Objectives

- Discuss importance of human anatomy related to paramedic practice
- Describe anatomical position
- Interpret anatomical terms
- List structures of the axial and appendicular skeleton
- Define division of the abdomen
- List the three major body cavities and their contents

Objectives

- Discuss functions of cellular structures
- Describe cellular reproduction
- Differentiate between body tissue types
- Label and list functions of body organs
- Label and list functions of special senses
Scenario
You are en route to a shooting. The BLS crew on the scene contacts you to tell you the patient has multiple gunshot wounds. They report one entrance wound superior to the umbilicus; another medial and inferior to the right nipple; and a third wound 6 inches proximal to the right knee.

Discussion
- Could this report have been given as accurately and concisely without using these directional terms?
- What does your knowledge of the organs and tissues underlying these injuries lead you to suspect?
- What are your immediate priorities for care based on this report?

Terminology
- Anatomical position
Terminology

- Supine
  - On back, face up

- Prone
  - On stomach, face down

- Lateral recumbent
  - On side

Anatomical Planes

- Sagittal plane
- Parasagittal plane
- Transverse (horizontal) plane
- Frontal (coronal) plane

Body Regions

- Appendicular
  - Extremities

- Axial
  - Head, neck, thorax, abdomen
Body Regions

- Abdominal region

Thoracic, Abdominal, Pelvic Cavities

Cells

- Most basic unit of life
- Composed of protoplasm
- Main parts of human cells
  - Cytoplasmic membrane
  - Cytoplasm
  - Nucleus
Cytoplasm and Organelles

- Cytoplasm
  - Between cytoplasmic membrane and nucleus

- Organelles
  - Structures perform functions important to cell’s survival

Cells

- Endoplasmic reticulum
- Ribosomes
- Golgi apparatus
- Lysosomes
- Mitochondria
- Centrioles
- Nucleus
  - Nucleolus
  - Chromatin granules

Cell Functions

- Movement
- Conductivity
- Metabolic absorption
- Secretion
- Excretion
- Respiration
- Reproduction
Cell Reproduction

- Human cells (except sex cells) reproduce by mitosis.
- Most undergo division throughout the life of the individual:
  - Epithelial cells
  - Liver cells
  - Bone marrow cells
- Some divide until near time of birth:
  - Nerve cells
  - Skeletal muscle cells

Tissues

- Epithelial:
  - Classified by shape and arrangement of cells
- Connective:
  - Seven subgroups
- Muscle:
  - Skeletal, cardiac, smooth
- Nerve:
  - Neurons, neuroglia

Organ Systems

- Organ:
  - A structure made of two or more kinds of tissues organized to perform a more complex function than one tissue alone can accomplish
- System:
  - Group of organs that perform a more complex function than any one organ alone can accomplish
  - 11 major organ systems in the human body
Body Systems

Integumentary System
- Largest organ system
- Functions
  - Protection against injury
  - Prevention of dehydration
  - Defense against infection
  - Aid in temperature regulation

Integumentary System
- Epidermis
- Dermis
- Hair
- Nails
- Glands
**Skeletal System**

- Bones
- Connective tissues
  - Cartilage
  - Tendons
  - Ligaments

**Axial Skeleton**

- Skull
  - 28 bones
- Hyoid bone

**Vertebral column**

- 26 bones
- 5 regions
  - 7 cervical vertebrae
  - 12 thoracic vertebrae
  - 5 lumbar vertebrae
  - 1 sacral bone
  - 5 fused vertebrae
  - 1 coccygeal bone
  - 5 fused vertebrae
Axial Skeleton—Vertebral Column

- Vertebral Column
- Protects organs
- Prevents collapse of thorax
- 12 rib pairs
- Sternum

Thoracic Cage

- Protects organs
- Prevents collapse of thorax
- 12 rib pairs
- Sternum

Appendicular Skeleton

- Bones of the upper and lower extremities and their girdles
- Pectoral girdle
  - Scapula and clavicle
  - Attaches upper limbs to the axial skeleton
Upper Extremity
- Humerus
- Radius/ulna
- Wrist
- Hand

