Blood Vessels

1. Functions

A) Serve as a conduit for blood flow

B) The site of exchange of nutrients and wastes

2. Structure of Vessels

A) All vessels except capillaries have the same basic structure

1) Tunica Interna (Intima)

a) Innermost layer composed of simple squamous

b) Remains unchanged in thickness throughout the circulation pathway

2) Tunica Media

a) Middle layer composed mostly of smooth muscle and elastin

3) Tunica Externa (Adventitia)

a) Outermost layer composed of areolar CT

3. Types of Vessels

A) Arteries

1) Carry blood away from the heart

2) Thick tunica externa & media with narrow, circular lumen

3) Two types

a) Elastic arteries

i) Large diameter arteries leaving the heart

ii) Their elasticity helps propel blood when ventricles are relaxed

b) Muscular arteries

i) Branch off of elastic arteries

ii) Distribute blood to the **large areas** of the body

iii) Capable of great vasoconstriction & vasodilation to control the rate of blood

flow to these areas

B) Arterioles

1) Small vessels that deliver blood from the arteries to the capillaries

2) Capable of vasoconstriction & vasodilation

a) Responsible for controlling blood flow into **specific tissues**, as well as systemic

blood pressure

C) Capillaries

1) Connect arterioles to venules

2) Have only a tunica interna (no media or externa)

3) Site of nutrient and waste exchange in the tissues

4) Three types

a) Continuous capillary

i) Complete cells with small intercellular clefts (gaps)

ii) Found in skeletal muscle, smooth muscle, and lungs

b) Fenestrated capillary

i) Cells contain small pores (fenestrations) with small intercellular clefts

ii) Found in kidney, small intestine, and brain

c) Sinusoids

i) Cells have very large fenestrations and wide intercellular clefts

ii) Found in spleen, liver, and bone marrow

5) Capillary Beds

a) Metarteriole

i) Vessel that connects an arteriole to 10-100 capillaries (capillary bed)

ii) Passes directly thru the capillary bed

(a) Directly connects the arteriole to the venule

b) Precapillary sphincters

i) Found at the junction of the metarteriole and the capillary bed

ii) Control blood flow within the capillary bed

D) Venules

1) Collect blood from capillaries

2) Primarily serve as a conduit for blood

3) No vasoconstriction/vasodilation

E) Veins

1) Carry blood back to the heart

2) Have thin tunica media, which contains little smooth muscle & elastin

a) No vasoconstriction/vasodilation

3) Thick tunica externa composed of collagen and elastin

4) Large, collapsed lumens

5) Have 1-way valves in their lumens to prevent the backflow of blood

4. Capillary Exchange – 3 main processes

A) Diffusion (simple & facilitated)

1) O2, CO2, glucose, amino acids, steroid hormones, and urea

B) Transcytosis

1) Protein hormones and antibodies

C) Bulk flow (filtration)

1) A large number of ions and molecules move within a fluid

2) Fluid may move out (filtration) or back into (reabsorption) the capillary

3) Responsible for the relative volumes of the blood and interstitial fluid

4) Driven by a pressure difference

a) NFP = CHP - BCOP

i) NFP – net filtration pressure

(a) The difference between the forces favoring filtration and those

opposing it

ii) CHP – capillary hydrostatic pressure

(a) Created by blood pushing against the walls of the vessel

(b) Favors filtration

(c) Only pressure to change significantly from one end of the capillary to the

other

iii) BCOP – blood colloid osmotic pressure

(a) Created by plasma proteins in the blood

(b) Favors reabsorption

(c) Remains constant from one end of the capillary to the other.

