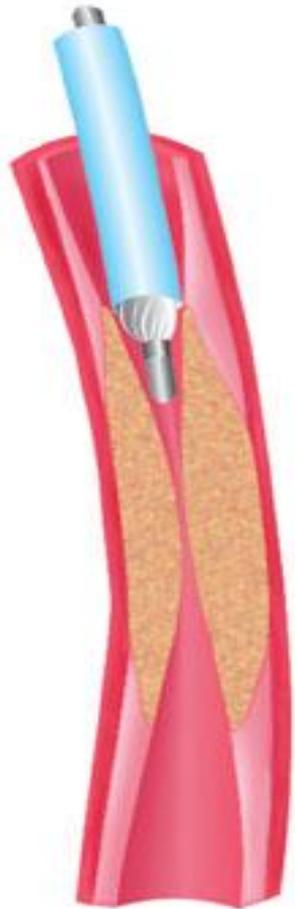
# Coronary bypass operation

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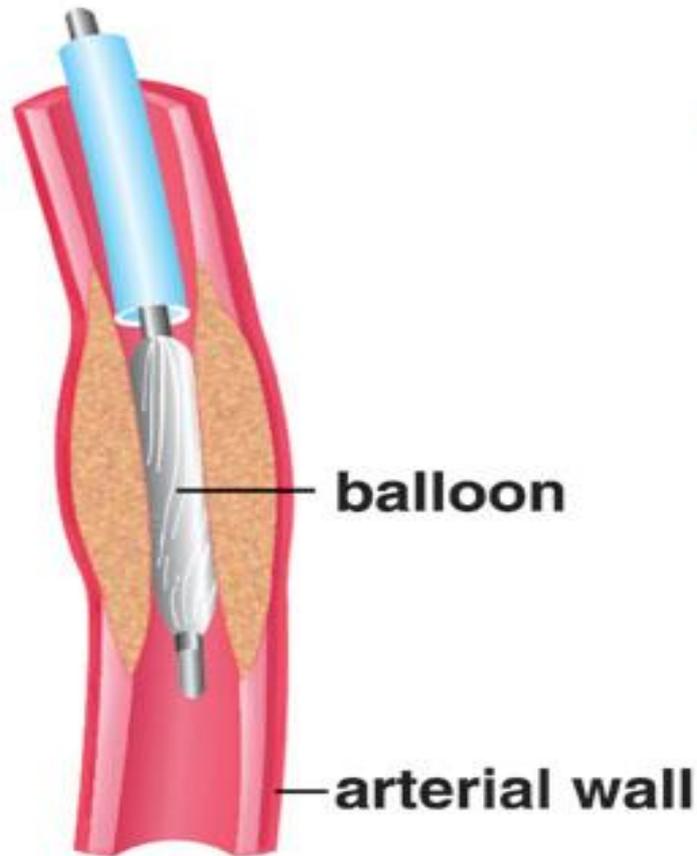


# Angioplasty

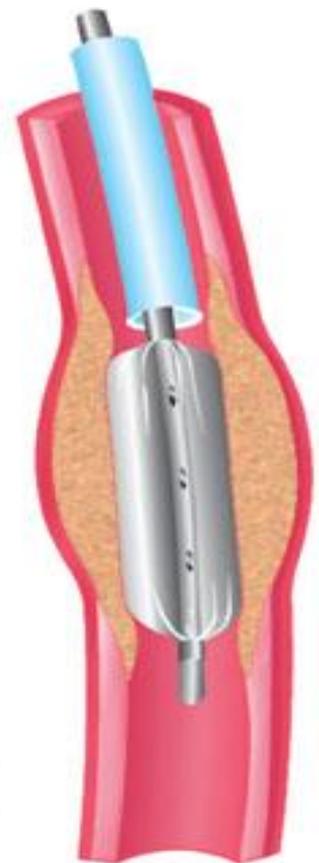
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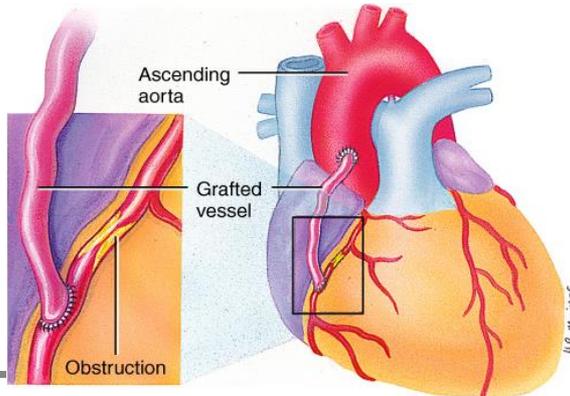
**a. Artery is closed.**