Pelvic Girdle
- Attaches legs to trunk
- Coxae
- Acetabulum

Femur
- Longest bone
- Articulates with acetabulum
- Articulates with patella
Tibia
- Larger than fibula
- Supports most of leg's weight
- Distal end forms lateral malleolus
- Medial side of ankle joint

Fibula
- Does not articulate with femur
- Articulates with tibia
- Distal end forms lateral malleolus
- Lateral aspect of ankle joint

Foot
- Tarsals, metatarsals, and phalanges
- Talus articulates with tibia and fibula
- Calcaneus
Biomechanics of Body Movement

- All bones (except hyoid) connect to at least one other bone

- Three major classifications of joints:
  - Fibrous joints
  - Cartilaginous joints
  - Synovial joints

Fibrous Joints

- Two bones joined by fibrous tissue
- Little or no movement
- Sutures

Fibrous Joints

- Syndesmoses
- Gomphoses
Cartilaginous Joints

- Synchondroses
  - Bones joined with hyaline cartilage
- Symphysis
  - Bones joined with fibrocartilage

Synovial Joints

- Contain synovial fluid
- Plane or gliding joints
- Saddle joints
- Hinge joints
- Pivot joints
- Ball-and-socket joints
- Ellipsoid joints
Types of Movement

- Flexion
- Extension

Types of Movement

- Abduction
- Adduction

Types of Movement

- Medial
- Lateral
Types of Movement

- Circumduction

Types of Movement

- Pronation
- Supination

Muscular System

- Primary functions of skeletal muscle:
  - Movement
  - Postural maintenance
  - Heat production
Physiology of Skeletal Muscle

- Contractile cells (muscle fibers)
- Skeletal muscle fiber
  - Thick and thin myofilaments
- Sarcomere
  - Contractile unit of skeletal muscle
- Contraction process
  - Myofilaments slide toward each other

Neuromuscular Junction

- Impulse enters muscle fibers through motor neuron
- Neuromuscular junction (synapse)

Skeletal Muscle Movement

- Muscle contraction pulls bone toward another across movable joint
- Attachment of each muscle at origin and insertion
- Synergists
- Antagonists
- Prime mover
Skeletal Muscle Movement

Types of Muscle Contraction
- Isometric or isotonic
- Muscle movement often is a combination of isometric and isotonic contraction

Postural Maintenance
- Extended periods of muscle tension
- Muscle tone
  - Keeps back and legs straight
  - Head upright
  - Abdomen flat
Heat Production

- Chemical reaction
- Breakdown of ATP during muscle contraction results in some energy loss as heat
  - Largely responsible for normal body temperature
- Shivering

Nervous System

- Major regulatory and coordinating system
- Rapidly transmits information from one body area to another

Central Nervous System (CNS)

- Brain
- Spinal cord
- Continuous with each other
Peripheral Nervous System (PNS)

- Nerves
- Ganglia
- 43 pairs of nerves form PNS
  - 12 pairs from brain
  - 31 pairs from spinal cord
- Afferent division
- Efferent division
  - Somatic nervous system

Autonomic Nervous System

- Transmits action potentials from CNS to
  - Smooth muscle
  - Cardiac muscle
  - Certain glands

Central Nervous System

- Brain and spinal cord
Brain Stem
- Medulla, pons, and midbrain
- Connects spinal cord to brain

Medulla
- Inferior portion of brain stem
- Pathway for ascending and descending nerve tracts
- Regulates:
  - Heart rate
  - Blood vessel diameter
  - Breathing
  - Swallowing
  - Vomiting
  - Coughing
  - Sneezing

Pons
- Relays information from cerebrum to cerebellum
- Sleep center
- Respiratory center
- Helps control breathing

### Midbrain (Mesencephalon)
- Smallest region of brain stem
- Involved in:
  - Audio pathways in the CNS
  - Visual reflexes
  - Helps regulate coordination of motor activities and muscle tone

