Objectives

- Explain the difference between aerobic and anaerobic metabolism
- Describe the importance of tissue perfusion
- List the four elements of the Fick principle
- List the primary components of the cardiovascular system and their roles

Objectives

- Discuss the role of water in its relationship with body function
- Discuss the fluid compartments of the body
- Identify the significant anions and cations in the body
- Explain the role of the semipermeable membrane in the function of the cell
Objectives

- Discuss the concepts of diffusion, facilitated diffusion, osmosis, osmotic pressure, and active transport
- Give examples of isotonic, hypotonic, and hypertonic solutions
- Explain the function of plasma, erythrocytes, platelets, hemoglobin, and hematocrit in blood

Objectives

- Describe the role of antigens and antibodies in the body
- Explain the Rh factor in blood
- Describe acids and bases in relation to pH
- Explain how the buffer systems, respiration, and kidney function help to maintain acid-base balance in the body

Objectives

- Describe the three principal stages of shock
- List the five types of shock
- Discuss the proper assessment and management of the patient in shock
- Describe fluid replacement in the management of the patient in shock
**Pathophysiology of Shock**

- **Perfusion**
- **Anaerobic metabolism**
  - Without O\(_2\)
- **Aerobic metabolism**
  - With O\(_2\)
- **Hypoperfusion**

---

**Pathophysiology of Shock**

- **Fick principle**
  - Adequate ventilation
  - O\(_2\) binds with hemoglobin
  - O\(_2\) transported via circulatory system
  - O\(_2\) off-loaded in capillaries

---

**Pathophysiology of Shock**

- **Cellular metabolism**
  - Cellular respiration
  - Pyruvic acid
Pathophysiology of Shock

- Aerobic metabolism
  - Person breathes O₂
  - O₂ binds with hemoglobin

Pathophysiology of Shock

- Anaerobic metabolism
  - Shock patient

The Cardiovascular System

- Closed system of blood vessels
The Cardiovascular System

- Stroke volume

Dependent on:
- Contractility
- Preload
- Afterload

The Cardiovascular System

- Contractility
  - Extent and velocity of muscle fiber shortening
  - Influenced by
    - \(O_2\) supply and demand
    - Degree of sympathetic stimulation
    - Electrolyte balance
    - Drug effects
    - Disease

The Cardiovascular System

- Preload
  - Affected by volume of blood returning
  - More blood ↑ preload
  - Less blood ↓ preload
The Cardiovascular System

**Afterload**
- Affects stroke volume
- Dictated by arterial blood pressure
- Factors that increase afterload
  - Obstruction of aortic valve
  - Circulatory fluid overload

**Blood pressure**
- Force exerted against arterial walls
- Cardiac output times peripheral resistance

**Blood vessels**
- Arteries
- Arterioles
- Capillaries
- Venules
- Veins
The Cardiovascular System

- Microcirculation system
  - Arterioles
  - Capillaries
  - Venules

Fluid and Electrolytes

- Water

- Solvent
  - Solute
    - Electrolytes
    - Nonelectrolytes
Fluid and Electrolytes

- **Intracellular fluid**
- **Extracellular fluid**
  - Intravascular fluid
  - Interstitial fluid

---

Fluid and Electrolytes

- **Homeostasis**

---

Fluid and Electrolytes

- **Electrolytes**
  - **Salts**
    - Ions—electrical current
    - Cations—positive charge
    - Anions—negative charge
Fluid and Electrolytes

- Cations (+ charge)
  - Sodium (Na+)
  - Potassium (K+)
  - Calcium (Ca2+)
  - Magnesium (Mg2+)

- Anions (- charge)
  - Chloride (Cl-)
  - Bicarbonate (HCO3-)
  - Phosphate (HPO42-)

Cellular Membranes

- Semipermeable
  - Allows substances to pass through

- Permeability
  - Degree to which substances are allowed to pass through

Cellular Membranes

- Diffusion
  - Movement of particles
  - Solutes
  - Passive process
**Cellular Membranes**

- **Facilitated diffusion**
  - Transport protein
  - Passive transport

**Osmosis**
- Movement of water across semipermeable membrane

**Fluid and Electrolytes**
- **Active transport**
  - Across membrane from ↓ concentration to ↑ concentration
  - Faster than diffusion
Fluid and Electrolytes

- Isotonic solution
  - Osmotic pressure equal to normal body fluid
  - 0.9% normal saline, lactated Ringer’s

- Hypotonic solution
  - Osmotic pressure less than body fluid

- Hypertonic solution
  - Osmotic pressure greater than body fluid

The effects of tonicity on a red blood cell

Blood

- Three functions
  - Transportation
  - Regulation
  - Protection
Blood

- Plasma
- Fluid portion
- Erythrocytes (E)
- Leukocytes (L)
- Hemoglobin
- Hematocrit
- Platelets