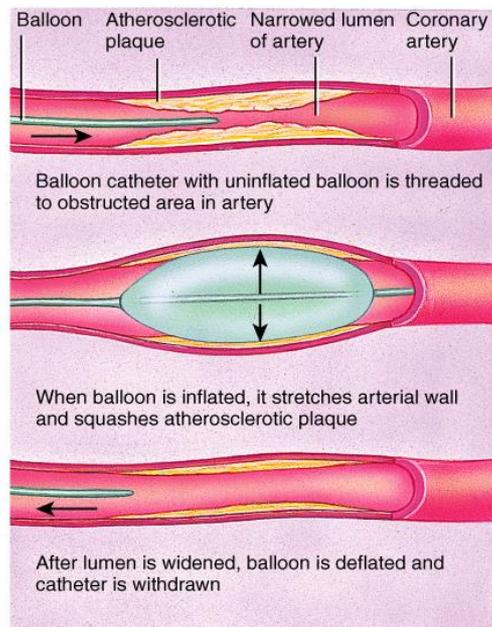
**b. Balloon is released.**



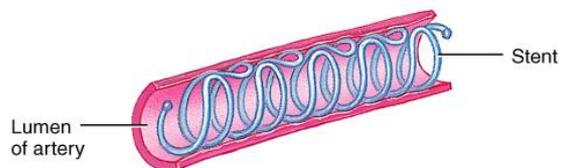
**c. Balloon is inflated.**



(a) Coronary artery bypass grafting (CABG)

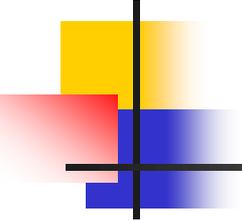


(b) Percutaneous transluminal coronary angioplasty (PTCA)



(c) Stent in an artery

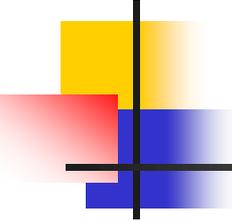
# Blood Flow: Brain



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- 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

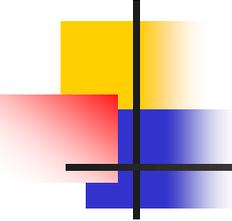
# Blood Flow: Brain



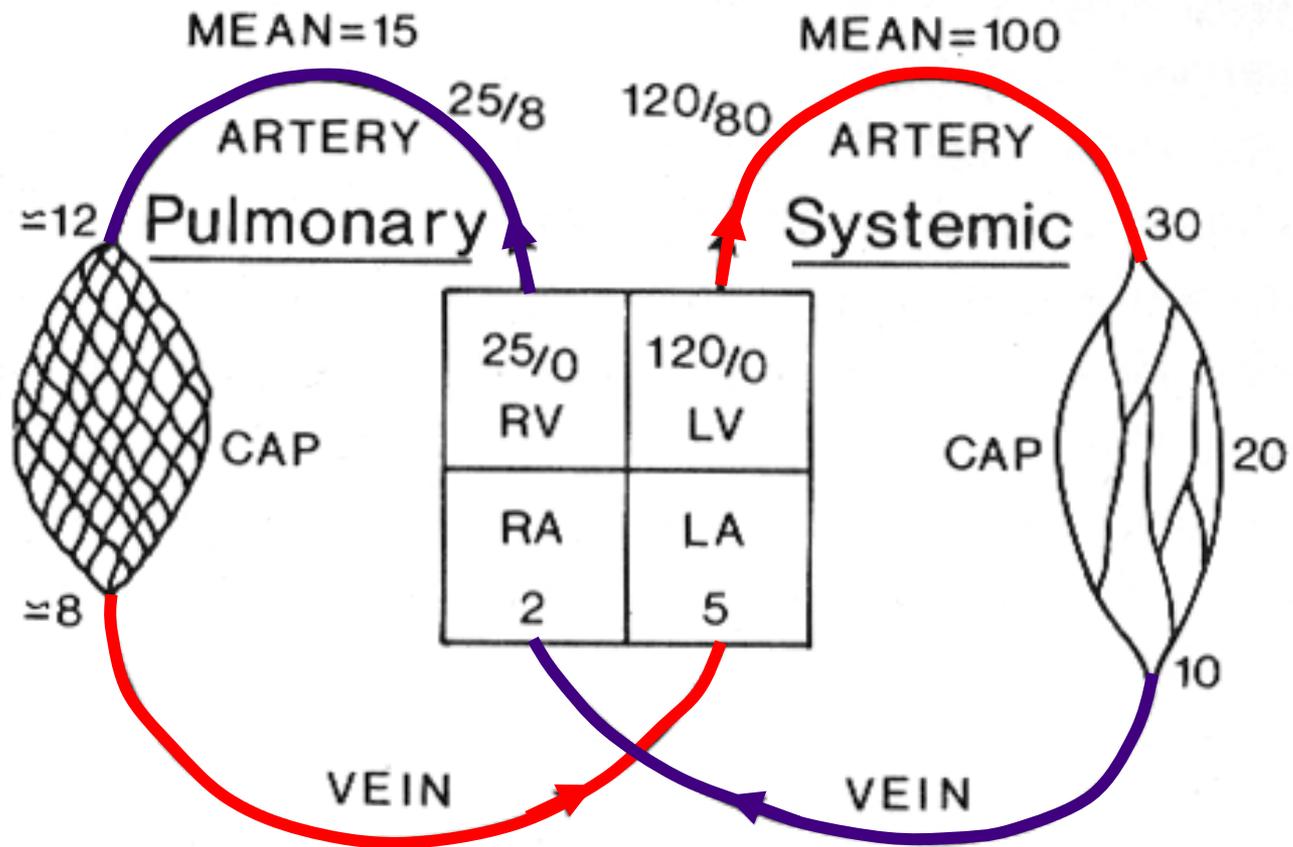
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- The brain can regulate its own blood flow in certain circumstances, such as ischemia caused by a tumor
- The brain is vulnerable under extreme systemic pressure changes
  - MAP below 60mm Hg can cause syncope (fainting)
  - MAP above 160 can result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

