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Anatomy and Physiology I Lab Manual

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UGA Anatomy and Physiology 1 Lab Manual

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Introduction to the Human Body

Topics Covered

Organization of the body

Anatomical position

Sectional planes of the body

Directional terms

Organ systems

Body cavities

Regions of the body

Regions of the abdomen

Introduction

Physiology is the study of organ function and interaction. Physiology may be studied from the molecular level to the organism level. The hierarchical levels of organization of the human body from the smallest structure to the largest structure are molecular, cellular, tissue, organ system, and organism. *Section 1.3.1- Organization*

Anatomical Position

Aantomical position is used as a standard frame of reference for describing the relationship of anatomical structures, anomalies, injuries and pathologies during dissection or treatement of a patient. When a person or cadaver is in anatomical postion, he or she is standing erect, with feet flat on the floor, arms at the sides, palms and eyes facing forward, eyes open. Descriptions of left and right always refer to the left and right of the subject or patient, not the observer.

Anatomical Planes

Anatomical planes are imaginary flat surfaces passing through the body. Anatomical sections are anatomical views in which the body is cut on a plane. There are 4 planes: coronal or frontal, sagittal, transverse or horizontal, and oblique. The frontal, or coronal plane divides the body into front and back portions (or anterior and posterior). The Sagittal plane divides the body into left and right halves. A midsagittal plane divides the body equally into left and right halves, while a parasagittal plane falls off center of the mid-line of the body. A transerves or horizontal plane divides the body into upper and lower portions (superior and inferior). And oblique plane passes through the body at an oblique angle. *Section 1.6.4- Body Planes*

Directional Terms

Directional terms are terms used to describe the location of one body part *relative* to another. They include:

Superior and inferior

Anterior and posterior

Superficial and deep

Proximal and distal

Medial and lateral

Figure 1.13- Directional Terms Applied to the Human Body

Section 1.6.2- Regional Terms

Organ Systems

There are 12 organ systems: the integumentary, skeletal, muscular, nervous, lymphatic, reproductive, endocrine, cardiovascular, respiratory, digestive, renal and sensory systems.

Review the location and function of the organ systems in your openstax text book.

Figure 1.4- Organ Systems of the Human Body

Figure 1.5- Organ Systems of the Human Body (continued)

Body Cavities

There are two major body cavities: the dorsal body cavity, which is made up of the cranial cavity and the ventral body cavity (also called the coelom), which is made up of the thoracic cavity and the abdominopelvic cavity. The thoracic cavity contains the pericardial cavity and two pleural cavities. The mediastinum is the region of the thoracic cavity that contains the heart, the large vessels, the thymus gland, and the esophagus. The adominopelvic cavity contains the abdominal and pelvic cavities. *(Figure 1.15- Dorsal and ventral Body Cavities; section 1.6.5.1- Subdivisons of the Posterior (Dorsal) and Anterior (Ventral) Cavitites)*

Regions of the Body

Section 1.6.2- Regional Terms

Figure 1.12 Regions of the Human Body

Regions of the Abdomen

Figure 1.16- Regions and Qaudrants of the Peritoneal Cavity

Section 1.6.5.2- Abdominal Regions and Qaudrants

Tissues

Topics Covered

Introduction to Tissues
Epithelial Tissues
Connective Tissues
Muscle Tissues
Nervous Tissues

Introduction

Definitions

- Tissues - groups of cells that are similar in structure and perform a common function
- Histology - the study of tissues and how they are arranged into organs

4 Primary Tissues (linked to figure 4.2- Four types of Connective Tissue)

1. Connective Tissue
2. Epithelial Tissue
3. Muscle Tissue
4. Nervous Tissue

Epithelial Tissue

CLASSIFICATION:

- **Cell Shape (Linked to figure 4.6- Cells of Epithelial Tissue)**
  - Squamous
  - Cuboidal
  - Columnar
- **Cell Organization (Linked to figure 4.6- Cells of Epithelial Tissue)**
  - Squamous
  - Simple
  - Stratified
  - Pseudostratified
  - Transitional

Epithelial Tissue (Linked to figure 4.8- Summary of Epithelial Tissue Cells)
Simple Squamous

- Air sacs of lungs, lining blood vessels
  - Smooth lining, reduces friction, allows simple diffusion

Simple Cuboidal

- Form many major glands and glandular organs, major cell type of kidney and pancreas
    - Secretion of fluids or hormones (sweat, oil), re-absorption (kidneys)

Simple Columnar

- Inner portion of digestive tract, uterine tubes, often associate with Goblet cells
    - Provides absorptive areas on inner portions of the digestive tract.
    - Goblet cells secrete mucin.

Stratified Squamous

- Surface of skin, lining mouth, throat, esophagus, rectum, anus, and vagina.
- Provides physical protection against abrasions, pathogens and chemical attack.

Transitional

- Urinary bladder, renal pelvis, and ureters.
- Permits expansion and recoil after stretching.

Pseudostratified Columnar

- Lining of the respiratory tract and portions of the male reproductive tract.
- Protection and secretion.
- Have cilia.

Connective Tissue

CLASSIFICATION:

- **Fibrous connective tissue (CT Proper)** **(Linked to figure 4.12- Connective Tissue Proper)**
    - **Loose CT** (reticular, areolar, adipose)
    - **Dense CT** (dense regular, dense irregular, elastic) (Linked to figure 4.15- Dense Connective Tissues)
- **Cartilage (supportive CT)** **(Linked to figure 4.16- Types of Cartilage)**
    - **Hyaline cartilage**
    - **Fibrocartilage**
    - **Elastic cartilage**
- **Bone (supportive CT)**
- **Blood (Fluid CT)**

Connective Tissue

Adipose **(Linked to figure 4.13- Adipose Tissue)**

- Deep in skin, padding around eyes and kidneys.
- Provides padding and cushions shock; insulates.

Blood

- Found throughout body in blood vessels.
- Transport; immune function.

Hyaline Cartilage

- Between tips of ribs and bones and trachea.
- Reduces friction between bony surfaces.
- Cells known as chondrocytes.

Bone

- Throughout body.
- Support; regulates calcium levels; immune function.
- Cells known as osteocytes.

