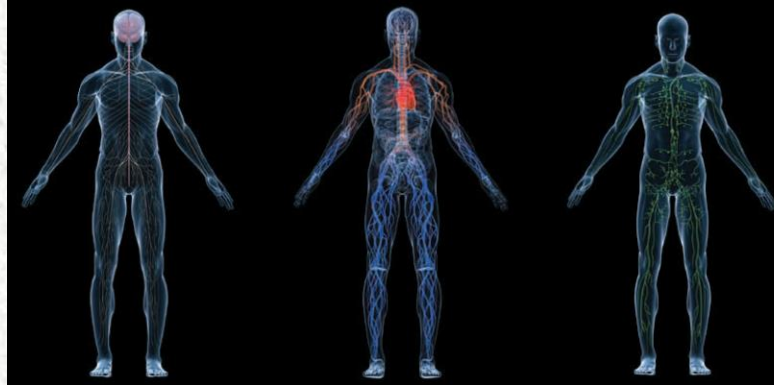


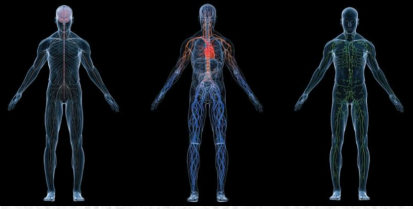
GUYTON AND HALL *Textbook of*  
**Medical Physiology**

TWELFTH EDITION



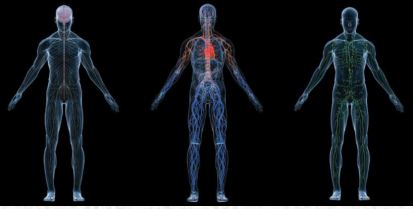
Chapter 17:

Local and Humoral Control of  
Tissue Blood Flow



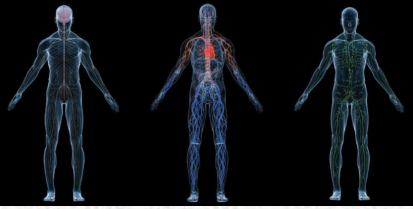
# Overall Objectives

- Know what factors affect tissue blood flow
- Describe the vasodilator and oxygen demand theories
- Know mechanisms of autoregulation
- Describe how angiogenesis occurs
- Know how various humoral factors affect blood flow



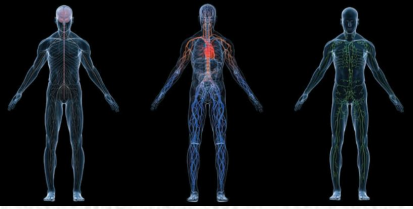
# Local Control of Blood Flow

- Each tissue controls its own blood flow in *proportion to its needs*
- Tissue needs include
  - 1) Delivery of *oxygen* to tissues
  - 2) Delivery of *nutrients* such as glucose, amino acids, etc.
  - 3) Removal of carbon dioxide hydrogen and other *metabolites* from the tissues
  - 4) Transport various *hormones* and other substances to different tissues
- Flow is closely related to metabolic rate of tissues



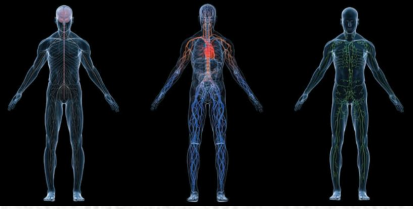
# Variations in Tissue Blood Flow

	Per cent	ml/min	ml/min/ 100 gm
Brain	14	700	50
Heart	4	200	70
Bronchi	2	100	25
Kidneys	22	1100	360
Liver	27	1350	95
Portal	(21)	(1050)	
Arterial	(6)	(300)	
Muscle (inactive state)	1	5750	4
Bone	5	250	3
Skin (cool weather)	6	300	3
Thyroid gland	1	50	160
Adrenal glands	0	.525	300
Other tissues	3.5	175	1.3
Total	100.0	5000	--