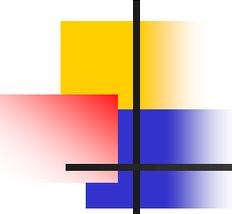
# Blood Flow: Skin

- 
- 
- 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

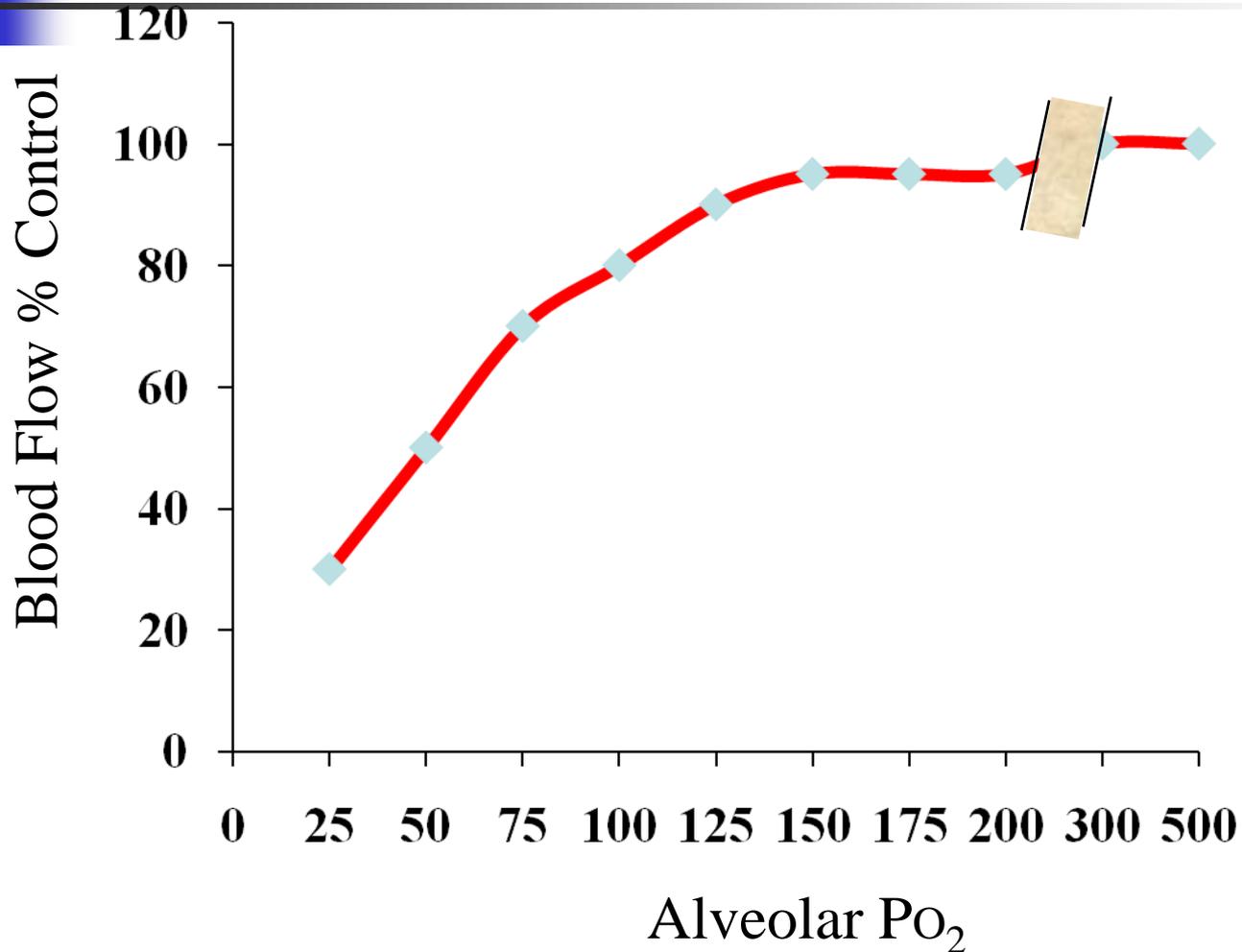
# Characteristics of the **Pulmonary Circulation**