Muscle Tissue

(Linked to figure 4.18- Muscle Tissue)

- **Skeletal Muscle**
  - Cells referred to as muscle fibers
  - Striated, multinucleated, voluntary
- **Cardiac Muscle**
  - Cells referred to as myocytes
  - Striated, branched, multinucleated, involuntary
  - Intercalated disc
- **Smooth Muscle**
  - Intestines (peristalsis), blood vessels, uterus, urinary tract, most organs.
  - Nonstriated, involuntary

Nervous Tissue

(Linked to figure 4.20- Nervous Tissue)

Two cell types found in nervous tissue:

- **Neuron (Linked to figure 4.19- The Neuron)**
  - Specialized cell that conducts electrochemical impulses.
  - 3 main regions- dendrites, cell body (soma) and the axon.
- **Glial cells or neuroglia**
  - Play supportive roles for neurons.

Integument

Topics Covered

Introduction to the skin
Epidermis
Dermis

Introduction

The integument, or skin is an organ system of the body made of tissues that work together as a single structure to perform unique and critical functions, such as protection from the external environment and body temperature regulation. The skin is composed of many layers of cells. It is made of two to three layers- the epidermis, and the dermis, which are made up of both epithelial tissue and different types of connective tissue. These layers are held to underlying structures by connective tissue. **(Link to figure 5.2- Layers of the Skin)**

The dermal layer of skin, which sits below the top layer- the epidermis- is well vascularized (has numerous blood vessels). It also has numerous sensory, and autonomic and sympathetic nerve fibers ensuring communication to and from the brain.

The hypodermis, which sits below the dermal layer, is not always considered a layer of the skin. It acts as a reserve for adipose tissue.

Epidermis

The outer layer of skin and is composed primarily of epithelial cells. It serves to primarily protect the body. The epidermis has 5 layers:

1. Stratum Corneum
2. Stratum Lucidum
3. Stratum Granulosum
4. Stratum Spinosum
5. Stratum Basale

(Linked to figure 5.5- Layers of the Epidermis)

What type of epithelium characterizes each layer? What are the characteristics that make each layer different? What are the other cell types found in the epidermis?

Dermis

The dermis is made of connective tissue that is attached to epidermis by a basement membrane. It serves to support the epidermis and connects epidermis to underlying hypodermis. The dermis contains the blood and nerve supply and the other accessory structures of the skin, like arrector pili and glands.

The dermis has 2 layers:

1. Papillary layer: adhesion to epidermis (dermal papillae)
2. Reticular layer: larger section of dermis. Primary sensory functions of skin. Nerve and blood vessels present throughout

(Linked to figure 5.7- Layers of the Dermis)

Introduction to the Skeletal System

Topics Covered

Functions of the skeletal system
Types of bone tissue
Composition of bone
Bone morphology
Bone features

Functions of the Skeletal System

- Support body's soft tissues and internal organs
- Stores materials like calcium.
- Blood cells are produced in bone marrow

Types of Bone Tissue

- Compact bone or dense bone *(Linked to figure 6.12- Diagram of Compact Bone)*
- Spongy bone or cancellous tissue *(Linked to figure 6.13- Diagram of Spongy Bone)*

Composition of Bone

- **Organic Material**
  - 30%
  - Cells and collagenous fibers
  - Gives bone a degree of flexibility
- **Inorganic material**
  - 70%
  - Hydroxyapatite
    - hydroxyapatite (HA), is a naturally occurring mineral form of calcium apatite. Commonly found in bone and teeth so for that reason it is used a lot in filler to replace amputated bone or as a coating to promote bone growth into prosthetic implants.
  - Enables bone to support the weight of the body without sagging

Bone Morphology (Linked to figure 6.7- Anatomy of a long Bone)

- **Periosteum** –Tough, fibrous membrane containing 2 layers (location of nerve and blood vessels; anchoring point for tendons and ligaments).
  - Outer fibrous layer
  - Inner cellular layer that produces osteoblasts
- **Osteoblast** – bone forming cells *(Linked to figure 6.11- Bone Cells)*
  - Originate from stem cells and form bone from collagen fibers and calcium salts.

- **Osteoclast** – bone dissolving cells *(Linked to figure 6.11- Bone Cells)*
    - Remove calcium/minerals by acid phosphatase and HCl
- **Osteocytes** – former osteoblasts that have become trapped in the matrix they deposited *(Linked to figure 6.11- Bone Cells)*
    - Mature bone cells that help to reshape the bone after stress.
- **Epiphyses**
    - Spongy bone present at the proximal and distal ends of a long bone
    - Enlarged to provide added surface area for the attachment of tendons
    - Covered with a layer of hyaline cartilage (articular cartilage) that helps reduce friction at the joint
- **Diaphysis**
    - Shaft of the long bone
    - Compact bone
    - Marrow cavity – space inside

Bone Features (Linked to figure 6.10- Bone Features)

- Each bone has certain anatomical features on the surface called bone markings or surface markings
- ***Head*** – rounded articular projection supported on the neck of the bone
- ***Neck*** – a constriction below the head
- ***Tubercle*** – a relatively small bump on a bone
- ***Tuberosity*** – a relatively large bump on a bone
- ***Fossa (cavity)*** – a shallow depression in a bone
- ***Groove*** – an elongated depression
- ***Trochanter*** – a very large projection
- ***Condyle*** – an irregular, smooth surface that articulates with another bone
    - Purpose: articulation
- ***Epicondyle*** – a projection above a condyle
    - Purpose: muscle attachment
- ***Process*** – a projection from the surface of the bone
- ***Spine*** – a pointed process
- ***Crest*** – prominent ridge
- **Foramen** – Round passageway for blood vessels or nerves
- **Canal** – Passageway through substance of bone
- **Fissure** – Elongated cleft
- **Sinus** – Chamber within bone usually filled with air
- **Facet** – Small flat, articular surface

Axial Skeleton: Skull

Topics Covered

Introduction
The Skull
Major bones of the cranium
Major bones of the face
Sutures of the skull

Introduction

- 80 bones total
- Consists of the skull, the vertebral column, the rib cage, the auditory ossicles and the hyoid bone

The Skull (Linked to figure 7.4- Anterior View of Skull)

- 22 bones joined together by sutures
- Cranial bones surround cranial cavity
    - 8 bones in contact with meninges
- Facial bones support teeth & form nasal cavity & orbit
    - 14 bones with no direct contact with brain or meninges
    - Attachment of facial & jaw muscles

The Major Bones of the Cranium

- Parietal Bone (2)
- Frontal Lobe (1)
- Temporal Bone (2)
- Ethmoid (1) *(Linked to figure 7.12- Ethmoid Bone)*
- Sphenoid (1)
- Occipital Bone (1)

Major Bones of the Face (Linked to figure 7.4- Anterior View of Skull)

- Nasal Bones (2)
- Zygomatic Bones (2)
- Maxillary Bones (2)
- Mandible (1)
- Inferior Nasal Conchae (2)
- Palatine Bone (2)
- Vomer (1)

- Lacrimal Bones (2)

Sutures (Linked to figure 7.4- Anterior View of Skull)

- Sagittal
- Coronal
- Squamosal
- Lambdoidal

Axial Skeleton: Vertebral Column

Topics Covered

Introduction
Vertebrae
Cervical vertebrae
Axis
Atlas
Thoracic vertebrae
Lumbar vertebrae
Sacral and coccygeal vertebrae
The rib cage
Ribs
Sternum
Hyoid bone

Introduction (Linked to figure 7.20- Vertebral Column)

- Made of 26 bones namely cervical, thoracic, lumbar, sacral and coccyx vertebrae
- Protects your spinal cord
- In humans the vertebrae increase in size from the cervical to the lower lumbar vertebrae – this is due to the increase in weight on the lower vertebrae.
- The number of vertebrae in each section line up with times of day one eats meals → cervical = 7, thoracic = 12, lumbar = 5.