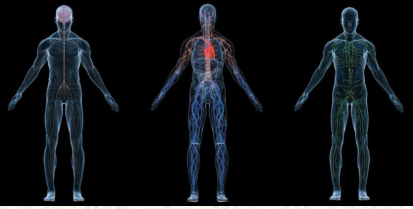
# Acute Control of Local Blood Flow

- Increases in *tissue metabolism* lead to increases in blood flow
- Decreases in *oxygen availability* to tissues increases tissue blood flow
- Two major theories for local blood flow are
  - 1) *The vasodilator theory*
  - 2) *Oxygen demand theory*



# Relationship Between Pressure, Flow, and Resistance

- $Q = \Delta P / R$
- *Flow* (Q) through a blood vessel is determined by:
  - 1) The *pressure difference* ( $\Delta P$ ) between the two ends of the vessel
  - 2) *Resistance* (R) of the vessel



# Effect of Tissue Metabolic Rate on Tissue Blood Flow

↑ Tissue Metabolism → ↑ Blood Flow

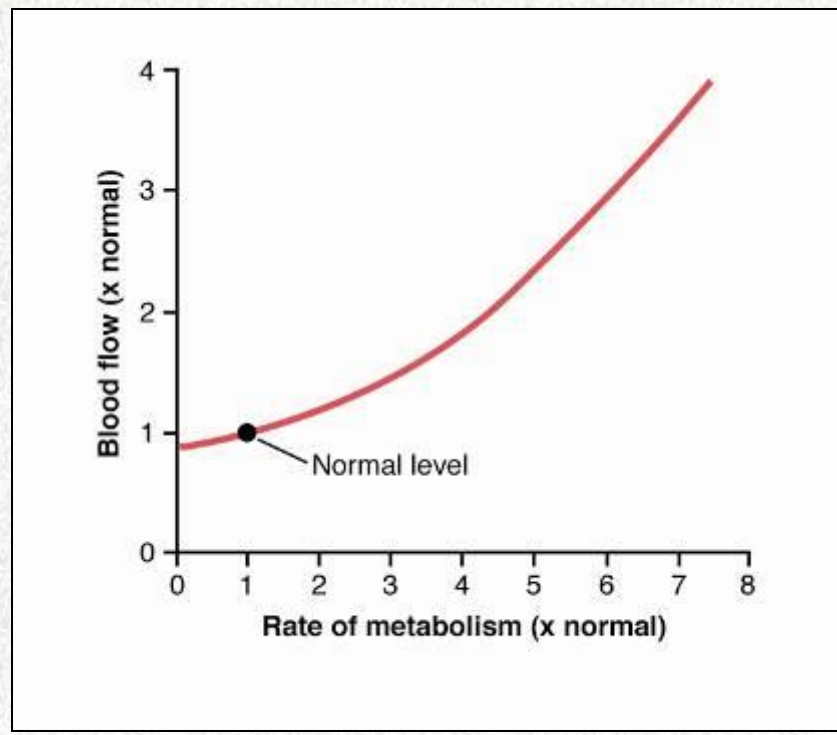
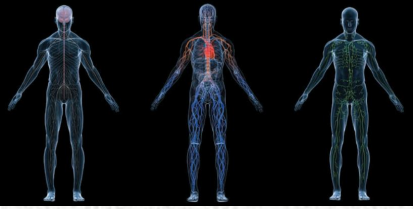
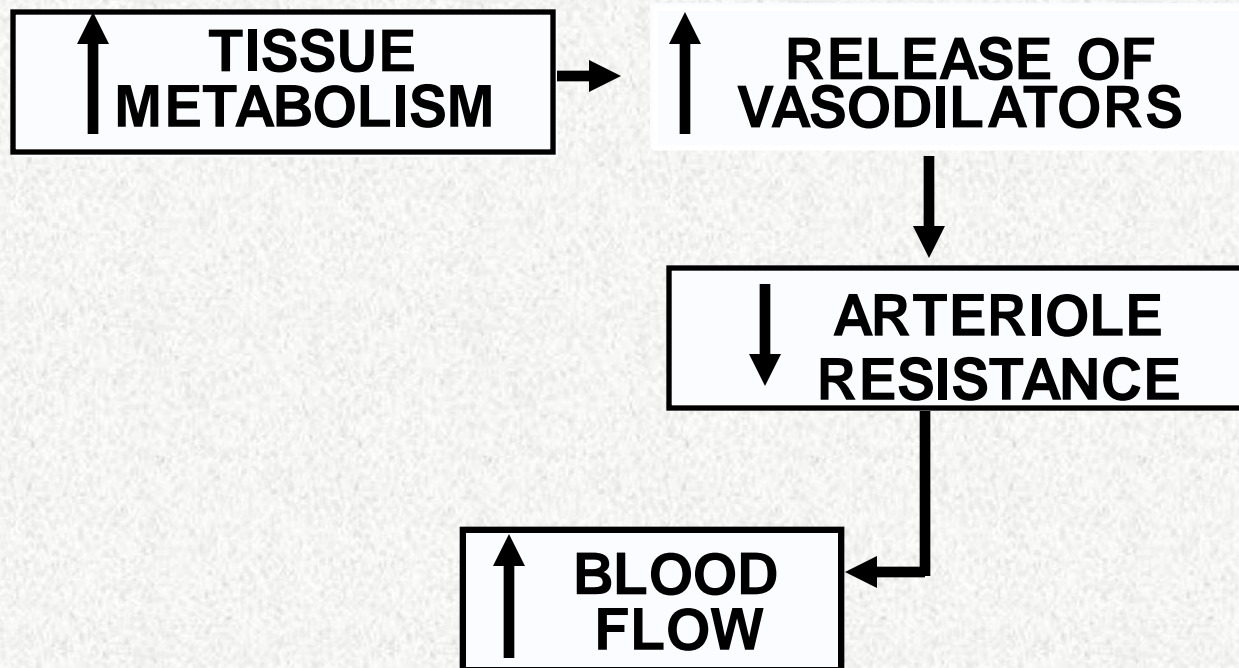


