Blood Vessels

Cardiovascular System
Blood Vessel Structure and Function

❖ Three major Vessels (60,000 mile combined length)
  ❖ Arteries (carry blood away from heart)
  ❖ Capillaries (exchange vessels)
  ❖ Veins (carry blood towards the heart)
Structure of Blood Vessel Walls

❖ Goals

❖ Describe the layers that typically form the wall of a vessel, and state the function of each
❖ Define vasoconstriction and vasodilation
Structure of Blood Vessel Walls

- All vessels, other than capillaries, have three distinct layers (tunics) surrounding a central lumen.
  - tunica intima (endothelium)
  - tunica media (sheets of elastin and smooth muscle cells)
  - tunica externa (supporting sheet of interwoven collagen fibers)
Check Your Understanding

❖ Which branch of the autonomic nervous system innervates blood vessels? Which layer of the vessel do these fibers innervate? What are the effectors?

❖ When vascular smooth muscle contracts what happens to the diameter of the blood vessel? What is this called?
Arterial System

❖ Goals

❖ Compare and contrast the structure and function of three types of arteries.
Arterial System

- Elastic Arteries (conducting arteries)
- Muscular Arteries (distribution arteries)
- Arterioles
Capillaries

- Describe the structure and function of a capillary bed.
Capillaries

- Consist solely of thin tunica intima
- Pericytes
- Provide access to nearly every cell in the body
- Provide exchange site of gases, nutrients, and hormones between the blood and interstitial fluid
Types of Capillaries

- Continuous Capillaries
- Fenestrated Capillaries
- Sinusoid Capillaries
Capillary Beds

- Flow of blood from an arteriole to venule (through capillary bed) is called microcirculation

- Components of Capillary Bed
  - terminal arteriole
  - metarteriole
  - thoroughfare channel
  - postcapillary venule
  - true capillaries
  - precapillary sphincter

Figure 19.4 Anatomy of a capillary bed.
Venous System

❖ Goals

❖ Explain the structure and function of veins, and explain how veins differ from arteries.
Venous System

- Venules
- Veins
  - capacitance vessels (65% of blood supply)
  - Venous Valves
Vascular Anastomoses

- Provide alternative blood flow pathways (collateral channels)
- Arterial anastomoses occur around joints, heart, and brain
- Arteriovenous anastomoses (metarteriole-thoroughfare channel)
- Venous anastomoses (incredibly common)
Blood Flow, Pressure, and Resistance

- Blood Flow
- Blood Pressure
- Resistance
  - Viscosity
  - Blood Vessel Length
  - Blood Vessel Diameter
Blood Flow (F) is directly proportional to the difference in pressure between to points in circulation ((ΔP)hydrostatic pressure gradient).

Blood Flow (F) is inversely proportional to the peripheral resistance (R).

\[ F = \frac{\Delta P}{R} \]
Check Your Understanding

❖ List three factors that determine resistance in a vessel. Which of these is physiologically most important
Goals

Define how blood pressure differs in the arteries, capillaries, and veins
Systemic Blood Pressure

- Arterial Blood Pressure
- Pulsatile
- Systolic Blood Pressure
- Diastolic Pressure
- Aorta acts as auxiliary pump
- SBP-DBP = pulse pressure
- Mean Arterial Pressure (MAP)
Systemic Blood Pressure

- Capillary Blood Pressure
  - Blood enters capillary bed at 35 mm Hg and exits bed at 17 mm Hg
Systemic Blood Pressure

- Venous Blood Pressure
  - steady (non-pulsatile)
  - Only a 15 mm Hg pressure gradient between venues and vena cavae
- 3 functional adaptations promote venous return
  - The muscular pump
  - The respiratory pump
  - Sympathetic vasoconstriction
Maintaining Blood Pressure

- List and explain the factors that influence blood pressure, and describe how blood pressure is regulated
- Define hypertension, describe its manifestations and consequences
Short Term Regulation: Neural Controls

- Neural controls alter both CO and peripheral resistance
- Control of peripheral resistance is directed at two main goals
  - Maintaining adequate MAP by altering blood vessel diameter
  - Altering blood distribution based on demand
Role of the Cardiovascular Center

- Consists of the cardioacceleratory center, cardioinhibitory center, and vasomotor center.
- Vasomotor center transmits impulses to blood vessel smooth muscle causing vasomotor tone.
- Cardiovascular center activity is modified by inputs from:
  - Baroreceptors
  - Chemoreceptors
  - Higher brain centers
Baroreceptor reflexes

- Increased Arterial BP activates Baroreceptors in Aorta and Carotid arteries
- Baroreceptors inhibit the vasomotor and cardioacceleratory centers bringing about three effects resulting in BP decrease
  1. Arteriolar Vasodilation
  2. Venodilation
  3. Decreased CO
- Carotid sinus reflex
- aortic reflex
- Baroreceptors are highly adaptable
Baroreceptor Reflexes

1. Stimulus: ↑ Blood pressure (arterial blood pressure rises above normal range).
2. Baroreceptors in carotid sinuses and aortic arch are stimulated.
3. Impulses from baroreceptors stimulate cardioinhibitory center (and inhibit cardioacceleratory center) and inhibit vasomotor center.
4a. ▼ Sympathetic impulses to heart cause ↓ HR, ↓ contractility, and ↓ CO.
5. ▼ CO and ▼ R return blood pressure to homeostatic range.
6. Vasomotor fibers stimulate vasoconstriction, causing ↑ R.
7. Impulses from baroreceptors activate cardioacceleratory center (and inhibit cardioinhibitory center) and stimulate vasomotor center.

Homeostasis: Blood pressure in normal range.

IMBALANCE

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Chemoreceptor Reflexes

- When CO2 levels rise, or if pH falls, the oxygen content of blood falls rapidly.
- Chemoreceptors in head and neck detect these changes and stimulate the cardioacceleratory and vasomotor centers.
- Results in increased speed of venous return
Influence of Higher Brain Centers

- Fight or Flight Response
- Response to exercise (hypothalamus)
Short-Term Regulation: Hormonal Controls

- Adrenal medulla Hormones
- Angiotensin II
- Atrial natriuretic peptide (ANP)
- Antidiuretic Hormone
Long Term Regulation: Renal Mechanisms

- Direct Renal Mechanism
Long Term Regulation: Renal Mechanisms

- Indirect Renal Mechanism

[Diagram showing the renin-angiotensin-aldosterone system with arrows and labels indicating the process.]