Vertebrae

- Body or centrum
- Spinous process
- Vertebral foramen
- Transverse process

Cervical Vertebrae (Linked to figure 7.25- Cervical Vertebrae)

C1-C7

- 3 foramina:
    - (1 vertebral foramen + 2 transverse foramina)
- Some have bifid spinous processes (split in two – bifurcated)
- Smaller, lighter weight bodies
- All cervical vertebrae have three formina and they have the smallest and lightest bodies when compared to the other vertebrae.

Atlas

C1

- 1st cervical vertebrae

- Only cervical vertebrae without a body
- Provides for the range of motion as nodding your head "yes"
- Superior articular facets articulate with the occipital condyles of the skull

Axis
C2

- The 2nd cervical vertebra
- Unique superior process, called the dens or odontoid process runs through the atlas
- Dens allows the atlas to rotate on the axis
- Provides for the range of motion as shaking your head "no"

Thoracic Vertebrae (Linked to figure 7.26- Thoracic Vertebrae)
****T1-T12****

- Medium sized body with markings on the lateral, posterior surface (attach to ribs)
- Long, narrow spinous process that commonly slants inferiorly
- Facets on the transverse process that articulate with the ribs

Lumbar Vertebrae (Linked to figure 7.28- Lumbar Vertebrae)
****L1-L5****

- No transverse foramina
- No rib facets
- Largest bodies
- Thick spinous processes that extend horizontally

Sacrum & Coccyx (linked to figure 7.29- Sacrum and Coccyx)

- The coccyx is actually 3-5 fused bones

The Rib Cage (Linked to figure 7.32- Thoracic Cage)

- Made of 25 bones (24 ribs and the sternum)

Ribs (Linked to figure 7.32- Thoracic Cage)

- Also called costae
- First seven pairs – True ribs as their costal cartilage attaches directly to the sternum
- Remaining five pairs – False ribs
- Pairs 11 and 12 - Floating ribs as they do not join with sternum

Sternum (Linked to figure 7.32- Thoracic Cage)

- 3 parts
    - Manubrium (on top)
    - Body (middle, main part)
    - Xiphoid Process (lowest tip)

Hyoid Bone (Linked to figure 7.19- Hyoid Bone)

- A horseshoe-shaped bone found in the neck between the chin and the thyroid cartilage
- Only distantly articulates to other bones by muscles and ligaments
- Important for swallowing and sound production

The Appendicular Skeleton: Introduction and Pectoral Girdle; Appendicular Skeletal Terms Checklist

Topics Covered

Introduction
Pectoral girdle
Checklist

Introduction

The appendicular skeleton is made of the 126 bones of four classes:

1. *Pectoral girdle* (4)
2. *Pelvic girdle* (2)
3. *Upper extremities* (60)
4. *Lower extremities* (60)

Pectoral Girdle (4) (Linked to figure 8.3- Pectoral Girdle)

1. **Clavicle (2)**
    a. **Acromial End**
        i. Horizontally flat
        ii. Rough
        iii. Lateral
        iv. Feature on the top of this end, which is called the Conoid Tubercle
    b. **Sternal End**
        i. Blunt
        ii. Vertical
        iii. Medial
2. **Scapula (2)** (Linked to figure 8.4- Scapula)
    a. **Acromion** forms the apex of the shoulder.
    b. **Coracoid process** is shaped like a crow's beak, providing attachment for biceps and other muscles of the arm.
    c. **Glenoid cavity** is shallow socket that articulates with the head of the humerus.
    d. **Spine** is a sharp, slender process.

Appendicular Terms Checklist

ectoral Girdle	*Upper Limb*	*Pelvic Girdle*	*Lower Limb*
lavicle P112 • Sternal end • Acromial end	Humerus P113 • Head • Greater tubercle • Lesser tubercle • Intertubercular groove • Deltoid tuberosity • Medial epicondyle • Lateral epicondyle • Capitulum • Trochlea • Olecranon fossa • Coronoid fossa	Ilium P117,118 (superior) • Iliac crest • Anterior superior iliac spine • Anterior inferior iliac spine • Posterior superior iliac spine • Posterior inferior iliac spine • Greater sciatic notch	Femur P119 • Head • Neck • Greater trochanter • Lesser trochanter • Linea aspera (posterior) • Lateral epicondyle • Medial epicondyle • Lateral condyle • Medial condyle • Intercondylar groove (fossa)
capula P111 • Acromion • Scapular spine • Coracoid process • Glenoid cavity (fossa) • Supraspinous fossa • Infraspinous fossa • Medial border • Lateral border • Superior border	Radius P114 • Head • Neck • Radial tuberosity • Styloid process Ulna P114 (medial) • Olecranon process • Trochlear notch • Coronoid process • Styloid process • Radial notch	*I*schium P117,118 (inferior,posterior) • Ischial tuberosity • Lesser sciatic notch • Ischial spine • Obturator foramen	Patella P120 • Sesmoid bone • Develops in tendons Tibia P121 (medial) • Intercondylar eminen • Medial condyle • Lateral condyle • Tibial tuberosity • Medial malleolus
	Carpals, Metacarpals, & Phalanges P115 • Carpals = 8 • Short bones of the wrist • Metacarpals = 5 • Palm of the hand • Phalanges = 14 • (3/finger, 2/thumb) • Total = 27 bones/hand	Pubis P117,118 (inferior,anterior) • Superior and inferior rami • Pubic arch • Pubic symphysis Acetabulum	Fibula P121(lateral) • Head • Lateral malleolus Tarsals, Metatarsals, & Phalanges P122 • Tarsals = 7 • Ankles • Metatarsals = 5 • Instep • Phalanges = 14 • (3/toe, 2/big toe)

The Appendicular Skeleton: Upper Limb

Upper Extremity/Limb (linked to chart on next page and figure 8.5- humerus and elbow joint)

- Arm
  - Humerus
- Forearm (linked to the chart on next page and figure 8.6- Ulna and Radius)
  - Radius
  - Ulna
- Wrist & Hand (linked to chart on next page and figure 8.7- bones of the wrist and hands)
  - 8 Carpals
  - 5 Metacarpals
  - 14 Phalanges

Refer to Checklist on Introduction to the Appendicular Skeleton module for and list of need to know terms.