Figure17-1

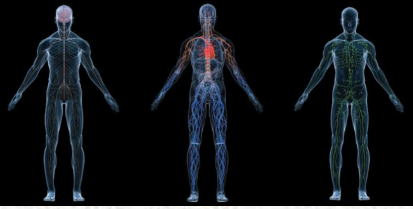


# Vasodilator Theory for Blood Flow Control

- Vasodilators: Adenosine, CO<sub>2</sub>, Lactic acid, ADP compounds, Histamine, K ions, H ions







# Effect of Tissue Oxygen Concentration on Blood Flow

↓ Tissue Oxygen Concentration → ↑ Blood Flow

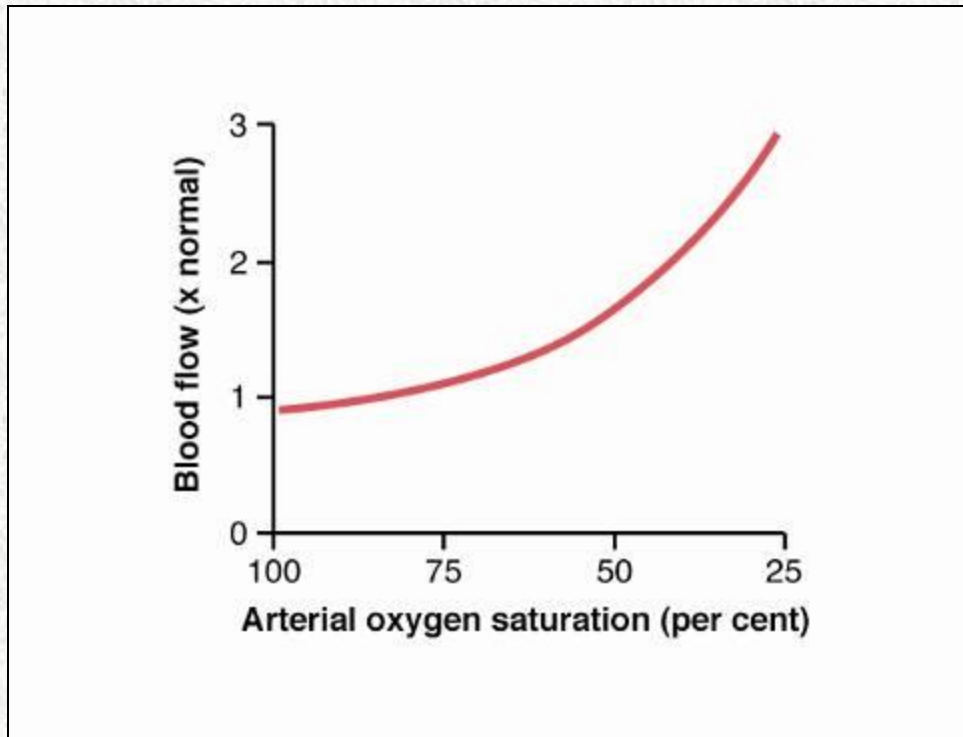
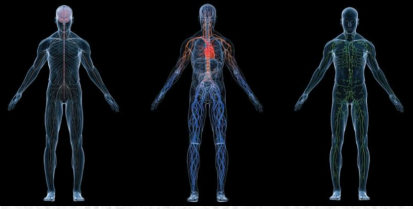
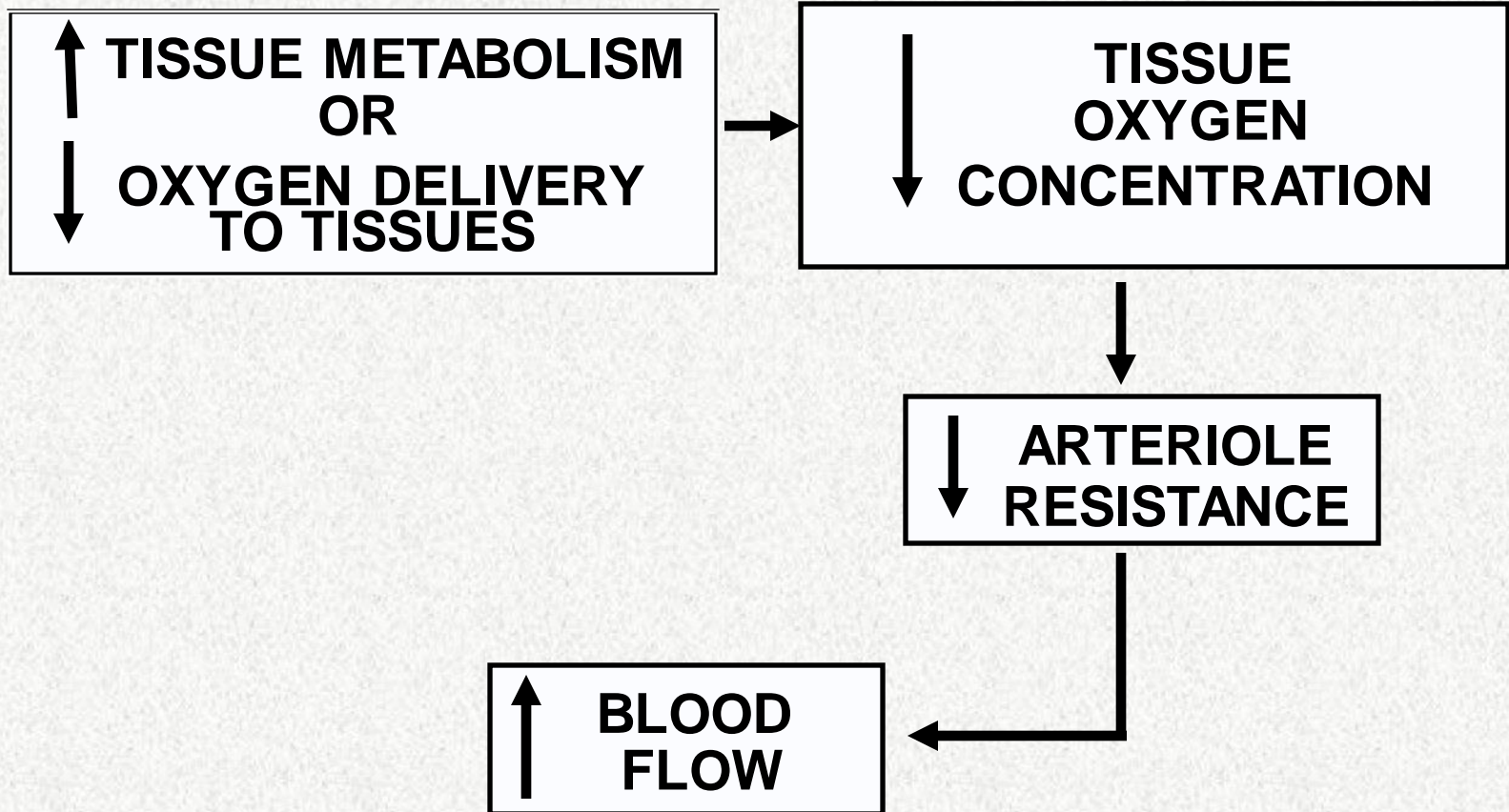
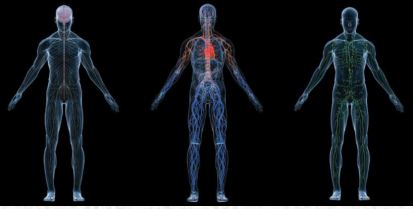