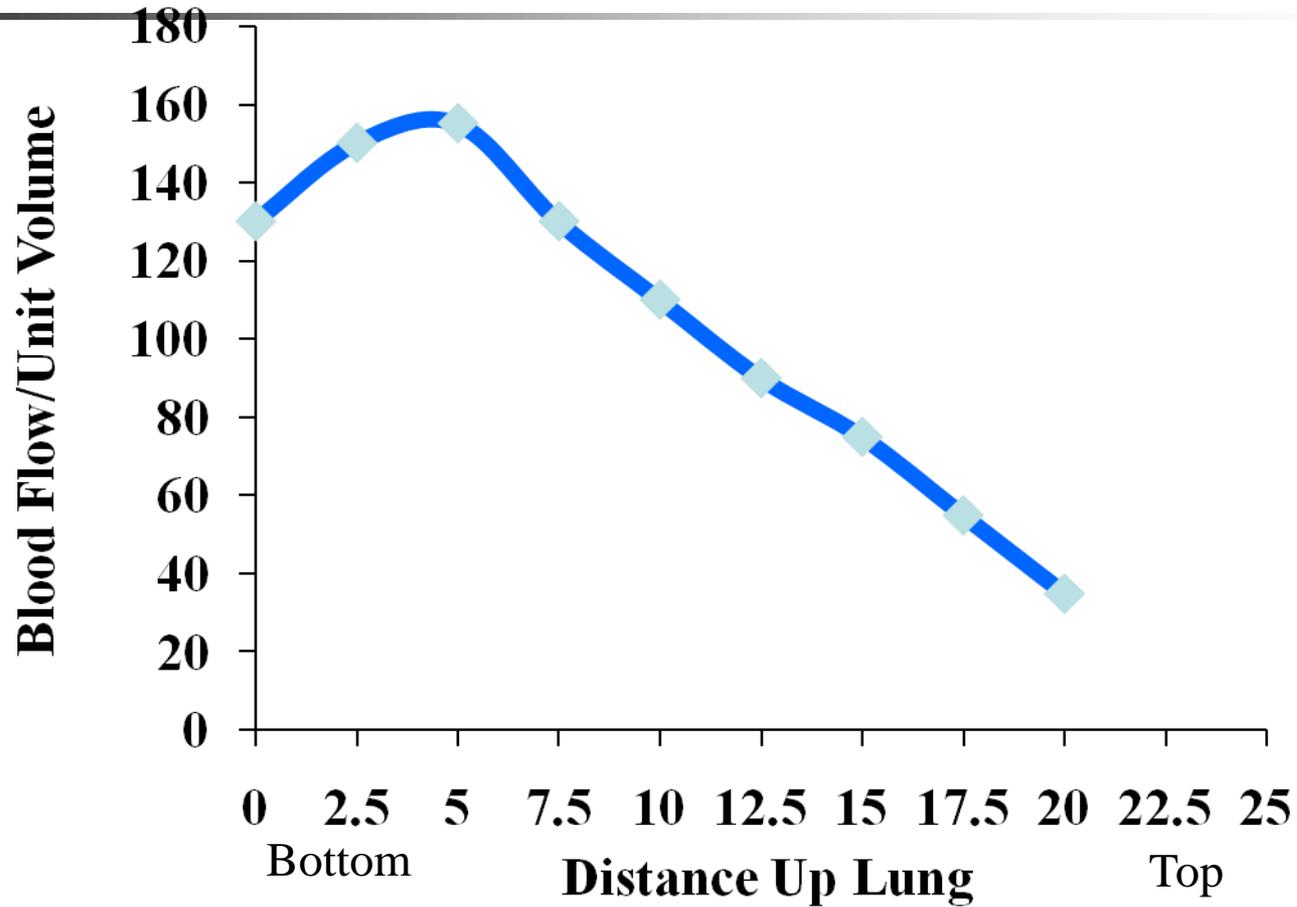
# Blood Flow: Lungs

- 
- 
- 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 $P_{O_2}$ on Blood Flow