The Appendicular Skeleton: Pelvis/ Pelvic Girdle

Pelvic Girdle (2) (linked to figure 8.12- Pelvis & 8.13- the hip bone)

1. **Os Coxae (2)**
    a. Comprised of two coxal bones
    b. Joined in the front at the pubic symphysis
    c. each os coxa is a fusion of 3 bones:
        i. Ilium
        ii. Ischium
        iii. Pubis
    d. The acetabulum is a **concave surface** of the pelvis. The head of the femur meets with the pelvis at the acetabulum, forming the **hip joint**.
    e. **pubic symphysis**---2 pubic bones are joined by a pad of fibrocartilage

The Appendicular Skeleton: Lower Limb

Lower Extremity/Limb

- Thigh (linked to image 8.16- femur and patella & chart on next page)
  - Femur
  - Patella
- Leg (Linked to figure 8.18- Tibia and Fibula and chart on next page)
  - Tibia
  - Fibula
- Ankle & Foot (Linked to figure 8.19- bones of the foot and chart on next page)
  - 7 Tarsals
  - 7 Metatarsals
  - 14 Phalanges

Refer to Checklist on Introduction to the Appendicular Skeleton module for and list of need to know terms.

Articulations/Joints

Topics Covered

Joints and their classification
Synarthrotic joints
Amphiarthrotic joints
Diarthrotic joints
Synovial joints anatomy
Types of synovial joints

Joints and Their Classification

Joints can be classified by their freedom of movement

- **Synarthrosis:** little or no movement
  - Skull sutures, teeth in sockets, etc.
- **Amphiarthrosis:** slightly movable
  - Intervertebral discs, pubic symphysis, etc.
- **Diarthrosis:** freely movable
  - shoulder, elbow, carpal joints, knee, tarsal joints, etc.

Or by their physical nature

- **Fibrous:** collagen fibers spanning the space between bones
  - Skull sutures, teeth in sockets, distal radioulnar joints, etc.
  - Linked to figure on 9.5- fibrous joints
- **Cartilaginous:** 2 bones bound to each other by cartilage
  - Intervertebral discs, pubic symphysis, etc.
  - Linked to figure 9.7- cartilaginous joints
- **Synovial**: bones held together by joint capsule filled with synovial fluid
  - Shoulder, elbow, carpal joints, knee, tarsal joints, etc.
  - Linked to figure 9.8- synovial joints

****There is overlap between the 2 classification systems****

Synarthrotic Joints

- **No movement between bones**

- **Types**
  - **Suture (linked to figure 9.5a)**
    - Fibrous joint
    - Ex: adjacent bones in the cranium
  - **Gomphosis**
    - Fibrous joint
    - Ex: teeth in sockets of mandible or maxilla
  - **Synchondrosis**
    - Hyaline cartilaginous joint
    - Ex: joint between epiphyses and diaphyses of growing bones
  - **Synostosis** occurs when two bones fuse and the joint becomes a bony joint
    - Ossification occurs with age between some cranial sutures and epiphyses and diaphyses of the long bones

Amphiarthrotic Joints

- Limited range of motion
- Types
  - **Syndesmosis (most movable)**
    - Fibrous joint – 2 bones bound by ligament only
    - Ex: Distal radius and ulna or distal tibia and fibula
  - **Synchondrosis**
    - Bones are bound by hyaline cartilage
    - Ex: Rib attachment to sternum by costal cartilage
  - **Symphysis (least movable)**
    - Bones are joined by fibrocartilage
    - Ex: Pubic symphysis

Diarthrotic Joints

- All diarthrotic joints are synovial joints
- Synovial joint: joint in which two bones are separated by a space called a joint cavity
- Most are freely movable

Synovial joint anatomy (linked to figure 9.8-synovial joints)

- **fibrous capsule** – outer part of synovial joint, is fused with ligaments
- **synovial membrane** – inside the joint capsule; secretes synovial fluid
- **synovial fluid** – lubricates the articular cartilage to reduce friction
- **synovial cavity** – space inside the joint between the two articulating bones
- **articular cartilage** – hyaline cartilage covering the ends of the bones in the synovial cavity

Types of synovial joints (linked to figure on 9.10- types of synovial joints)

1. Hinge

- One bone with convex surface that fits
- Into a concave depression on other bone
- Change the angle between two bones
- Angular movement

2. Pivot
    - One bone has a projection that fits into a ringlike ligament of another
    - Allow for rotational movement between two bones
3. Ball-and-socket
    - Smooth hemispherical head fits within a cuplike depression
    - Extensive movement, yet less stable (dislocation)
4. Condyloid
    - A convex surface articulates with a concave surface
    - Allows significant movement in two planes
5. Gliding
    - Allows movement between two plane surface
6. Saddle
    - Two concave surfaces that articulate with one another
    - Similar, but, greater movement than a condyloid joint

Body Movements

(Links to Section 9.5)

Types of Body Movements

Flextion and Extension

Abduction and Adduction

Circumduction

Rotation (medial, lateral)

Pronation and supination

Dorsiflexion and plantar flexion

Inversion and eversion

Retraction and protraction

Elevation and depression

Opposition and reposition

Link to (Figures 9.12 and 9.13)

Movements of the Joints

(Link to Table 9.1)

Movements of the Joints

Type of Joint	Movement	Example
Pivot	Uniaxial joint; allows rotational movement	Atlantoaxial joint (C1–C2 vertebrae articulation); proximal radioulnar joint
Hinge	Uniaxial joint; allows flexion/extension movements	Knee; elbow; ankle; interphalangeal joints of fingers and toes
Condyloid	Biaxial joint; allows flexion/extension, abduction/adduction, and circumduction movements	Metacarpophalangeal (knuckle) joints of fingers; radiocarpal joint of wrist; metatarsophalangeal joints for toes
Saddle	Biaxial joint; allows flexion/extension, abduction/adduction, and circumduction movements	First carpometacarpal joint of the thumb; sternoclavicular joint
Plane	Multiaxial joint; allows inversion and eversion of foot, or flexion, extension, and lateral flexion of the vertebral column	Intertarsal joints of foot; superior-inferior articular process articulations between vertebrae
Ball-and-socket	Multiaxial joint; allows flexion/extension, abduction/adduction, circumduction, and medial/lateral rotation movements	Shoulder and hip joints

Muscle 1: Axial Muscles of the Head, Neck, and Back

Topics Covered

Introduction
Muscles of the head
    Muscles of facial expression
    Eye movement
    Tongue
    Muscles of the lower jaw
Muscles of the neck and back
    Head movement
    Anterior neck
    Posterior neck and back

Introduction

Muscles of are discrete and made up of fascicules, or bundles of muscle fibers (cells). Muscles have a point of origin and a point of insertion, which are usually found on bone, but can also be found on skin (such as the muscle of facial expression) or on other muscle (such as pharyngeal muscles).