Antigen
- Protein that triggers formation of antibodies

Antibody
- Protein developed in response to an antigen

Rh factor
- Antigen factor considered during blood typing

Blood type is determined by the antigens present on blood cell membranes.
Acid-Base Balance

- **pH**
  - Measure of relative hydrogen ion concentration

- **Acid**
  - ↑ hydrogen ion concentration, pH < 7.0

- **Base**
  - ↓ hydrogen ion concentration, pH > 7.0

Acid-Base Balance

- **Buffer systems**
  - Fastest acting defenses
  - Act as chemical sponge
  - Major buffer system
    - Bicarbonate/carbonic acid
Acid-Base Balance

- **Respiration**
  - Vital role
  - Regulates concentration of carbon dioxide

- **Kidney function**
  - Role is complex
  - Able to deal with alkalosis or acidosis

Primary acid-base imbalances
- Respiratory acidosis
- Respiratory alkalosis
- Metabolic acidosis
- Metabolic alkalosis

Acid-Base Balance—Respiratory Acidosis
Stages of Shock

- Compensated shock
- Decompensated shock
- Irreversible shock
Stages of Shock—
Decompensated Shock

Types of Shock

- Primary mechanisms
  - Fluid loss
  - Significant vasodilation
  - Pump failure

- Hypovolemic shock
- Cardiogenic shock
- Neurogenic shock
- Anaphylactic shock
- Septic shock
Types of Shock—
Hypovolemic Shock

Types of Shock—
Cardiogenic Shock

Types of Shock—
Neurogenic Shock
Assessment and Management of the Patient in Shock

Evaluation directed at:
- assessing oxygenation
- perfusion of body organs

Goals
- Patent airway
- Oxygenation and ventilation
- Perfusion

Level of responsiveness
- Assessed throughout survey
- Better indicator
- Significant alteration
- Alcohol and drugs

Airway assessment
- Opened and maintained
- Upper airway obstruction
  - Snoring
  - Gurgling
  - Stridor
Assessment and Management of the Patient in Shock

- Airway management
  - Airway adjunct
  - Endotracheal intubation
  - Suctioning
  - Positioning

- Breathing and oxygenation assessment
  - Adequacy of air exchange
  - Rate and depth of respirations

- Breathing and oxygenation management
  - Assist breathing
  - 100% oxygen
  - Nonrebreather mask
  - Nasal cannula
  - Pulse oximeter
Assessment and Management of the Patient in Shock

Circulation assessment
- External bleeding
- Pulse rate and character
- Skin color, appearance, temperature
- Capillary refill

Circulation management
- Positioning
  - Supine
  - Legs elevated
  - Respiratory compromise

Fluid replacement
- Common solutions
  - Lactated Ringer’s
    - Volume replacement
  - 0.9% sodium chloride
    - Volume replacement
  - 5% dextrose in water
    - To keep vein open
Assessment and Management of the Patient in Shock

- Fluid replacement
  - Blood preparations
    - Packed erythrocytes
    - Plasma
    - Platelets
    - Whole blood

Assessment and Management of the Patient in Shock

- Maintaining body temperature
  - Factors
    - Environmental/weather
    - Oxygen and IV fluids
    - Patient location
  - Protect the patient
    - Wet clothing
    - Cover patient
  - Vasodilation

Assessment and Management of the Patient in Shock

- Focus history and physical examination
  - Thoroughness depends on patient’s condition
  - Obvious life-threatening problems
  - Continual reassessment
  - Ask the patient
Summary

- Long-term survival depends on delivery of adequate amounts of oxygen and glucose to individual cells.

- Shock is inadequate tissue perfusion, causing lack of tissue oxygenation, which leads to anaerobic metabolism.

- Decreased blood flow is common in shock, may occur from hemorrhage, pump failure, or inappropriate systemic vascular resistance.

Summary

- Body attempts to compensate for shock by several mechanisms.

- Three stages of shock are compensatory, progressive, and irreversible.

- Progressive shock develops when body fails to compensate for insult.

Summary

- Signs and symptoms become more apparent during progressive shock.

- Survival depends on prompt recognition, rapid care, and prompt transport.

- As shock progresses, oxygen supply to cells decreases and cells resort to anaerobic metabolism, leads to production of lactate acid and to acidosis.
Summary

- In irreversible stage of shock, tissues die
- Trauma victim is evaluated for shock in primary survey
- Continue assessment for shock during secondary survey
- Reassess for developing shock until patient is delivered to hospital

Summary

- Treatment for shock includes adequate ventilation and oxygenation and further prevention of shock process
- Rapid transport is imperative
- Low blood pressure is late sign of shock

Summary

- Evaluation of shock begins with scene survey, mechanism of injury, and history
- If these factors indicate shock is or could be present, take measures to counter effects of shock