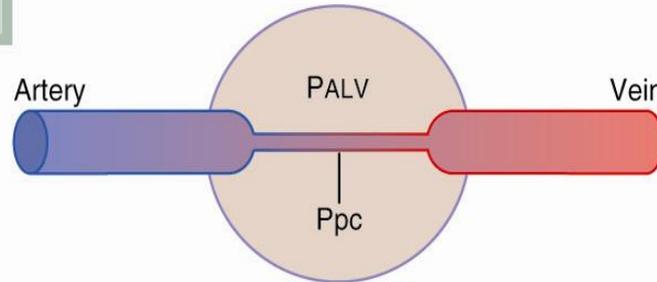


# Distribution of Blood Flow

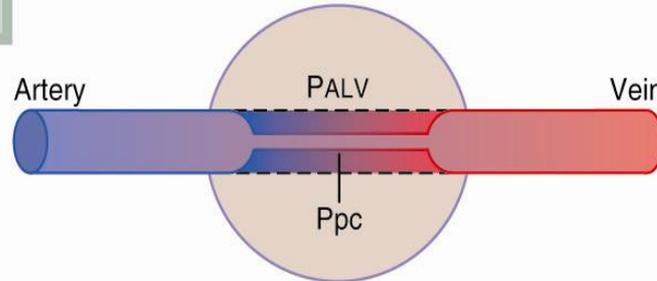


# Hydrostatic Effects on Blood Flow

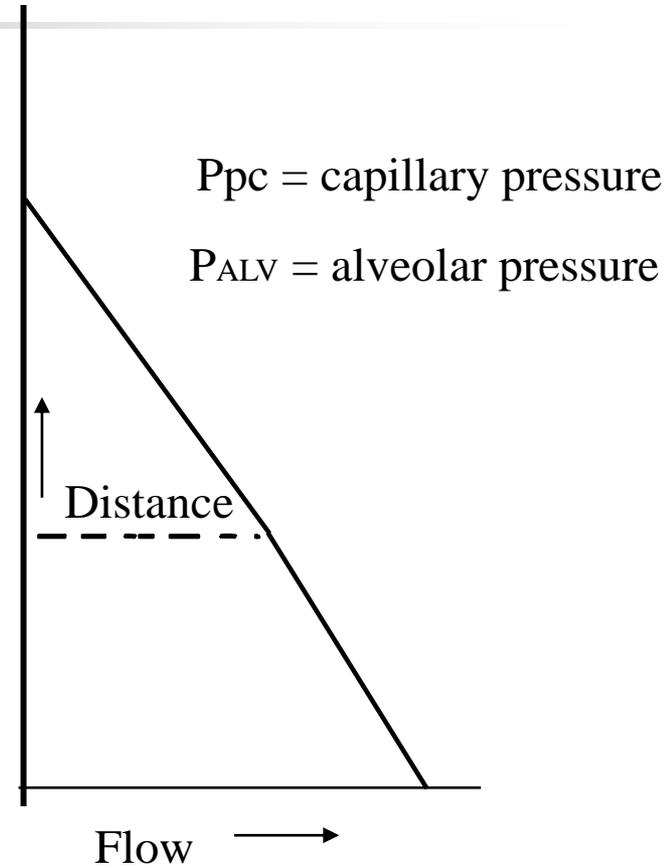
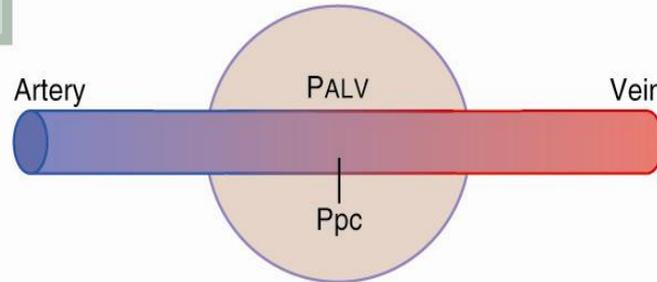
ZONE 1



ZONE 2



ZONE 3



# Thank You