- *Origin* – the attachment point of the muscle that does not move during contraction, also called the proximal attachment
- *Insertion* – the attachment that moves during contraction, also called the distal attachment
- *Action* – the effects(s) the muscle has on a part of the body

Muscles often cross a joint; this is the joint that they act on. When a muscle contracts, it shortens, bringing the insertion closer to the origin. Muscle fiber orientation can tell the direction of muscle contraction; when muscle contracts it shortens along the long axis of the fiber. Discrete muscles can be made up of muscle fibers that are oriented in many different directions- such as the temporalis muscle or the trapezius muscle.

Muscles of the Head

Muscles of facial expression

- Section 11.3.1- Muscles that create Facial Expression
    - Figure 11.7- Muscles of Facial Expression
    - Figure 11.8- Muscles in Facial Expression

Muscles of eye movement

- Section 11.3.2- Muscles that move the eyes

- Figure 11.9- Muscles that Move the Eyes
- Table 11.3- Muscles that Move the Eyes

Muscles that move the jaw

- Section 11.3.3- Muscles that Move the Lower Jaw
  - Figure 11.10- Muscles that move the lower jaw
  - Table 11.4- muscles that move the lower jaw

Muscles that move the tongue

- Section 11.3.4- Muscles that move the tongue
  - Figure 11.11- muscles that move the tongue
  - Figure 11.12- muscles for tongue movement, swallowing, and speech

Muscles of the Neck and Back

Muscles that move the head

- Section 11.3.6- Muscles that move the head
  - Figure 11.14- muscles that move the head
  - Table 11.5- muscles that move the head

Muscles of the anterior neck

- Section 11.3.5- Muscles of the anterior Neck
  - Figure 11.13- Muscles of the anterior neck

Muscles of the posterior neck and the back

- Figure 11.15- muscles of the neck and back

Muscle 2: Axial Muscles of the Abdominal Wall and Thorax

Topics Covered

Muscles of the abdomen
Muscles of the thorax
- The diaphragm
- The intercostal muscles
- The pectoral girdle

Muscles of the Abdomen

- Section 11.4.1- muscles of the abdomen
  - Figure 11.16- muscles of the abdomen
  - Table 11.6- muscles of the abdomen

Muscles of the Abdomen

Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Twisting at waist; also bending to the side	Vertebral column	Supination; lateral flexion	External obliques; internal obliques	Ribs 5–12; ilium	Ribs 7–10; linea alba; ilium
Squeezing abdomen during forceful exhalations, defecation, urination, and childbirth	Abdominal cavity	Compression	Transversus abdominus	Ilium; ribs 5–10	Sternum; linea alba; pubis
Sitting up	Vertebral column	Flexion	Rectus abdominis	Pubis	Sternum; ribs 5 and 7
Bending to the side	Vertebral column	Lateral flexion	Quadratus lumborum	Ilium; ribs 5–10	Rib 12; vertebrae L1–L4

Muscles of the Thorax

- Section 11.4.2- muscles of the thorax
- Table 11.7- muscles of the thorax

Muscles of the Thorax

Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Inhalation; exhalation	Thoracic cavity	Compression; expansion	Diaphragm	Sternum; ribs 6–12; lumbar vertebrae	Central tendon
Inhalation;exhalation	Ribs	Elevation (expands thoracic cavity)	External intercostals	Rib superior to each intercostal muscle	Rib inferior to each intercostal muscle
Forced exhalation	Ribs	Movement along superior/inferior axis to bring ribs closer together	Internal intercostals	Rib inferior to each intercostal muscle	Rib superior to each intercostal muscle

The diaphragm

- Section 11.4.2.1- The diaphragm

- Figure 11.17- The diaphragm

The intercostal muscles

- Section 11.4.2.2- The intercostal muscles
- Figure 11.18- intercostal muscles

Muscles that position the pectoral girdle

- Section 11.5.1- Muscles that position the pectoral girdle
- Figure 11.22- Muscles that position the pectoral girdle

Muscle 3: Appendicular Muscles of the Pectoral Girdle and Upper Limb

Topics Covered

Introduction
    Specific actions
    Naming of muscles
Muscles of the pectoral girdle and upper limb
Muscle action during elbow flexion

Introduction

As you have probably observed, muscles can work together or in opposition to accomplish a particular movement. Some movements are highly coordinated and rely on the contraction or relaxation of several muscles. The following terms describes muscles in terms of their role in a particular movement:

- ***Prime mover*** – the muscle that has the main force on a joint
- ***Synergist*** – muscles that assist the prime mover; modifies the direction of movement that occurs
- ***Antagonist*** – muscles that oppose (move the bones in the opposite direction) of the prime mover; preventing excessive movement and injury
- ***Fixing*** – to prevent motion in either direction by contraction of prime movers and antagonists at the same time; prevents movement of bone that prime mover is attached to

Remembering the names of muscles can be tedious and daunting. Therefore, try to use tricks to help yourself remember the name of a muscle by asking yourself these questions:

- What type of movement is produced (ex. adduction)?
- What region of the body (ex. Posterior; ex. Brachial)?
- How many heads?
- Where is the origin or insertion?
- What direction do the fascicles run?
- What shape is the muscle?

Also, see Table 11.2 for a list of mnemonic devices for the Latin roots of muscle terminology.

