BIOLOGY 211: HUMAN ANATOMY & PHYSIOLOGY

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**BONES OF THE SKELETAL SYSTEM**

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Reference: Saladin, KS: Anatomy & Physiology, The Unity of Form and Function, 8th ed. (2018)

**Please review Chapters 7 & 8 before beginning this lab.**

**INTRODUCTION**

 The skeletal system has a number of important functions in the human body. It is the framework around which the body is organized, it provides levers for muscles to pull against, and it surrounds and protects many soft organs. Equally important, bones serve as a "buffer" in which calcium and other ions can be deposited and withdrawn according to the changing needs of the body, and they are the site of almost all blood cell production. Contrary to our popular conceptions, bones are not rigid, inflexible structures: they are constantly changing, and can have a remarkable degree of flexibility before they break.

 The **organs** of the skeletal system are the bones and joints, and like all organs are composed of different types of **tissue.** Although we tend to classify them into "types" such as "long bones", "flat bones", etc., each is in fact unique and ideally suited to its particular location and function. We classify bones as belonging to either:

 a) the **axial skeleton** (head and trunk)

 b) the **appendicular skeleton** (arms and legs),

However, you should always bear in mind that the entire skeletal system functions as a unit.

 If you look at any bone, you will see that it is rarely flat or smooth. Bones have a variety of bumps, grooves, holes, etc. which allow them to serve their specific functions. In fact, it is these **markings** which will allow you to identify specific bones, including which side of the body they come from. In general, bone will have numerous holes (or **foramen,** plural = **foramina**) wherever something like a blood vessel or nerve must pass through. Typically, these will not be visible to the naked eye, but you should be aware of their presence. Enlargements at the ends of a bone allow it to connect, or **articulate**, with other bones in the proper manner. Bumps, grooves, and ridges on bones indicate where muscles, tendons, and ligaments attach or travel.

 We will use a number of lab periods to learn the names of the bones which comprise the human skeleton and their major markings. Since this is more-or-less a matter of simple memorization, there will not be step-by-step instructions: instead, it will be an independent study exercise in which you can proceed at your own pace, using your Saladin textbook (Chapter 8) as reference. You will need to make use of open lab times as well as scheduled lab periods.

 Keep in mind that the simple memorization of the actual names and locations of bones is only a small part of the process of really understanding the skeletal system. You will also be responsible for identifying the markings (tubercles, foramina, condyles, etc.) of each bone.

 Study the skeletons hanging in the lab and the individual bones found in the cupboard at the back of the lab, and learn the names of the bones and major markings listed below. Some of the skulls, skeletons and individual bones are real, while others are plastic reproductions. Be sure you study both types. The real bone specimens show greater detail and more variation, but they are fragile and many of them are broken or have pieces missing (especially true for the skulls). The plastic reproductions are more durable, but are not as good at showing more intricate details.

 **Please be careful not to do any further damage.** Only soft probes, such as a rolled-up piece of paper or tissue, should be used to identify structures – DO NOT use pens, pencils, or metal probes, and do not mark on any of the specimens.

**BONE PARTS AND MARKINGS:**

 The following terms are used to identify the various parts of a bone. You should understand the meaning of each of these terms and how they apply to specific bones. One or more questions on a lab exam will relate to your understanding of these terms**.**

**BODY** The main part of a bone from which other markings often extend.

 Example: the *body* of the sphenoid bone.

**CANAL**  A tube-like opening through which nerves and blood vessels often pass.

 Example: the *carotid canal* of the temporal bone.

**CONDYLE** A large, rounded projection where the bone articulates with part of another bone.

 Example: the *lateral condyle* of the tibia.

**CREST** A narrow ridge on the bone, usually found where a flat muscle, tendon, or ligament

 attaches to the bone.

 Example: the *anterior crest* of the tibia.

**DIAPHYSIS** The cylindrical shaft of a long bone. May have other markings on it.

 Example: the *diaphysis* of the radius.

**EPICONDYLE** A relatively small, rounded bump where muscles, tendons, and ligaments attach to

 the bone. An epicondyle is always located on the surface of a condyle.

 Example: the *medial epicondyle* of the humerus.

**EPIPHYSIS** The enlarged end of a long bone. Often includes other markings such as condyles or

 epicondyles

 Example: the *distal epiphysis* of the tibia.

**FACET** A smooth, flat area where the bone articulates with part of another bone.

 Example: the *facet* on the superior articular process of a vertebra.