### Reticular Formation
- A group of nuclei scattered throughout the brain stem
- Part of reticular activating system
  - Involved in sleep-wake cycle and in maintaining consciousness

### Diencephalon
- Between brain stem and cerebrum
- Thalamus and hypothalamus
Thalamus

- Largest portion of diencephalon
- Receives sensory input
- Relays impulses to cerebral cortex
- Influences mood, general body movements
- Strong emotions

Hypothalamus

- Major controller
- "Gatekeeper" to cerebrum
- Active in
  - Emotions
  - Hormonal cycles
  - Sexual activity
  - Temperature regulation

Cerebrum

- Largest portion of brain
- Right and left hemispheres
- Each hemisphere divided into lobes
Cerebrum
- Frontal lobe
- Parietal lobe
- Occipital lobe
- Temporal lobe

Limbic System
- Portions of cerebrum and diencephalon
- Influences:
  - Emotions (and visceral responses)
  - Motivation
  - Mood
  - Sensations of pain and pleasure

Cerebellum
- Second largest part of brain
- Major functions
  - Motor coordination
  - Compares impulses from motor cortex with those from moving structures
  - Compares intended movement with actual movement
  - Responsible for precise movements
Spinal Cord

- Location and function
  - Dorsal root
  - Ventral root
  - Spinal ganglia
- Primary reflex center

Meninges

Peripheral Nervous System

- Collects information from inside body and body surface
  - Relays information by afferent fibers to CNS
  - Relays information by efferent fibers from CNS to various parts of body
Spinal Nerves

- First pair exits between skull and first cervical vertebrae.
- Spinal nerves in sacrum exit through the bone.
- 8 pairs exit in cervical region.
- 12 pairs exit in thoracic region.
- 5 pairs in lumbar region.
- 5 pairs in sacral region.
- 1 pair in coccygeal region.

Dermatomes

- Spinal nerves (except C1) have specific cutaneous sensory distribution.
- Dermatome: Skin surface area supplied by single spinal nerve.

Cranial Nerve Functions

- Sensory
- Somatomotor
- Proprioception
- Parasympathetic
**Autonomic Nervous System**

- Afferent neurons
- Efferent neurons
  - Somatomotor neurons

**Endocrine System**

- Hormones
  - Dissolved in blood plasma
  - Quickly distributed throughout the body
Circulatory System

- Blood functions
- Blood components
  - Plasma (55%)
  - Formed elements (45%)
    - Erythrocytes (red blood cells)
    - Leukocytes (white blood cells)
    - Thrombocytes (platelets)

Anatomy of the Heart

- Muscular pump
  - Two atria
  - Two ventricles
- Cone shaped
- Size of a closed fist

Anatomy of the Heart

- In mediastinum
- In pericardial cavity
  - 2/3 of mass lies left of midline of sternum
- Pericardium
- Coronary vessels
Normal Conduction

- Sequence of normal impulse conduction
  - SA node
  - Both atria
  - AV node
  - Bundle of His
  - Purkinje fibers
  - Both ventricles

Blood Flow through the Heart

- Flow of blood
  - Ventricles
  - Arteries
  - Arterioles
  - Capillaries
  - Venous system
    - Thinner, less elastic than arteries

Peripheral Circulation
**Capillary Network**

- Blood supply to capillaries by arterioles
- Blood flows to venules
  - Flow regulated by precapillary sphincters
- Function
  - Nutrient and waste exchange

**Arteries and Veins**

- Walls have three layers of elastic tissue (except capillaries and venules)
  - Tunica intima (inner layer)
  - Tunica media (middle layer)
  - Tunica adventitia (outer layer)

**Types of Arteries**

- Conducting arteries
  - Large and elastic
- Distributing arteries
  - Small to medium size
- Arterioles
  - Smallest
**Venules**

- Similar structure to capillaries
- Collect blood from capillaries
- Transport blood to small veins
- Nutrient exchange occurs across venule walls

**Veins**

- Walls are layer of smooth muscle cells
- Medium and large veins carry blood to venous trunks and then to heart
- Large veins have valves
  - Allow blood to flow to but not from the heart