Figure17-2



# Oxygen Demand Theory for Blood Flow Control





# Autoregulation of Blood Flow

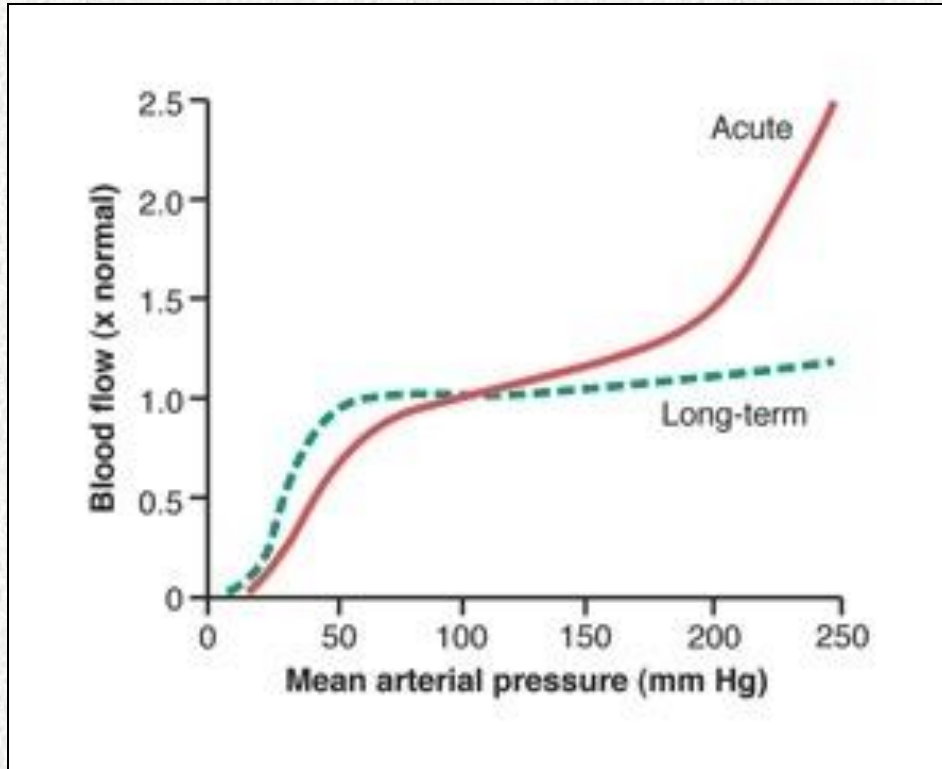
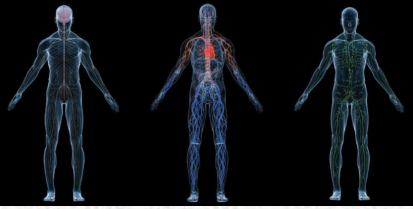


