Vertebrate Anatomy & Physiology
Vertebrate Anatomy And Physiology

- Study of cells, tissues and organs
- Gross anatomy
- Histology
- Physiology
Body Organization

- Animal’s body has three levels of organization
  - Cellular
  - Tissue
  - Organ

- Animal cells have three basic components
  - Cell membrane
  - Nucleus
  - Cytoplasm

- Some cellular processes are active, while others are passive.
Body Organization

- Pituitary
- Thyroid
- Parathyroids
- Right adrenal
- Pancreas
- Right ovary (female)
- Left testis (male)

Endocrine System
Four Tissue Types:

• **Connective tissue**
  - Binds together or supports cells, other tissues/organs

• **Muscle (contractile) tissue**
  - Contracts on stimulation
  - Movement, posture and heat production

• **Nerve tissue**
  - Conducts nerve impulses throughout the body

• **Epithelial tissue**
  - Covers all body surfaces; lines all cavities; forms glands
  - Protective barrier against the environment
Organ and Organ Systems

Major Organ Systems

- Integumentary
- Skeletal
- Muscular
- Circulatory
- Lymphatic
- Respiratory
- Digestive
- Urinary
- Reproductive
- Nervous
- Endocrine
Integumentary System

• The skin, or integument, covers an animal and protects it for the outside environment.

• Vertebrate skin has three basic structures:
  - Epidermis
  - Dermis
  - Glands
Skeletal System

- A skeleton is the framework of an animal’s body.
- Most vertebrates have an internal skeleton or endoskeleton, which protects various parts of the body.
- The skeleton facilitates movement.
- Two tissue types in the vertebrate skeleton:
  - Bone
  - Cartilage
Bone Classification

Four types of bones classified by shape:

**Bones**
- Long bones
- Short bones
- Flat bones
- Irregular bones

**Bone Parts**
- Diaphysis
- Epiphysis
- Medullary cavity
- Periosteum
Main Bone Groups

Two main bone groups:
- Axial skeleton
- Appendicular skeleton

Axial Skeleton
- Skull
  - Two parts: cranium and facial
- Vertebrae
  - Vertebral column consists of bones known as vertebrae
- Ribs and sternum
  - Part of the thoracic region
Main Bone Groups

Appendicular Skeleton is made up of bones and includes the pectoral girdle

- **The forelimb** consists of the:
  - Humerus (upper arm)
  - Radius and ulna (forearm)
  - Carpals (wrist bones)
  - Metacarpals (hand bones)
  - Phalanges (fingers, digits, thumbs)

- **The hindlimb** consists of the:
  - Femur (thigh)
  - Tarsals (ankle bones)
  - Metatarsals (foot bones)
  - Patella (knee cap)
  - Tibia and fibula (lower leg)
  - Phalanges (toes)
Main Bone Groups
Joints and Movement

The following general terms apply to joint movement:

• Rotation
  • Pivot movement; e.g., turning the head

• Flexion
  • Bending or folding; e.g., elbow joint

• Extension
  • Opening the joint

• Abduction
  • Movement of bone away from midline

• Adduction
  • Movement toward the midline
Muscular System

Muscle tissue found in almost every part of the body and consists of three distinct types:

- Skeletal muscle
- Smooth muscle
- Cardiac muscle
Muscle Classification

Muscles and their functions

- Skeletal muscle (striated muscle)
  - Primary function is movement of bones

- Smooth muscle
  - Muscle contractions are involuntary
  - Walls of blood vessels and organs of digestive system

- Cardiac muscle (heart)
  - Specialized type of striated muscle
  - Normally self-stimulating, producing the continuous pumping of the heart
Circulatory System - Blood

• Primary function of circulatory system is to remove carbon dioxide and waste products from cells.

• The medium transport is blood.
  ▪ Blood is composed of a plasma portion and several types of cellular elements.
  ▪ Plasma comprises 55 percent of total blood volume.

• Erythrocytes are the most abundant type of blood cell.
  ▪ Produced primarily in the bone marrow and aids the transport of respiratory gases.
Circulatory System - Blood
Leukocytes

• Leukocytes are less abundant than RBCs.

• Two main types:
  - Granulocytes
  - Lymphoid cells

• Granulocytes
  - Relatively large cells; nuclei are multi-lobed; cytoplasm contains microscopic granules
  - Classified based on staining properties:
    - Neutrophils
    - Eosinophils
    - Basophils
Lymphoid and Thrombocyte Cells

- **Lymphoid cells**
  - Most commonly occur in lymph vessels and in the nodes along these vessels
  - Large lymphoid cells - monocytes
  - Small white blood cells - lymphocytes
  - Lymphoid and small white blood cells help make up the immune system

- **Thrombocytes**
  - Platelets essential for blood clotting
  - Formation of hemostatic plugs or clots
  - Serum
Structures of the Circulatory System

Heart

- **Four chambers in mammals and birds**
- **Composed of three separate tissue layers**
  - Myocardium (heart muscle)
  - Epicardium (covers outer surface of myocardium)
  - Endocardium (delicate layer of tissue lining the inside of the heart’s chambers)
- **Right and left halves**
  - Each contains an atrium and a ventricle, which acts to collect blood and circulate it throughout the body
Structures of the Circulatory System

Blood Vessels

- Heart contains three types of blood vessels:
  - Arteries
    - Carry blood away from the heart
  - Veins
    - Return blood to the heart
  - Blood capillaries
    - Connect arteries and veins
Structures of the Circulatory System

Blood Vessels

- Blood passes from the capillaries into the venous system; first through venules and then veins.