5. Blood Flow (Circulation) & Blood Pressure

A) Blood flow – volume of blood that flows thru any tissue

1) Total blood flow = cardiac output

2) Distribution of blood throughout the body is dependent on:

a) A pressure difference at the tissues (localized blood pressure)

b) Vascular resistance

B) Blood Pressure – pressure of the blood on the walls of the vessel

1) Decreases as you move away from the heart

2) 2 components

a) Systolic pressure (100-120mmHG)

b) Diastolic pressure (70-80mmHG)

3) Pulse pressure

a) Pulse P = systolic P – diastolic P

4) Mean arterial blood pressure (MABP)

a) MABP = diastolic P + (pulse pressure/3)

5) Dependent on total blood volume

a) Small decrease (<10%) in blood volume

b) Large decrease (>10%) in blood volume

c) Any increase in blood volume

C) Resistance

1) Created by friction between blood and walls of vessels

2) Dependent on:

a) Blood viscosity (thickness)

i) Ratio of RBC to plasma

(a) Dehydration increases

(b) Anemia decreases

b) Total blood vessel length

c) Blood vessel diameter

i) Controlled by sympathetic NS through vasoconstriction/vasodilation

3) Total peripheral resistance

a) The total resistance of all systemic blood vessels combined

b) Adjusted by altering arteriole diameter

i) Controlled by vasomotor center

c) Determines localized blood pressure and flow to particular tissues & systemic

BP

D) Venous Return

1) Requires pressure difference

2) Heart normally creates enough pressure to keep blood moving

3) Aided by:

a) Skeletal muscle pump

b) Respiratory pump

6. Control of Blood Flow & Pressure

A) 3 mechanisms

1) Alter cardiac output (addressed during heart lecture)

2) Change vascular resistance

3) Adjust total blood volume

B) Autonomic NS – Short-Term

1) Via cardiovascular center

2) Input

a) Baroreceptors

i) Monitor blood pressure

b) Chemoreceptors

i) Monitor O2, CO2, H+

3) Output

a) Sympathetic fibers

i) Cardiac accelerator nerves

(a) Innervate the conduction system & ventricular myocardium

(i) Causes an increase in SR & HR

ii) Vasomotor nerves (sympathetic) – cause both excitatory and inhibitory

responses in the tunica media of select vessels

(a) Cause vasoconstriction of **most** systemic arterioles

(i) This increases systemic blood pressure

(b) Cause vasodilation of the blood vessels supplying the **heart &**

**skeletal muscle**

(i) This increases blood flow to these areas

(ii) Because of their limited numbers (as compared to the constricting

arterioles previously mentioned), it does not cause a drop in systemic

blood pressure

b) Parasympathetic fibers

i) Vagus nerves

(a) Innervates the conduction system only

(b) They **do not** innervate any blood vessels

4) Vasomotor Reflexes

a) Baroreflex

i) Triggered by increased stretch (BP)

ii) Inhibits sympathetic output and stimulates the Vagus nerve

(parasympathetic)

b) Chemoreflex

i) Triggered by hypoxia, acidosis, or hypercapnia

ii) Stimulates sympathetic output

c) Medullary ischemic reflex

i) Triggered by hypoxia or hypercapnia at the brainstem

ii) Stimulates the vasomotor center (sympathetic)

(a) Causes vasoconstriction of vessels in lower parts of the body

C) Hormonal Control – Long-Term

1) Renin-angiotensin system

a) Increases blood volume

i) Renin

(a) Released from the kidney in response to decreased blood volume

(b) Converts angiotensinogen (plasma protein) to angiotensin I

ii) ACE (angiotensin converting enzyme)

(a) Found primarily in the lungs

(b) Converts angiotensin I to angiotensin II

iii) Angiotensin II

(a) Systemic vasoconstrictor

(b) Causes aldosterone release from adrenal cortex

(i) Increases Na+ & H2O reabsorption by the kidneys

2) Atrial Natriuretic Peptide (ANP)

a) Decreases blood volume

i) Released from the ventricles of the heart in response to an increase in blood

volume

ii) Decreases Na+ & H2O reabsorption (increases excretion) by the kidneys and

inhibits the release of aldosterone

7. Blood Vessel Disorders

A) Atherosclerosis – plaque build-up (fat and cholesterol) within the vessel

1) The plaque obstructs the vessel causing increased blood pressure and a reduction in

elasticity

B) Aneurysm – ballooning of a blood vessel, which increases the risk of rupture

C) Hypotension – low blood pressure

1) Systolic below 90 or diastolic below 60

D) Hypertension – high blood pressure

1) Prehypertension – systolic 120-139 or diastolic 80-89

2) Stage 1 Hypertension – systolic 140-159 or diastolic 90-99

3) Stage 2 Hypertension – systolic 160 & up or diastolic 100 & up