SABS I: Vascular Physiology

INTRODUCTION

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A. Primary Function of the Peripheral Circulation

- Maintain tissue environment for optimal cell survival and function (HOMEOSTASIS)
- Homeostasis requires:
  - Exchange
  - Transportation
  - Maintenance of internal temperature and pH
  - Defense against foreign agents

Transportation and Exchange

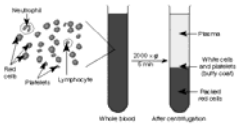
- To tissues: O_2, metabolic fuels, hormones
- From tissues: CO_2, metabolic wastes, hormones

As tissue needs change, how are transportation and exchange altered?

B. Major Components of the Peripheral Circulation

1. Blood

- Plasma: carriers, coagulation, water balance, pH
- Red blood cells: transportation of O_2, $CO_2 \rightarrow$bicarbonate, pH
- White blood cells: immune function
- Platelets: hemostasis (procoagulants, vasoconstrictors, aggregation), growth factors



B. Major Components of the Peripheral Circulation

2. Vessels

- Conduit arteries: elastic vessels, pressure reservoir, low resistance, distribute blood to organs
- Resistance arteries: (≥100µm diameter), at least 2 continuous layers of innervated vascular smooth muscle.
- Arterioles: (5-100+ µm diameter), single layer of innervated vascular smooth muscle.

B. Major Components of the Peripheral Circulation

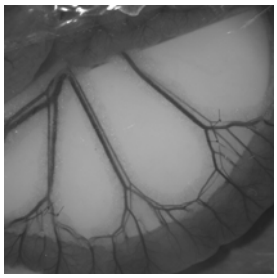
2. Vessels

- Capillaries: (5-10µm) single layer of endothelial cells
- Venules: single layer of innervated vascular smooth muscle; larger venules paired with companion arterioles
- Veins: conduits for the return of blood to the heart, contain innervated smooth muscle cells and provide a volume reservoir

B. Major Components of the Peripheral Circulation

2. Vessels

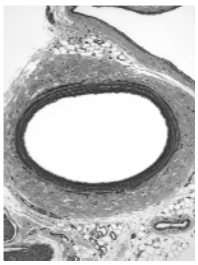
- Macrocirculation: vessels responsible for the blood distribution to, or collection from, tissues.
- Microcirculation: vessels embedded within tissues and responsible for the perfusion of the tissues.



B. Major Components of the Peripheral Circulation

2. Vessels

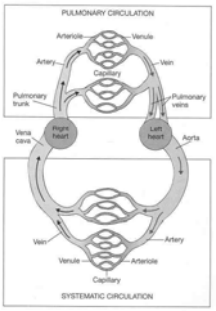
- Intima: basement membrane and endothelium
- Media: smooth muscle cells, elastin, and collagen
- Adventitia: collagen, fibroblasts



B. Major Components of the Peripheral Circulation

2. Two major circuits

- Pulmonary and systemic
- Major physiological differences



B. Major Components of the Peripheral Circulation

	Systemic	Pulmonary
Vessels transporting O_2	**Arteries**	**Veins**
Arterial Pressure (mmHg)		
Organ blood flow (%CO)		
Response to local hypoxia		

B. Major Components of the Peripheral Circulation

	Systemic	Pulmonary
Vessels transporting O_2	Arteries	Veins
Arterial Pressure (mmHg)	**70-120**	**8-25**
Organ blood flow (%CO)		
Response to local hypoxia		

B. Major Components of the Peripheral Circulation

	Systemic	Pulmonary
Vessels transporting O_2	Arteries	Veins
Arterial Pressure (mmHg)	70-120	8-25
Organ blood flow (%CO)	**Fraction**	**Total**
Response to local hypoxia		

B. Major Components of the Peripheral Circulation

	Systemic	Pulmonary
Vessels transporting O_2	Arteries	Veins
Arterial Pressure (mmHg)	70-120	8-25
Organ blood flow (%CO)	Fraction	Total
Response to local hypoxia	**Vasodilation**	**Vasoconstriction**

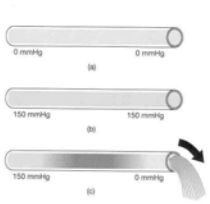
Example of the Autoregulation of Blood Flow

C. Physical Principles Associated with Blood Flow

What determines the flow of blood through the vasculature?

C. Physical Principles Associated with Blood Flow

1. **Blood flow (F)**
- **Definition: volume flux per unit time (ml/min or L/min)**
- **Determinates**
  - **Pressure difference**
  - **Resistance**
  - **F = ΔP/R**



C. Physical Principles Associated with Blood Flow

2. **Pressure (P)**
- **Definition: force per unit wall area (mm Hg)**
- **Components**
  - **Distension (balloon)**
  - **Gravity (draining water hose)**
  - **Kinetic (water leaving water hose)**

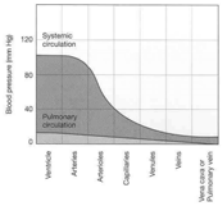
C. Physical Principles Associated with Blood Flow

3. **Resistance (R)**
- **Definition: sum of forces resisting flow**
- **Determinants**
  - **vessel radius (r): $R \propto 1/r^4$**
  - **vessel length (l): $R \propto l$**
  - **blood viscosity (η): $R \propto \eta$**

C. Physical Principles Associated with Blood Flow

4. Pressure profile in the peripheral circulation

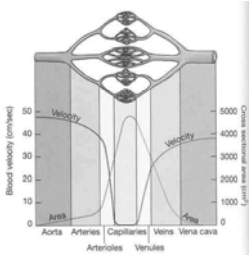
- **arteries>arterioles>capillaries >venules>veins**
- **Pressure gradient required for flow**



C. Physical Principles Associated with Blood Flow

5. Velocity of blood flow

Linear velocity varies inversely with the cross-sectional area

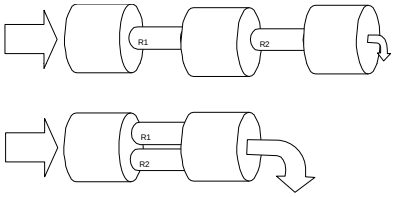


C. Physical Principles Associated with Blood Flow

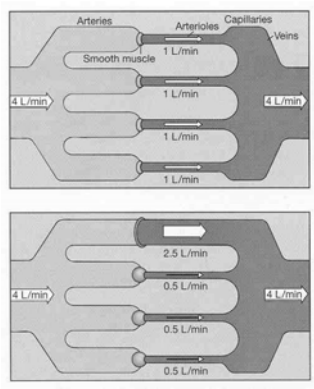
6. Serial/parallel arrangement

- **Redistribution of blood flow**
- **Decreases total resistance**
- **Provides collateral pathways**

Serial/parallel arrangement of the peripheral vasculature



Redistribution of blood flow



Collateral Pathways