CARDIOVASCULAR PHYSIOLOGY

BLOOD VESSEL CHARACTERISTICS

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Cardiovascular: Blood Vessel Characteristics

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OUTLINE

I) COURSE OF BLOOD VESSEL CIRCULATION

- **Arterial Course**
  - Heart → Elastic artery → Muscular artery → Arteriole → Capillaries
- **Venous Course**
  - Capillaries → Venules → Veins → Heart

Note: Capillaries and Venules will be further discussed in Ninja Nerd's Microcirculation video.

II) DIFFERENT TYPES OF VESSELS

1. Elastic Conducting Arteries
2. Muscular Distributing Arteries
3. Arterioles
4. True Capillaries
5. Venules
6. Veins

Table 1. Arteries vs Veins

	Arteries	Veins
Blood flow direction	Away from the heart	Away from the heart
Pressure	High	Low
Oxygen content	High ● Except → Pulmonary artery → Umbilical artery	Low ● Except → Pulmonary vein → Umbilical vein

A nice mnemonic to remember:

- **A**rteries: **A**way from the heart
- **V**eins: **V**ack to the heart

III) ARTERIES

Table 2. Muscular Arteries vs Elastic Arteries

FEATURES	MUSCULAR ARTERIES	ELASTIC ARTERIES
Characteristics	Smaller of Medium-sized vessels	Large vessels Nearest to the heart
Diameter	6mm *(due to **thick tunica media**)*	Ranges from 1-1.5cm
Structure	Less elastic lamina → less elasticity	Lots of elastic lamina → more elasticity
Functions	Delivers blood to specific organs Regulates blood flow to target organs - Vasoconstriction - Vasodilation	Absorbs and dampens high-pressure blood from heart's ventricles - **Stretches** during **systole** to take on high systolic pressure - **Recoils** during **diastole** Maintains relatively constant pressure gradient despite heart's high-pressure pumping action [Tucker, et al.]
Examples	Renal artery Femoral artery Gonadal artery Mesenteric artery Inferior phrenic artery	Pulmonary Trunk **Aorta** (prime example) - Even branches are high pressure systems → Brachiocephalic branches to right common carotid and right subclavian

(1) Arterioles

- Very small vessels with a diameter of around 35 µm
- Feed the capillary bed where true capillaries come from
- **High Resistance Vessels**
  - Develop the most resistance to blood flow
- **Pre-capillary sphincters**
  - Smoot muscle layer wrapped around arterioles or the capillary bed
  - When the SNS innervates them, it causes them to constrict
    - SNS = Sympathetic Nervous System
    - This makes the arterioles high resistance vessels

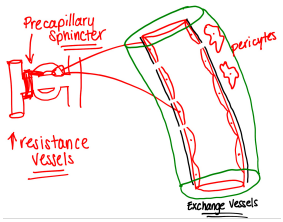

Figure 1.1 Arteries

(2) True Capillaries

- Diameter of 8-10 µm
- **Exchange vessels**
  - Main significance of capillaries
  - Designed for exchange of different substances *(e.g., gases, nutrients, hormones, wastes)*
- Tunica Intima
  - Inner lining with simple squamous epithelial cells
- Basement membrane/ Basal lamina
  - Connective tissue layer wrapped around the capillaries
  - Depending on where it's located, it may have intracellular clefts, fenestration pores, tight junctions, or pericytes

IV) VEINS

- 5mm in diameter
- Designed to be lower pressure systems
  - 5-10 mmHg
- Thin tunica media
- Main Function: **Capacitance or reservoir vessels**
- **Large lumen**
  - Occupies large volume of blood
  - 70% of all the body's blood at any given instance
- **Decreased smooth muscle**
  - Not great at pushing blood up towards heart

(A) FOUR SPECIALTIES OF THE VEIN

- Since the vein is not a high-pressure system, it must develop some adaptations to get blood back up against gravity despite the decreased smooth muscle

(1) Valves of tunica interna

- Tunica interna is an endothelial cell lining that fold inwards to form **valves**
  - Valves help prevent the blood from going back down
  - Blood is pushed up → Some blood that circulates back down pushes the valve close → prevent blood from flowing into the inferior portion of the vein
  - Prevents *pooling of blood*
    - Causes varicose veins

(2) Muscular Milking

- Veins are usually **near muscles**
- Slow process of muscular contraction that squeezes the blood vessels and push the blood upward

(3) Respiratory Pump

- Breathing increases thoracic cavity volume → can push on some lower vessels and help the blood push upward
  - Helps increase blood flow from the lungs and back to the heart
  - Helps push blood flow from the lower systemic veins back up to the heart

(4) Sympathetic Tone

→ Sympathetic nerves in the SNS innervate tunica media
→ Causes venoconstriction of smooth muscle
→ Help push blood upward

(B) VARICOSE VEINS

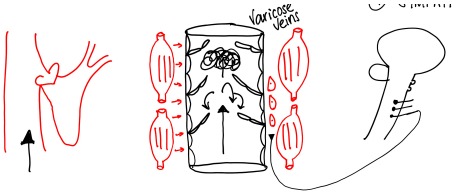

Figure 1.2 Varicose veins

- Tortuous, dilated, twisted, and/or enlarged blood vessels
- Valves can become incompetent and leaky