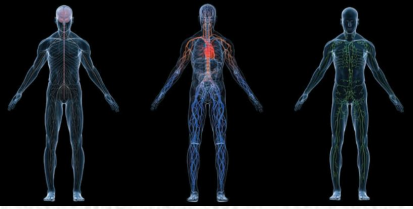
Figure17-4

*Autoregulation*- Ability of a tissue to maintain blood flow relatively constant over a wide range of arterial pressures



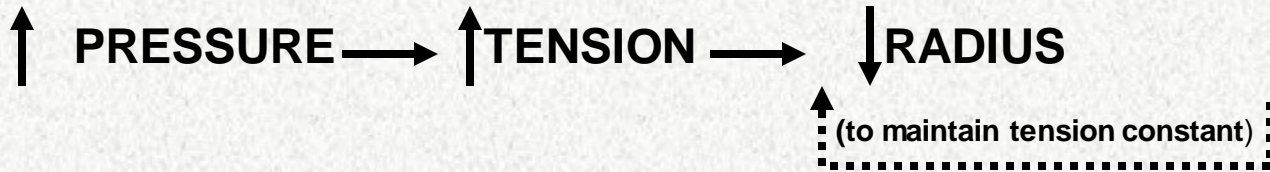
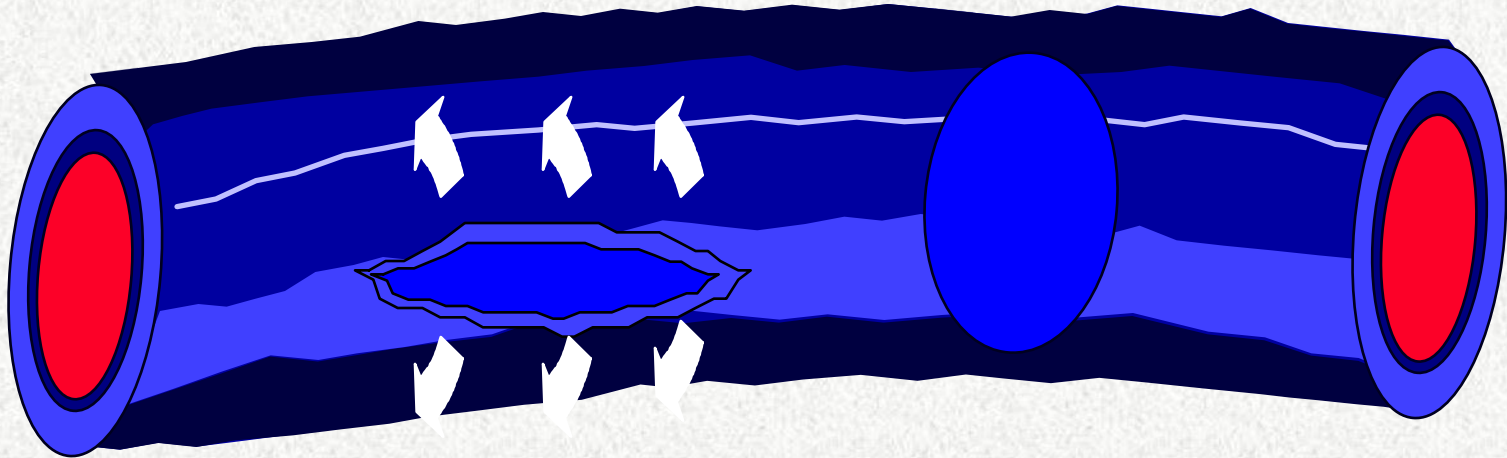
# Blood Flow Autoregulation Theories