Muscles of the pectoral girdle and upper limb

Muscles that position the pectoral girdle

- Figure 11.22
- Table 11.8

Muscles that Position the Pectoral Girdle

Position in the thorax	Movement	Target	Target motion direction	Prime mover	Origin	Insertion
Anterior thorax	Stabilizes clavicle during movement by depressing it	Clavicle	Depression	Subclavius	First rib	Inferior surface of clavicle
Anterior thorax	Rotates shoulder anteriorly (throwing motion); assists with inhalation	Scapula; ribs	Scapula: depresses; ribs: elevates	Pectoralis minor	Anterior surfaces of certain ribs (2–4 or 3–5)	Coracoid process of scapula
Anterior thorax	Moves arm from side of body to front of body; assists with inhalation	Scapula; ribs	Scapula: protracts; ribs: elevates	Serratus anterior	Muscle slips from certain ribs (1–8 or 1–9)	Anterior surface of vertebral border of scapula
Posterior thorax	Elevates shoulders (shrugging); pulls shoulder blades together; tilts head backwards	Scapula; cervical spine	Scapula: rotests inferiorly, retracts, elevates, and depresses; spine: extends	Trapezius	Skull; vertebral column	Acromion and spine of scapula; clavicle
Posterior thorax	Stabilizes scapula during pectoral girdle movement	Scapula	Retracts; rotates inferiorly	Rhomboid major	Thoracic vertebrae (T2–T5)	Medial border of scapula
Posterior thorax	Stabilizes scapula during pectoral girdle movement	Scapula	Retracts; rotates inferiorly	Rhomboid minor	Cervical and thoracic vertebrae (C7 and T1)	Medial border of scapula

Muscles that move the humerus

- Figure 11.23
- Figure 11.24

Muscles that move the forearm

- Figure 11.25
- Figure 11.26

Muscles that move the wrist, hand, and fingers

- Figure 11.27
- Figure 11.28
- Table 11.9

Muscle Actions during Elbow Flexion

(Linked to figure 11.2- Prime Movers and Synergists)

- **Prime mover (agonist)** = biceps brachii m.
- **Synergist** = brachialis m
- **Antagonist** = triceps brachii m.
- **Fixator** = muscle that holds scapula firmly in place such as rhomboideus m.

Muscle 4: Appendicular Muscles of the Pelvic Girdle and Lower Limbs

Topics Covered

Muscles of the pelvic girdle and lower limbs

Muscles of the Pectoral Girdle and Upper Limb

Muscles of the thigh

- Figure 11.29
- Figure 11.30

Muscles that move the femur, tibia and fibula

- Figure 11.31

Muscles that move the feet and toes

- Figure 11.32
- Figure 11.33
- Figure 11.34
- Figure 11.35

Spinal Cord, Spinal Nerves, Cranial Nerves and Reflexes

Topics Covered

Introduction

The central nervous system of the body is broken into two anatomically distinct divisions: the central nervous system, made up of the brain and the spinal cord; and the peripheral nervous system, made up of all the nervous tissue exiting the brain and spinal cord. Within the nervous system, there are 3 fundamental types of neurons:

1) Sensory (afferent) neurons conduct signals from receptors to the CNS
2) Interneurons (association neurons) are confined to the CNS
3) Motor (efferent) neurons conduct signals from the CNS to effectors such as muscles and glands (PNS)

It is important to distinguish between these types of neurons when interpreting the anatomy of the both the central and peripheral nervous system.

The spinal cord carries information to and from the brain to and from the body. It is made up of all three types of neurons and their parts: cell bodies, dendrites, and axons.

The Spinal Cord

Overview

- Information highway between brain and body
- Extends through vertebral canal from foramen magnum to L1
- Each pair of spinal nerves receives sensory information and issues motor signals to muscles and glands
- Spinal cord is a component of the Central Nervous System while the spinal nerves are part of the Peripheral Nervous System
- .

Anatomy of the Spinal Cord

- Cylinder of nerve tissue within the vertebral canal (thick as a finger)

    - Vertebral column grows faster so in an adult the spinal cord only extends to L1
- 31 pairs of spinal nerves arise from cervical, thoracic, lumbar and sacral regions of the cord
    - Each cord segment gives rise to a pair of spinal nerves; This results in 31 spinal nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal

Cross-Sectional Anatomy of the Spinal Cord

(Link to figure 13.14- Cross-section of Spinal Cord)

- Central area of gray matter shaped like a butterfly and surrounded by white matter in 3 columns
- Gray matter = neuron cell bodies with little myelin
- White matter = myelinated axons

Nerve Plexuses

(Link to figure 13.24- Nerve Plexuses of the Body)

- **Cervical in the neck, C1 to C5**
    - Supplies neck and phrenic nerve to the diaphragm
- **Brachial in the armpit, C5 to T1**
    - Supplies upper limb and some of shoulder & neck
- **Lumbar in the low back, L1 to L4**
    - Supplies abdominal wall, anterior thigh & genitalia
- **Sacral in the pelvis, L4, L5 & S1 to S4**
    - Supplies remainder of butt & lower limb
- **Coccygeal, S4, S5 and C0**

Spinal Reflexes

- Quick, involuntary, stereotyped reactions of glands or muscle to sensory stimulation
    - Automatic responses to sensory input that occur without our intent or often even our awareness
- Functions by means of a somatic reflex arc
    - Stimulation of somatic receptors
    - Afferent fibers carry signal to dorsal horn of spinal cord
    - Interneurons integrate the information
    - Efferent fibers carry impulses to skeletal muscles
    - Skeletal muscles respond

The Patellar Tendon Reflex Arc

1) Extensor muscle stretched
2) Muscle spindle stimulated
3) Primary afferent neuron excited

4) Primary afferent neuron stimulates X motor neuron to extensor muscle
5) Primary afferent neuron stimulates inhibitory interneuron
6) Interneuron inhibits X motor neuron to flexor muscle
7) X motor neuron stimulates extensor muscle to contract
8) Flexor muscle (antagonist) relaxes

Brain

Topics Covered

Introduction
- Overview
- Structure of a neuron
- The synapse

The brain
- Directional terms
- Cerebrum
- The cerebellum
- The brainstem
- Cranial meninges
- Brain ventricles
- Cerebrospinal fluid

Introduction

Subdivisions of the Nervous System

Two major anatomical subdivisions

- *Central nervous system (CNS)*
  - Brain & spinal cord enclosed in bony coverings
- *Peripheral nervous system (PNS)*
  - Nerve = bundle of nerve fibers in connective tissue
  - Ganglion = swelling of cell bodies in a nerve

Structure of a Neuron
(link to figure 12.8- Parts of a Neuron)

- Cell body = perikaryon= soma
  - single, central nucleus with large nucleolus
- Dendrites - for receiving signals
- Axon - (nerve fiber) arising from axon hillock for rapid conduction
- Schwann cells – wrap around axons; contain myelin; Forms myelin sheath (increased speed)
  - White matter (myelinated)
  - Gray matter (unmyelinated)