**FISSURE** A narrow elongated opening, usually irregular in shape. Nerves and blood vessels

 often pass through fissures.

 Example: the *superior orbital fissure* of the sphenoid bone.

**FORAMEN** A round or oval hole through a bone, not as long as a canal or meatus.

 Example: the *jugular foramen* of the temporal bone.

**FOSSA** A large, flat region or shallow depression on a bone.

 Example: the *infraspinous fossa*  of the scapula.

**GROOVE**  A narrow depression on a bone through which some other structure runs.

 Example: the *intertubercular groove* of the humerus.

**HEAD** A rounded enlargement carried on a neck of a bone which takes part in forming a joint.

 Example: the *head* of the femur.

**LINE** A narrow ridge, smaller than a crest, but also a place where a flat ligament, tendon,

 or muscle attaches to the bone.

 Example: the *superior nuchal line* of the occipital bone.

**MEATUS** A tube-like opening or passage in a bone.

 Example: *the external auditory meatus* of the temporal bone.

**NECK** A narrowed region at one end of a long bone, leading to a head.

 Example: the *neck* of the femur.

**PROCESS** A general term for a long projection from a bone.

 Example: the z*ygomatic process* of the temporal bone.

**PROTUBERANCE** A general term for a small, irregular projection from a bone.

 Example: the *external occipital protuberance* of the occipital bone.

**RAMUS** A round or flattened extension from the body of a bone, usually for articulation

 with another bone.

 Example: the *ramus* of the mandible.

**SINUS** An air-filled cavity within a bone, lined by mucous membrane.

 Example: the *frontal sinus* of the frontal bone.

**SPINE** A sharp, slender projection of a bone for muscle, tendon, or ligament attachment.

 Example: the *anterior superior iliac spine* of the ilium.

**TROCHANTER** A large, irregularly shaped projection of a bone.

 Example: the *greater trochanter* of the femur.

**TUBERCLE** A small round projection of a bone.

 Example: the *tubercle* of a rib.

**TUBEROSITY** A large, rounded projection of a bone for muscle attachment, usually rough.

 Example: the *deltoid tuberosity* of the humerus.

**WING** An elongated, flattened extension of a bone.

 Example: the *greater wing* of the sphenoid bone.

**BONES OF THE SKULL (Figures 8.3 - 8.15)**

 The skull consists of two separate sets of bones: bones of the **cranium** surround and protect the brain, while bones of the **face** support the eyes, nose, and mouth and provide attachment for the **muscles of facial expression.** These two sets of bones attach to each other in many places, and all bones in the head include a large number of foramina because of the large numbers of nerves and blood vessels which must pass through.

 With only one exception, the joints between the bones of the skull are a type which prevents, rather than allows, motion between the bones. These nonmovable joints are called **sutures**, and they are found only in the head. The exception to this pattern is the joint between the condyle of the mandible and the temporal bone, which allows the mandible to move freely when eating, speaking, yawning, etc.