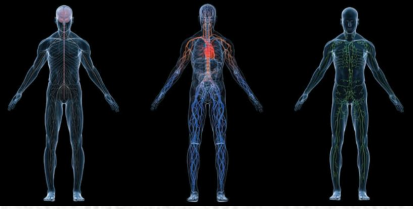
- *Metabolic theory* suggests that as arterial pressure is decreased, oxygen or nutrient delivery is decreased resulting in release of a vasodilator
- *Myogenic theory* proposes that as arterial pressure falls the arterioles have an intrinsic property to dilate in response to decreases in wall tension
- Certain tissues have *other mechanisms* for blood flow control the kidneys have a feedback system between the tubules and arterioles and the brain blood flow is controlled by carbon dioxide and hydrogen ion conc.



# Laplace's Law: Myogenic mechanism

$$\text{TENSION (dynes/cm)} = \text{PRESSURE (dynes/cm}^2\text{)} \times \text{RADIUS (cm)}$$





# Long-term Regulation of Blood Flow

- Long-term regulatory mechanisms which control blood flow are more effective than acute mechanism
- Long-term local blood flow regulation occurs by changing the degree of vascularity of tissues (*size and number of vessels*)
- *Oxygen* is an important stimulus for regulating tissue vascularity

# Long-term Regulation of Blood Flow

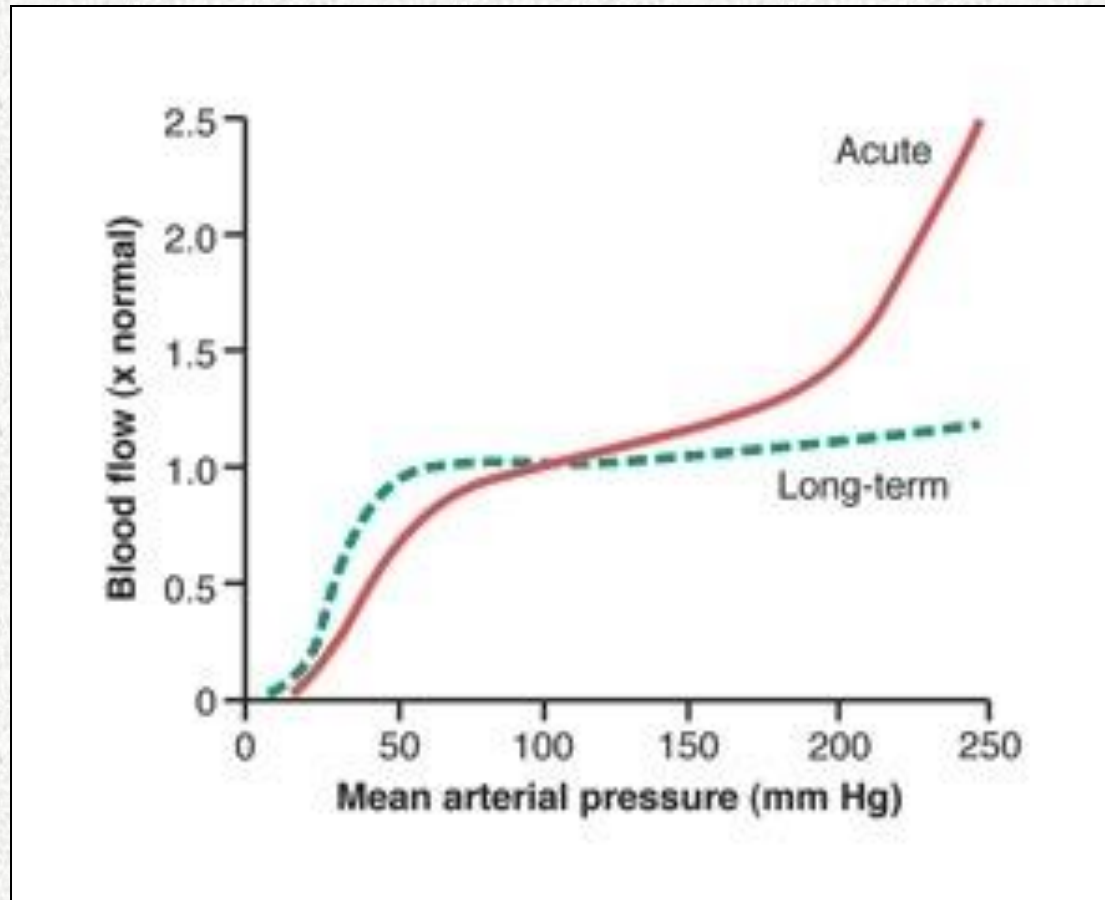