Chemical Synapse Structure
(link to figure 12.27- The Synapse)

- Presynaptic neurons have synaptic vesicles with neurotransmitter and postsynaptic have receptors

The Brain

Directional terms and landmarks

- Rostral (toward the forehead) - Caudal (toward the cord)
- Major parts of the brain - cerebrum, cerebellum, brainstem
    - cerebrum is 83% of brain volume; cerebellum contains 50% of the neurons
    - Brainstem – diencephalon, cerebral peduncles, midbrain, pons, medulla oblongata

Fore-, Mid-, and Hindbrain

- Forebrain
    - Cerebrum
    - Corpus callosum
    - Diencephalon (Pineal gland, Thalamus, Hypothalamus, Pituitary gland, Mammillary bodies)
- Midbrain
    - Cerebral peduncles
    - Superior and Inferior colliculi
- Hindbrain

(link to figure 13.12- the brain stem)

    - Pons
    - Medulla oblongata
    - Cerebellum

Cerebrum

(link to figure 13.6- the cerebrum)

- Longitudinal fissure separates 2 cerebral hemispheres.
    - Gyri are the folds and sulci the grooves
    - Surface layer of gray matter is called cortex; deeper masses of gray matter are called nuclei
- Bundles of axons (white matter) are called tracts;
- Cerebral cortex is 3mm layer of gray matter with extensive folds to increase surface area—divided into lobes

Functions of Cerebral Lobes

(link to figure 13.7- lobes of the cerebral cortex)

- Frontal contains voluntary motor functions and areas for planning, mood, smell and social judgment
- Parietal contains areas for sensory reception & integration of sensory information
- Occipital is visual center of brain
- Temporal contains areas for hearing, smell, learning, memory, emotional behavior

The cerebellum

(link to figure 13.13- the cerebellum)

- Connected to brainstem by cerebellar peduncles
- White matter (arbor vitae) visible in sagittal section
- Sits atop the 4th ventricle

The brainstem

Pons

- Bulge in the brainstem, rostral to the medulla
- Nuclei concerned with sleep, hearing, balance, taste, eye movements, facial expression, facial sensation, respiration, swallowing, bladder control & posture

Cranial meninges

Link to figure 13.17- meningeal layers of superior sagittal sinus

Brain ventricles

Link to figure 13.18- cerebrospinal fluid circulation

Cerebrospinal fluid

- Clear liquid fills ventricles and canals & bathes its external surface (in subarachnoid space)
- Goes into ventricles from choroid plexus
- Functions
    - Buoyancy -- floats brain so it neutrally buoyant
    - Protection -- cushions from hitting inside of skull
    - Chemical stability -- rinses away wastes

Cranial Nerves

Topics Covered

Cranial nerves

Cranial nerves

(Link to table 13.3- Cranial Nerves; Figure 13.23)

I. Olfactory
II. Optic
III. Oculomotor
IV. Trochlear
V. Trigeminal
VI. Abducens
VII. Facial
VIII. Auditory
IX. Glossopharyngeal
X. Vagus
XI. Accessory
XII. Hypoglassal

Special Senses – Anatomy of the Ear

Topics Covered

Introduction
Anatomy of the ear
Cochlea
Semicircular canals

Introduction

Sound/Hearing

- Sound is any audible vibration of molecules
- Vibrating object pushes air molecules into eardrum making it vibrate
- Signals sent to brain by cochlear nerve via the auditory (CN VIII) nerve.
- somatic afferents and special visceral afferents.

Equilibrium/Balance

- Two types of equilibrium:
  - Static: determines nonmoving position. i.e. standing upright or lying down.
  - Dynamic: motion is detected. i.e. sudden acceleration, spinning.

- Signals sent to brain by vestibular nerve via the auditory (CN VIII) nerve.

Anatomy of the ear

(Link to figure 14.5)

Outer ear

- Fleshy auricle (pinna=helix and lobule) directing air vibrations down auditory canal (external auditory meatus)
  - S-shaped tunnel within temporal bone ending at eardrum
- Eardrum, also known as the tympanic membrane, separates the outer and middle ear.

Middle ear

- Tympanic membrane: 1 cm in diameter, slightly concave, freely vibrating membrane
- Tympanic cavity: air-filled cavity in temporal bone separated from air outside the head by tympanic membrane
- Ear ossicles span tympanic cavity
  - Tympanic membrane -> malleus ->incus ->stapes ->oval window of inner ear
- Tympanic cavity filled with air by auditory tube connected to nasopharynx

- opens during swallowing or yawning to equalize air pressure on both sides of eardrum

Inner ear

- Cochlea
- Vestibular apparatus
  - vestibule (saccule and utricle)
  - semicircular ducts (anterior, posterior, lateral)

Transmission of sound
(Figure 14.6)

- Tympanic membrane vibrates quite easily
  - Sends vibrations through ossicles to oval window of inner ear
    - Due to size difference between large tympanic membrane and small oval window, magnifies vibrations in inner ear (18X).
- Tympanic Reflex – Protection of inner ear by muscle contraction in response to loud noises
  - tensor tympani muscle pulls tympanic membrane inward, tightening it
  - stapedius muscle reduces mobility of stapes to lessen vibrations
  - designed for slowly building noises like thunder not gunshots
    - does not protect us from sustained loud noises such as music
  - muscles also contract while speaking; enables us to hear others

Cochlea

(Linked to Figure 14.11 and Figure 14.12)

- Three chambers within the cochlea:
  - the middle chamber is part of the membranous labyrinth and is filled with endolymph
  - the surrounding two are part of the bony labyrinth and are filled with perilymph.

- Endolymph in the scala media carries vibrations from oval window to Organ of Corti.
- Endolymph vibrates gelatinous tectorial membrane, causing the vibration of the stereocilia on hair cells.
- Two types of hair cells:
  - Inner hair cells: responsible for hearing
  - Outer hair cells: increase precision
  - Sends signals along cochlear nerve
- Loudness produces more vigorous vibrations & excites more hair cells over a larger area
  - triggers higher frequency of action potentials along the cochlear nerve; brain interprets this as louder
- Determination of pitch depends on which part of cochlea receives vibrations.

