Chapters 9 & 10
Cardiorespiratory Control

Cardiorespiratory System
- Pulmonary ventilation
- Gas exchange
- Left heart
- Arterial system
- Tissues
- Right heart
- Lungs
- Pulmonary ventilation

Cardiovascular Adjustments to Exercise
- Neural and hormonal control — Balance:
  - Demand for blood to active tissues
  - Critical need to maintain blood pressure
- Cardiovascular control mechanisms
  - Central command → cardiovascular control center
  - Muscle afferents → CVC
  - Baroreceptors → CVC
  - Muscle chemoreceptors → CVC
  - Hormonal → CVC
- Mechanisms are redundant, not additive

Nervous System Components
- CNS
- Peripheral nervous system
  - Sensory division
  - Motor division
    - Somatic (voluntary)
      - Sympathetic
      - Parasympathetic
  - Autonomic (involuntary)

Cardiovascular Regulation—Exercise
- Central Command
  - Motor signal in brain
  - Initial CV changes due to motor signals
  - Set pattern of CV&R response
Cardiovascular Control-Exercise

- Central command
  - Stimulates CV center
  - VD skeletal muscles
- CV control center
  - Loose connection of nerve cells in brain stem - pons, medulla

Cardiorespiratory Control

Cardiovascular Control - Exercise

- Central Command (efferent signals)
  - Sends impulses to CV area
- CV area sends signals
  - Parasympathetic efferents
  - Withdrawal from control of HR
  - Sympathetic efferents
  - Stimulate contractility
  - Blood vessels
    - VC nonworking areas
    - Stimulate release of E and NE from adrenals

Feedback (afferent signals - fine tune)

Cardiovascular Control

- CV control center (vasomotor center) - medulla - 4 areas
  - Pressor area
    - Increases BP, VC of vessels
  - Depressor area
    - Decreases BP by inhibiting nerves causing VC

Cardiovascular Control

- Cardioacceleration center
  - Increases HR
- Cardioinhibitory center
  - Depresses cardiac activity (associated with vagus)

CV Regulation - Exercise

- CV Regulation - Exercise
  - Feedback (afferent signals - fine tune)
  - Muscle afferent receptors
    - Skeletal muscle blood flow - balance between VC and metabolic VD
      - Muscle afferents signal CVC regarding muscular movement and metabolic state
      - Helps balance need muscle BF vs blood pressure
**CV Regulation - Exercise**

- **Muscle mechanoreceptors (cont)**
  - Types I, II
    - Nerve endings in muscle spindles, Golgi tendon organs
    - No effect on CV function
  - Type III – mechanoreceptors
    - Sensitive to stretch, mechanical deformation (ergoreceptors)
  - Type IV – metaboreceptors (muscle chemoreceptors)
    - Responsive to chemical stimuli, (increased K⁺, H⁺ and decreased pH)
    - Vasodilation

- **Baroreceptors (aortic and carotid)**
  - Sensitive to stretch – changes in arterial blood pressure
  - Send afferent information to CVC to affect
    - HR, contractility, vascular resistance
    - Chronic and acute regulation of BP

- **Baroreceptors - work from a set point**
  - Low pressure BR
    - Atria, ventricles, pulmonary artery, vein
  - High pressure BR
    - Carotid sinus, aortic arch

- **Onset of exercise**
  - BR set point increases
  - Immediate increase in HR and BP

- **Rest**
  - Return BP to baseline - previous set point

- **Exercise pressor reflex**
  - CV changes reflexly induced from contracting skeletal muscle that are responsible for the increase in arterial blood pressure.
    - Fine-tune
Ventilatory Regulation

- Respiratory control center
  - Medulla oblongata
- Somatic motor nerves (spinal cord)
  - Control respiratory muscles
    - Contraction and relaxation

Control of Ventilation

- Respiratory control center
  - Receives neural and humoral input
  - Feedback from muscles
  - CO₂ level in the blood
  - Regulates respiratory rate

Input to the Respiratory Control Centers

- Neural input
  - Input other than stimuli from blood
  - Motor cortex (afferent)
    - Stimulates respiratory center
      - Increase \( V_e \) needed during exercise
  - From skeletal muscle
    - Type III, Type IV – lactic acid accumulation
      - (more important for control of \( CO_2 \) responses)
  - Respiratory muscles
    - Internal intercostals, diaphragm, airways

Input to the Respiratory Control Centers

- Humoral chemoreceptors
  - Central chemoreceptors – Located in the medulla
    - Cerebral spinal fluid
      - ↑ \( PCO_2 \) and ↑ H⁺ concentration (↓ pH)
  - Peripheral chemoreceptors - Aortic and carotid bodies
    - Arterial blood
      - ↓ \( PO_2 \), ↑ \( PCO_2 \), ↑ H⁺, and ↑ K⁺ in blood