Cardiorespiratory System

What are the functions of the cardiorespiratory system?

- Transport $O_2$ to tissues and removal of waste
- Transport of nutrients to tissues
- Regulation of body temperature
Cardiorespiratory System

What are the components of the cardiorespiratory system?

Cardio-
- Heart = a pump between external and internal respiration
- Blood Vessels = transportation

Respiratory
- Lungs = gas exchange
Cardiovascular System

- Heart
- Blood vessels
THE HEART

FOUR CHAMBERS

2. Right atria - blood from systemic system to...
3. Right ventricle - blood to pulmonary system and then to...
4. Left atria - blood from pulmonary system to...
5. Left ventricle - blood to systemic system and then to... right atria (and repeat)
Cardiovascular System

**Systemic circuit**
- Which side of the heart is part of the systemic circuit?
- What is the oxygen content of the blood as it leaves the heart (high or low)?

**Pulmonary circuit**
- Which side of the heart is part of the pulmonary circuit?
- What is the oxygen content of the blood as it leaves the heart (high or low)?
BLOOD FLOW THROUGH THE HEART

• Blue section shows blood flow through the right side of the heart

• Red section shows blood flow through the left side of the heart
MYOCARDIUM
or Cardiac Muscle

What is the myocardium?

Why is the left ventricle the most powerful and largest of the chambers?
**MYOCARDIUM**

- Intercalated disks
  - What are they?
  - What is their function?
CONTROL OF THE HEART - INTRINSIC

- Superior vena cava
- SA node
- Right atrium
- AV node
- AV bundle
- Bundle branches
- Purkinje fibers
- Left atrium
CONTROL OF THE HEART

- What part of the heart is referred to as the pacemaker of the heart?
- What is the function of the A-V node?
- What is an electrocardiogram?
Electrocardiogram (ECG or EKG)

TERMS

- Depolarization: stimulation of the myocardium
- Repolarization: recovery of the myocardium from stimulation
CONTROL OF THE HEART - ECG

Atrial depolarization (P wave)
Ventricular depolarization (QRS)
Ventricular repolarization (T wave)

PR interval
QT interval

P Q R S T
MEDULLA
Control Center

1. Neural input to medulla
   - Higher brain centers
   - Receptors
     - Baroreceptors (blood vessels)
     - Stretch receptors (heart)
     - Chemoreceptors (blood vessels)
     - Mechanoreceptors (muscles/joints)

2. Neural output from the medulla
   - Sympathetic nervous system
   - Parasympathetic nervous system
MEDULLA
Control Center
CONTROL OF THE HEART

NEURAL CONTROL

- Parasympathetic Nervous System acts through the vagus nerve.
- What affect does the vagus have on heart rate?
- What affect does the Sympathetic Nervous System have on heart rate?

HORMONAL CONTROL

- What affect do the hormones epinephrine and norepinephrine have on heart rate?
HEART FUNCTION - Heart Rate

- Definition?
- What is a typical resting heart rate?
**HEART FUNCTION - Cardiac Cycle**

- **Cardiac Cycle**: Events that occur between two consecutive heartbeats (systole to systole)
  - What is Systole?
  - What is Diastole?
HEART FUNCTION - Cardiac Cycle

- Systole: 0.3 seconds
- Diastole: 0.5 seconds

Rest
Heart rate = 75 beats/min

Systole: 0.2 seconds
Diastole: 0.13 seconds

Heavy exercise
Heart rate = 180 beats/min
HEART FUNCTION - Heart Rate

- Why does heart rate increase during exercise?
- How is heart rate increased?
HEART FUNCTION – Stroke Volume

- What is stroke volume?
- What happens to stroke volume during exercise?
- How is stroke volume increased?
What is **cardiac output**?

Cardiac Output = Heart Rate x Stroke Volume

Example: HR of 72 beats/minute x SV of 70 mL/beat

Therefore, Q = 72 x 70 or 5,040 mL/min or 5.040 L/min
HEART FUNCTION

- **Heart Rate**
  - 50-75 beats per minute

- **Stroke Volume (SV)**
  - 60-100 milliliters per beat (ml/beat)

- **Cardiac Output (Q)**
  - 4500-5000 milliliters per minute
  - 4.5-5 liters per minute (L/min)
How is cardiac output increased during exercise?

Why is cardiac output increased during exercise?
a-v O2 Difference

- Oxygen Extraction at Rest
  - Arteries
    - 20 ml or oxygen in every 100 ml of arterial blood
  - Veins
    - 15 ml/100 ml of blood.
- How much oxygen did the muscles use?
  - This amount is called the a-vO2 difference.
THE VASCULAR SYSTEM (Circulation)

- Arteries
- Arterioles
- Capillaries
- Venules & Veins
How do arteries differ from other blood vessels?
THE VASCULAR SYSTEM - Arterioles

- Unique?
- Smooth muscle sphincters
- Function?
- Blood distribution
- Vasodilation
- Vasoconstriction
What makes capillaries unique from other blood vessels?
What makes veins unique from other blood vessels?
Muscle Pump

![Diagram showing muscle pump with contracted and relaxed states, valves open and closed, and blood flow to the heart.](image)
Muscle Pump

Muscle contracts
Valve closed

Muscle relaxes
Valve open

Blood propelled forward by muscle contractions and, possibly, by gravity

Back pressure due to contractions of atria, contractions of muscles, and, possibly, gravity
BLOOD PRESSURE

- Systolic is the pressure in the [insert blank] when the heart is [insert blank].
- Diastolic is the pressure in the [insert blank] when the heart is [insert blank].

What is a normal resting blood pressure?

What happens to systolic blood pressure during exercise? Why?
BLOOD PRESSURE

(a) Brachial artery
Mercury gauge
Release valve
Inflation bulb
Cuff pressure: 0
Blood flow: Laminar
Sound: None

(b) Cuff pressure: 140 mmHg
Blood flow: Occluded
Sound: None

(c) Cuff pressure: 120 mmHg
Blood flow: Partially occluded, turbulent
Sound: First Korotkoff sound = SBP

(d) Cuff pressure: 80 mmHg
Blood flow: Laminar
Sound: Fourth Korotkoff sound (muffling) = DBP$_1$
Fifth Korotkoff sound (disappearance) = DBP$_2$
THE BLOOD

- What are some of the functions of the blood?
  - Transportation: gas, nutrients, and wastes
  - Regulates temperature
  - Others
THE BLOOD — FORMED ELEMENTS

- **Red blood cells.**
  - What do they do?

- **White blood cells.**
  - What do they do?

- **Platelets.**
  - What do they do?
THE BLOOD – BLOOD VOLUME

Centrifuged whole blood

55% plasma
- 90% H₂O
- 7% plasma proteins
- 3% other

45% formed elements
- > 99% red blood cells
- < 1% white blood cells and platelets
THE BLOOD - Hematocrit

What is Hematocrit?

- Ratio of formed elements (mostly RBC) to the total blood volume

What is a typical value?

- Centrifuged whole blood
  - 55% plasma
  - 90% H₂O
  - 7% plasma proteins
  - 3% other
  - 45% formed elements
    - > 99% red blood cells
    - < 1% white blood cells and platelets