**Arteriovenous Anastomoses**

- AV shunts
- Allow blood flow from arteries to veins without passing through capillaries
- Natural AV shunts
- Pathological shunts
**Pulmonary Circulation**

- Blood from right ventricle is pumped into pulmonary trunk
  - Bifurcates into right and left pulmonary arteries
  - Transports blood to respective lungs
- After exchange of oxygen and carbon dioxide:
  - Two pulmonary veins exit each lung and enter the left atrium

**Systemic Circulation**

- Blood enters left heart from pulmonary veins
- Blood passes through left atrium into left ventricle and then into aorta
- From aorta, blood is pumped throughout the body

**Arteries of Systemic Circulation**

- Aorta
- Coronary arteries
- Arteries to the head and neck
- Arteries of the upper and lower limbs
- Thoracic aorta and its branches
- Abdominal aorta and its branches
- Arteries of the pelvis
Veins of Systemic Circulation

- Coronary veins
- Veins of the head and neck
- Veins of the upper and lower limbs
- Veins of the thorax
- Veins of the abdomen and pelvis
- Veins of the hepatic-portal system

Lymphatic System

- Considered part of circulatory system
- Carries fluid away from tissues
- Components
- Functions
  - Maintain fluid balance
  - Absorb fats
  - Role in immune system

Airway Anatomy

- Upper airway
  - Above glottis
- Lower airway
  - Below glottis
Pharynx

- Nasopharynx
  - Uppermost part of airway
  - Behind nasal cavities
  - Nasal septum
  - Vestibule
  - Olfactory membranes
  - Sinuses

- Oropharynx
  - Begins at level of uvula
  - Extends to epiglottis
  - Opens into oral cavity

- Laryngopharynx
  - Tip of epiglottis to glottis and esophagus
  - Mucous membrane lining to protect internal surfaces
Larynx

- Three functions
  - Air passageway
  - Prevents solids and liquids from entering respiratory tree
  - Speech production

Larynx

- Nine cartilages
  - Thyroid cartilage
  - Cricoid cartilage
    - Only complete cartilaginous ring in larynx
  - Epiglottis
  - Hyoid bone
  - Cricothyroid membrane

Larynx

- Vestibular folds
  - False vocal cords
- Vocal cords
  - True vocal cords
**Lower Airway Structures**

- Trachea
- Bronchial tree
  - Primary bronchi
  - Secondary bronchi
  - Bronchioles
- Alveoli
- Lungs

**Pulmonary Surfactant**

- Thin film that coats alveoli
- Prevents alveoli from collapsing

**Lungs**

- Respiration
- Attached to heart by pulmonary arteries and veins
- Separated by mediastinum
- Bases of lungs rest on diaphragm
- Apex extends 2.5 cm above clavicles
**Pleural Cavity**

- Pleural cavity surrounds each lung
- Two layers (visceral and parietal)
- Pleural space

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**Digestive System**

- Provides body with water, electrolytes, and nutrients
- Specialized to
  - Ingest food
  - Propel food through GI tract
  - Absorb nutrients
- Functions
- Components

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**Stomach**

- Storage and mixing area
- Secretes mucus
- Gastric gland secretes:
  - Hydrochloric acid
  - Intrinsic factor
  - Gastrin
  - Pepsinogen

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Small Intestine

- Secretes mucus, electrolytes, water
- Lubricates and protects intestinal walls
- Mixes, propels chyme
- Absorbs fluid and nutrients

Liver

- Secretes 600-1000 mL bile per day
  - Dilutes stomach acid
  - Emulsifies fat
- Role in
  - Iron metabolism
  - Plasma-protein production
  - Detoxification of drugs
  - Glucose metabolism

Gallbladder

- Stores bile
- Stimulated to contract by
  - Cholecystokinin
  - Secretin
- Excretes bile into small intestine
Pancreas

- Exocrine gland
  - Pancreatic juice
    - Amylase
    - Sodium bicarbonate
    - Other digestive enzymes
- Endocrine gland
  - Insulin
  - Glucagon