Process

→ Blood vessels expand and blood pools in that area
→ Edges of blood vessels pull away from one another
→ The space between the valves increases
→ Blood starts to move back down
→ Blood pools in one area
→ Blood vessel becomes tortuous, dilated, twisted, and/or enlarged

Common in the following:

- Calves: *varicose veins*
  - May be caused by standing for a long time
- Testes: *varicoceles*
  - Particularly the left testes
    - left gonadal vein comes up with renal artery and turns to put blood into the IVC
      - IVC: Inferior Vena Cava
    - blood leads to backflow into the testes
    - right gonadal vein goes straight to the IVC
  - May lead to inflammation and in some cases, infertility
- Anus: *hemorrhoidal veins*
  - Hemorrhoids
  - Accumulated pressure due to various scenarios
    - *E.g., high pressure straining, forcing to go to the bathroom, sitting for long periods of time*

V) APPENDIX

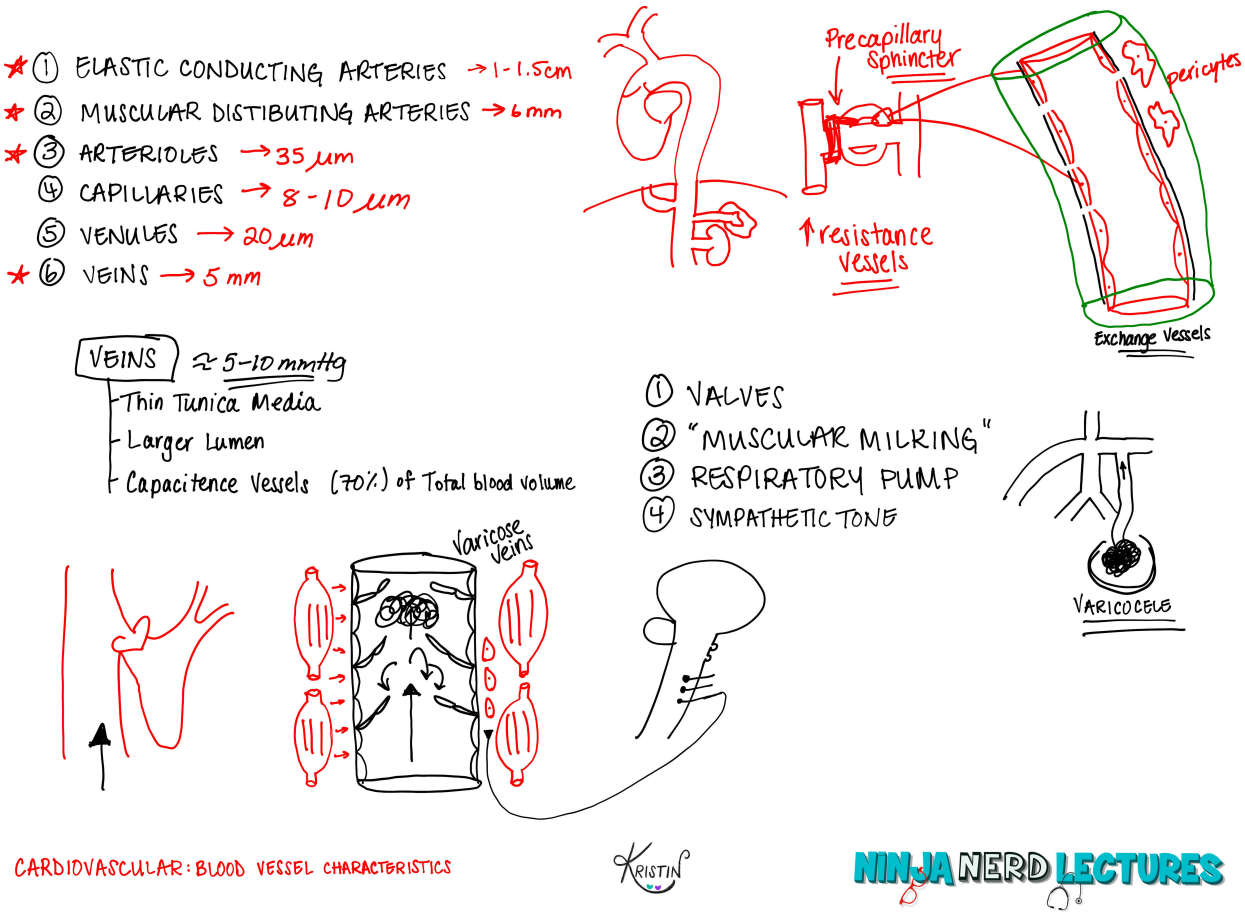

Figure 1.3. Summary of Blood Vessel Characteristics

VI) REVIEW QUESTIONS

1) Which of the following is considered the largest blood vessel?

a) Elastic Conducting Arteries
b) Muscular Distributing Arteries
c) Arterioles
d) Veins

2) Which of the following is not a specialty feature of a vein?

a) Valves of tunica externa
b) Muscular Milking
c) Respiratory Pump
d) Sympathetic Tone

3) All of the following are features of a varicose vein, except:

a) Tortuous
b) Constricted
c) Twisted
d) Enlarged

CHECK YOUR ANSWERS

VII) REFRENCES

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