- **Veins**
  - Carry blood at pressures lower than arteries.
  - Venous systems act as reservoir.
    - Hold roughly 60% of total blood volume.
  - Largest vein in body: **Vena Cava**, which lies next to the aorta.
  - Vena cava empties into the right atrium.
Circulation Control

- Blood flows from an area where pressure is greater to an area where it is lower.
- Left ventricle is source of highest pressure.
- Blood pressure is recorded as **diastolic** and **systolic** pressures.
  - Diastole
    - occurs as the blood flows in and the ventricle is at rest.
  - Systole
    - occurs as the mitral valve closes just as the ventricle begins to contract.
- Blood is taken from the ventricles during a cardiac puncture procedure.
Lymphatic System

• Lymphatic system is the filter mechanism for the body; it provides one of the major defenses against pathogenic invasion.

• System components
  - Lymph
  - Lymphatics
  - Lymph Nodes
Lymphatic System

- Deep Cervical Nodes
- Mandibular Nodes
- Retropharyngeal Nodes
- Superficial Cervical Nodes
- Right Lymphatic Duct
- Thoracic Duct
- Hepatic and Gastric Nodes
- Axillary Nodes
- Cysterna Chyli
- Mesenteric Nodes
- Lumbar Nodes
- External Iliac Nodes
- Internal Iliac Nodes
- Superficial Inguinal Nodes
- Popliteal Nodes
- Deep Inguinal Nodes
Respiratory System

• **Respiration**
  • The exchange of gases between cells and the tissue fluids around them
  • Largely a mechanical process

• **Gills and skin**
  • Fish and larval amphibians

• **Lungs**
  • All terrestrial vertebrates

• **Gas exchange:** $O_2$ & $CO_2$ by diffusion

• **Respiratory system aids vocalization, temperature and water loss in vertebrates.**
Anatomy of the Respiratory System

• The structures of the vertebrate respiratory system consist of:
  - Nose
  - Pharynx
  - Larynx
  - Trachea
  - Bronchi
  - Alveoli
  - Lung
Mechanism of Ventilation

- **Air moves into and out of the lungs.**
  - Air flows into the lungs if atmospheric pressure is greater than pressure within the lungs.
  - Air flows out of the lungs if pressure within the lungs is greater than atmospheric pressure.

- **Inspiration (breathing in) is accomplished by increasing volume of the thoracic cavity.**

- **Expiration (breathing out) is accomplished by relaxation of the diaphragm.**
Exchange of Gases and Transport by the Blood

- Exchange of gases and CO$_2$ between blood in the capillaries and air in the alveoli occurs by diffusion.

- Venous blood arrives at lungs deficient in oxygen and rich in CO$_2$.

- Gases are exchanged as the blood passes through the capillary at the alveolus.
Digestive System

- Carnivore, herbivore & omnivore
- Alimentary canal
- Stomach
- Rumen
- Intestines
- Cecum
Digestive System Anatomy and Operation

- **Gastrointestinal tract**
  - Long tube called the alimentary canal consisting of several organs (e.g., stomach, intestines)
    - Begins at the lips, teeth and tongue
  - Inside of digestive system lined with epithelial tissue

- **Carnivorous and omnivorous animals have one stomach; some herbivores (ruminants) have four specialized stomach compartments.**

- **Primary purpose of stomach is storage.**
Most digestion occurs in first section of small intestine, which is the duodenum.

Digestion is accomplished by bacteria found in the cecum.
- Cecum is large in rabbits, horses, and rodents and helps to digest roughage.
- Cecum is small in other species, such as humans and dogs, and contributes little to digestion.

Nutrient and water absorption completed in large intestine or colon.

Feces are eliminate through anal sphincter muscle.
Digestive System Anatomy and Operation

- **Process of digestion** breaks down large particles of food into smaller molecules.
- **Liver and pancreas** play vital roles in digestion.
- **Pancreas serves two functions:**
  - Exocrine gland
    - secretes digestive enzymes through ducts into small intestine
  - Endocrine gland
    - secretes glucose-regulating hormones directly into the bloodstream
- **Technicians should monitor appearance of feces and promptly report abnormalities.**
Urinary System

- **Kidneys**
  - nephron
  - urine

- **Ureters**
  - transports urine to bladder

- **Urinary bladder**
  - urine storage

- **Urethra**
  - connects bladder with exterior
Urinary System

MALE URINARY and REPRODUCTIVE SYSTEM

- Kidney
- Seminal Vesicle
- Coagulating Gland
- Vas Deferens
- Urinary Bladder
- Cowpers Gland
- Preputial Gland
- Ureter
- Ampullary Glands
- Prostate Gland
- Caput Epididymus
- Testis
- Cauda Epididymus
- Urethra
- Penis (root)
Urinary System
Urinary System

- Nephrons
- Cortex
- Medulla
- Calix
- Renal Pelvis
- Renal Artery
- Renal Vein
- Ureter
Reproductive System

• **Gonads**
  • Production of gametes and secretion of sex hormones

• **Female reproductive organs**

• **Male reproductive organs**
Reproductive System

FEMALE URINARY and REPRODUCTIVE SYSTEM

- Kidney
- Ureter
- Body of Uterus
- Cervix
- Urinary Bladder
- Urethra
- Ovary
- Left Oviduct
- Left Uterine Horn
- Vagina
- Vulva
- Clitoral Gland
The Nervous System

- **Neurons**
- **Brain**
- **Central nervous system**
  - Includes brain and spinal cord
- **Peripheral nervous system**
  -Controls voluntary movement
  -Subdivision is the ANS which regulates involuntary functions of visceral and other organs
Endocrine System

• **Regulation**
  - Digestion, metabolism, growth, puberty, reproduction and aging

• **Glands**
  - Pituitary “master gland”
  - Adrenal
  - Thyroid
  - Parathyroid
  - Pancreas
  - Gonads