Large Intestine

- Absorption of water and salts
- Secretion of mucus
- Microorganism actions
  - Vitamin K
  - Nutrient release and absorption
- Conversion of chyme
- Defecation through anus

Urinary System

- Helps maintain:
  - Homeostasis
  - Constant body fluid volume and composition
  - Control of RBC production
  - Vitamin D metabolism
Kidneys

- On either side of vertebral column
- Outer cortex and inner medulla
- Nephron
  - Basic functional unit of kidney

Ureters, Urinary Bladder, and Urethra

- Ureters
- Urinary bladder

- Urethra
  - In males, extends to end of penis, where it opens to outside
  - In females, much shorter urethra
    - Opens into vestibule anterior to vaginal opening
Urine Production
- Filtration
- Reabsorption
- Secretion

Urine Regulation
- Controlled by:
  - Hormonal mechanisms
  - Autoregulation
  - Sympathetic nervous system stimulation

Hormonal Mechanisms
- Aldosterone
- Antidiuretic hormone (ADH)
- Atrial natriuretic factor
- Prostaglandins and kinins
**Autoregulation**

- Kidneys can regulate stable filtration rate over a wide range of blood pressures
- Large increases in arterial pressure increase rate of urine production
- Decreases in arterial pressure decrease urine production

**Sympathetic Nervous System Stimulation**

- Sympathetic neurons innervate blood vessels of the kidney
- Decreased renal blood flow may result from:
  - Severe stress
  - Intense exercise
  - Circulatory shock

**Male Reproductive System**

- Testes
- Epididymis
- Ductus deferens
- Urethra
- Seminal vesicles
- Prostate gland
- Bulbourethral glands
- Scrotum
- Penis
Female Reproductive System

- Ovaries
- Fallopian tubes
- Uterus
- Vagina
- External genitalia
- Mammary glands

Ovaries

- Ovaries are attached to broad ligament (mesovarium)

- Other ovarian ligaments
  - Suspensory ligament
  - Ovarian ligament

Ovaries

- Ovarian arteries, veins, and nerves traverse the suspensory ligament

- Enter the ovary through mesovarium
  - Dense outer portion (cortex)
  - Looser inner portion (medulla)
  - Ovarian follicles
    - Each contains an oocyte
    - Distributed throughout cortex
Uterine Tubes
- Ducts for the ovaries
- Open directly into the peritoneal cavity to receive the oocyte

Uterus
- Size and shape of a pear
- Fundus
- Cervix

External Genitalia (Vulva)
- Vestibule and surrounding structures
- Labia minora
- Clitoris
- Labia majora
- Clinical perineum
  - Area between vagina and anus
Mammary Glands
- Milk production
- Lactiferous duct divides to form smaller ducts
  - Forms secretory sacs that secrete milk during nursing

Special Senses
- Provide brain with information about outside world
- Include:
  - Smell
  - Taste
  - Sight
  - Hearing and balance

Olfactory Sense Organs
- Receptors lie in upper nasal cavity
- Impulses are interpreted by brain as odors
Taste

- Taste receptors
- Taste buds

Visual System

- Eyes
- Accessory structures
- Optic nerve, tract, and pathways
- Second cranial nerve (optic nerve)
- Third cranial nerve (oculomotor nerve)

Anatomy of the Eye

- Sclera
- Cornea
- Vascular tunic
- Iris
- Retina
- Compartments of the eye
  - Anterior chamber
  - Posterior chamber
Compartments of the Eye

- Anterior chamber
  - Aqueous humor
    - Helps regulate intraocular pressure
    - Refracts light
    - Provides nutrition

- Posterior chamber
  - Vitreous humor
    - Helps regulate intraocular pressure
    - Refracts light
    - Holds retina

Accessory Structures

- Conjunctiva
- Lacrimal gland

Hearing and Balance

- External ear
- Middle ear
- Inner ear
Conclusion

The paramedic must thoroughly understand human anatomy to organize a patient assessment by body region and to communicate effectively with medical direction and other members of the health care team.