  - Stimulation closer to the middle ear results from sounds of shorter wavelength, which are high-pitched
  - Stimulation further from the middle ear results from sounds of longer wavelength, which are low-pitched

Semicircular ducts/ Vestibule

- Saccule: located next to cochlea
- Utricle: located next to semicircular ducts
- Both chambers contain macula
  - patch of hair cells with stereocilia buried in a gelatinous otolithic membrane weighted with granules called otoliths
  - otoliths add to the density & inertia and enhance the sense of gravity and motion
- With the head erect, stimulation is minimal, but when the head is tilted, weight of membrane bends the stereocilia (static equilibrium)
- When car begins to move at green light, linear acceleration is detected since heavy otolith lags behind (one type of dynamic equilibrium)
- Ampullae of semicircular ducts contain crista ampullaris (one in each ampulla), which consists of hair cells buried in a mound of gelatinous membrane called the cupula
- Orientation of ducts causes different ducts to be stimulated by rotation in different planes
- Crista Ampullaris: As head turns, the endolymph lags behind pushing the cupula and stimulating its hair cells

Special Senses – Anatomy of the Eye

Topics Covered

Introduction
Accessory structures of the eye
Anatomy of the eyeball

Introduction

Senses

- Sensory receptors – Detects changes in body's internal and external environments
- Two types – **General** and **special** senses

General sense

- Have simple neural pathways
- Touch, temperature, pain, chemical and pressure detection, and body perception
- **Does not have a specialized organ but comes from almost all over the body**

Special sense

- Have complex pathways
- Includes taste (gustation), smell (olfaction), vision, hearing (audition) and equilibrium.
- **Information from special senses is carried in special somatic afferents and special visceral afferents**.

Vision and Light

- Vision (sight) is perception of light emitted or reflected from objects in the environment
- **Visible light** is electromagnetic radiation with wavelengths from **400 to 750nm**
- Light must cause a photochemical reaction in order to produce a nerve signal that is sent to the occipital lobes of the brain for processing
    - Radiation below 400 nm has so much energy it kills cells (Ultraviolet)
    - Radiation above 750 nm has too little energy to cause photochemical reaction (it only warms the tissue) (Infrared)

Accesory structures of the eye

(Link to figure 14.13- Structure of the Eye)

- **Lateral and medial commissure** – upper and lower lids meet
- **Lacrimal caruncle** – Red fleshy globe-like nodule in the medial commissure that contains sebaceous and sweat glands
- **Palpebrae** – eyelids

- **Palpebral fissure –** Space between eyelids
- **Palpebral conjunctiva**
  - Thin mucus membrane that **lines the inside of the eyelids**.
  - Secretes mucus to reduce friction and moisten the eyeball surface
- **Ocular conjunctiva**
  - Covers the sclera (white part of the eye). Reflects over the anterior surface of eyeball.
- **Levator Palpebrae Superioris Muscle –** lifts upper eyelids
- **Cornea-** the transparent part of the coat of the eyeball that covers the iris and pupil and admits light to the interior
- **Tarsal Plates-** are two comparatively thick, elongated plates of dense connective tissue, and contributes to eyelids form and support.

Lacrimal Apparatus
Lacrimal fluid or tears flowing across eyeball helps wash away foreign particles, help with diffusion of O_2 & CO_2 and contain bactericidal enzyme called lysozyme.

Extrinsic Eyes Muscles
(Figure 14.14)
- 6 muscles inserting on external surface of eyeball 4 rectus muscles move eye up, down, left & right superior & inferior oblique more complicated
- Innervated by **cranial nerves III, IV and VI**
- **CN III (Oculomotor):** Superior rectus, medial rectus, inferior rectus, and inferior oblique
- **CN IV (Trochlear):** Superior oblique
- **CN VI (Abducens):** Lateral rectus
- The Trochlea of superior oblique is a pulley structure in the eye. The tendon of the superior oblique muscle passes through it

Anatomy of the eye
(Linked to Figure 14.15)

The Tunics of the Eyeball
tunica fibrosa – fibrous layer
- sclera and cornea
- provides protection

tunica vasculosa – vascular layer
- choroid, ciliary body & iris
- provides nourishment

tunica interna – internal layer
- retina and optic nerve
- converts light to nerve signal and sends it to the occipital lobes of the brain

Tunica fibrosa
- **Sclera**

- White part of the eye
- Covers the eyeball EXCEPT at the **cornea**
- Covered by the ocular conjunctiva
- Resists punctures and protects the eye
- Helps maintain pressure in the eye to keep its shape and keep the retina adhered to the back of the eye
- Attachment point of extrinsic muscles of the eye

- **Cornea**
  - Clear, curved portion covering the pupil
  - Light enters the eye through the cornea
  - Most responsible for bending of light to focus towards the back of the eye
  - Consists of many layers of densely packed collagen fibers
  - Dense and fibrous nature provides protection

Tunica vasculosa

- **Choroid**
  - Most posterior portion of this tunica
  - Contains **melanin** that absorbs light to prevent reflection back into eyeball, which can cause blurred vision
  - Also provides nourishment to the retina
- **Ciliary body**
  - Contains ciliary process and ciliary muscle
  - Connected to the lens by the suspensory ligaments
  - Helps in adjusting the shape of the lens for near and far vision
  - Produces aqueous humor
- **Iris**
  - Pigmented portion around the central aperture --the **pupil**
  - Constrictor and dialator muscle of the iris change the diameter of the pupil to regulate the amount of light striking the retina

Tunica interna

- **Retina and optic nerve**
  - Contains 2 layers
    - Outer pigmented layer prevents light scattering and absorbs light
    - Inner neural layer contains 2 types of photoreceptors (Figure 14.16)
      - **rods –** determine motion and general shape of objects in dim light; black-and-white vision
      - **cones –** color vision and visual acuity; used in bright light
  - Anterior margin of the retina where the choroid is exposed is the

Ora serrata.

- Optic nerve exits the eyeball at the **optic disc,** so the optic disc lacks photoreceptors and, hence, is called the **blind spot.**
- Lateral to the optic disc is an area of high cone density called the

Macula lutea.

- In the center of the macula lutea is a small depression called the **fovea centralis,** which is the area of sharpest vision because of the abundance of cones.

Additional Structures

- **Pupil-** a contractile hole located in the center of the iris of the eye that allows light to enter the retina
- **Lens** – fine-tunes bending of light to focus the image on the retina
    - Divides the eyeball into two cavities:
        - **Anterior cavity** – Area between the lens and the cornea
        - **Posterior cavity** – Area between the lens and the retina
- **Anterior cavity**
    - Contains a watery fluid called **aqueous humor**
    - Aqueous humor helps to maintain the intraocular pressure and supply nutrients to the lens and the cornea
    - Divided into an anterior and posterior chamber by the iris
- **Posterior cavity**
    - Contains a jelly-like substance called **vitreous humor**
    - Vitreous humor holds the retina against the choroid layer and prevents the eyeball from collapsing