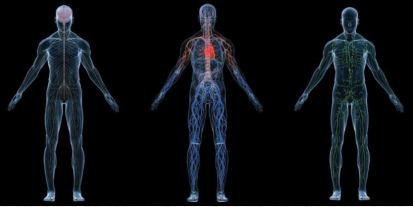
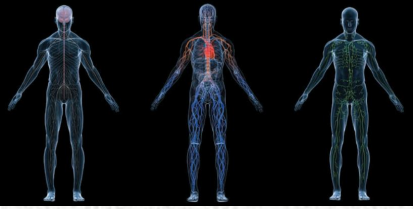


Figure17-4

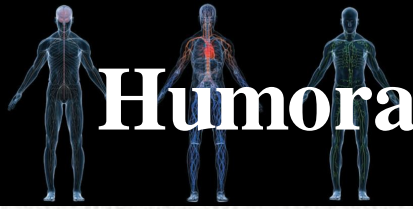


# Angiogenesis

- *Angiogenesis* is the growth of new blood vessels
- Angiogenesis occurs in response to angiogenic factors released from
  - 1) Ischemic Tissue
  - 2) Rapidly growing tissue
  - 3) Tissue with high metabolic rates
- Most angiogenic factors are small peptides such as Vascular endothelial cell growth factors (VEGF), fibroblast growth factor (FGF), and angiogen







# Humoral Regulation of Blood Flow: Acute

- Vasoconstrictors

  - Norepinephrine and epinephrine

  - Angiotensin

  - Vasopressin

  - Endothelin

- Vasodilator agents

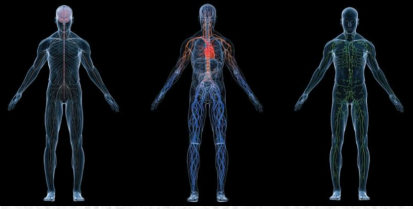
  - Bradykinin

  - Serotonin

  - Histamine

  - Prostaglandins

  - Nitric oxide



# YOU SHOULD KNOW

- ✓ Know what factors affect tissue blood flow
- ✓ Describe the vasodilator and oxygen demand theories
- ✓ Know autoregulation mechanisms
- ✓ Describe how angiogenesis occurs
- ✓ Know how various humoral factors affect blood flow