**IDENTIFY THE FRONTAL BONE AND ITS FOLLOWING MARKINGS**:

 Supraorbital margin

Supraorbital foramen

**IDENTIFY THE PARIETAL BONE**

**IDENTIFY THE OCCIPITAL BONE AND ITS FOLLOWING MARKINGS:**

 Foramen magnum

 Occipital condyle

 Hypoglossal canal

External occipital protuberance

Superior nuchal line

**IDENTIFY THE TEMPORAL BONE AND ITS FOLLOWING MARKINGS:**

 Squamous region

 Tympanic region

 Petrous region

 Mastoid region

 Mastoid process

 Mandibular fossa

 External auditory (acoustic) meatus

 Internal auditory (acoustic) meatus

 Styloid process

 Jugular foramen

 Foramen lacerum

 Stylomastoid foramen

 Carotid canal

 Zygomatic process

**IDENTIFY THE ETHMOID BONE AND ITS FOLLOWING MARKINGS:**

 Crista galli Cribriform plate

 Perpendicular plate Orbital plate

**IDENTIFY THE SPHENOID BONE AND ITS FOLLOWING MARKINGS:**

 Body

 Sella turcica

 Greater wing

 Lesser wing

 Pterygoid process

 Superior orbital fissure

 Optic canal

 Foramen ovale

 Foramen rotundum

 Foramen spinosum

**IDENTIFY THE MAXILLA AND ITS FOLLOWING MARKINGS:**

 Alveolar margin Palatine process

 Frontal process Zygomatic process

 Infraorbital foramen

**IDENTIFY THE MANDIBLE AND ITS FOLLOWING MARKINGS:**

 Body Ramus

 Condyles (right & left) Angle

 Mandibular notch Alveolar margin

 Coronoid process

**IDENTIFY THE ZYGOMATIC BONE**

**IDENTIFY THE NASAL BONE**

**IDENTIFY THE LACRIMAL BONE**

**IDENTIFY THE VOMER**

**IDENTIFY THE FOLLOWING FEATURES OF THE SKULL:**

 Coronal suture

 Sagittal suture

 Lambdoid suture

 Squamous suture

 Occipitomastoid suture

 Anterior cranial fossa

 Middle cranial fossa

 Posterior cranial fossa

 Orbit

 Nasal cavity

**IN THE ORBIT, IDENTIFY THE FOLLOWING:**

 Superior orbital fissure

 Inferior orbital fissure

 Optic canal

Be sure you can identify where each of these openings leads. Two of them lead back between the

cranial cavity and the orbit while one leads from the cranial cavity onto the face behind the zygomatic arch.

**IN THE NASAL CAVITY, IDENTIFY THE FOLLOWING:**

 Nasal septum (composed of parts of vomer and ethmoid bones)

 Middle nasal concha Inferior nasal concha

 Superior nasal concha (cannot be seen on the skull models, but you should know its location)

**ON YOURSELF AND/OR ANOTHER PERSON, LOCATE THE FOLLOWING:**

 Frontal bone

 Parietal bones

 Occipital bone

 Temporal bones

 Nasal bones

 Zygomatic bones

 Orbits

 Supraorbital margins

 External auditory (acoustic) meatus

 Mastoid processes

 External occipital protuberance

 Nasal septum

 Body, angle, and ramus of mandible

 Temporomandibular joints

 Approximate location of the sagittal, coronal, and lambdoid sutures

**THE SPINAL COLUMN (Figures 8.18 - 8.26)**

 The spinal column consists of 33 individual **vertebrae**. They surround the spinal cord and the nerves which arise from it, and they provide places for many muscles to attach. The size and shape of each vertebra depends on where it is located, which muscles and ligaments attach to it, etc. Five of them are fused together to carry the weight of the upper body and transfer this weight to the bones of the lower limb.

**ON AN INTACT SKELETON, IDENTIFY THE:**

 Seven cervical vertebrae Five fused sacral vertebrae

 Twelve thoracic vertebrae Four partially fused coccygeal vertebrae

 Five lumbar vertebrae

**ON A THORACIC OR LUMBAR VERTEBRA, IDENTIFY THE FOLLOWING:**

 Body

 Lamina

 Pedicle

 Vertebral foramen

 Transverse process

 Spinous process

 Superior articular process and facet

 Inferior articular process and facet

 Superior notch

 Inferior notch

 Costal facet on thoracic vertebra

 Look at an intact skeleton and understand how the inferior and superior notches of adjacent

 vertebrae form an intervertebral foramen

**EXAMINE TWO OR THREE CERVICAL VERTEBRAE:**

 Specifically identify the 1st and 2nd vertebrae, called the Atlas and the Axis.

 Identify the transverse foramen which is characteristic of all cervical vertebrae

**EXAMINE TWO OR THREE THORACIC VERTEBRAE:**

 Identify where ribs articulate on both the body and the transverse process of each vertebra

 Note the characteristic inferior angle of the spinous processes of thoracic vertebrae

**EXAMINE TWO OR THREE LUMBAR VERTEBRAE:**

 Note characteristically large bodies and short spinous processes of lumbar vertebrae

**IDENTIFY THE SACRUM, CONSISTING OF FIVE FUSED VERTEBRAE:**

 Note the thicker medial region where the vertebral bodies are fused

 Note that even though the vertebrae are fused, intervertebral foramina are still present

**IDENTIFY THE COCCYX, CONSISTING OF FOUR PARTIALLY FUSED VERTEBRAE**:

 Note that these vertebrae are not well formed, lacking most of the markings of other

 vertebrae, and are partially or completely fused together.

**ON YOURSELF AND/OR ANOTHER PERSON, LOCATE THE FOLLOWING:**

 Spinous processes of thoracic and lumbar vertebrae

 Border between lumbar vertebrae and sacrum

 Sacrum and coccyx

 Notice the curvatures of the cervical, thoracic, lumbar, and sacral regions of the vertebral column

This will require removal of clothing and exposure of the skin of the back so you should do it at home.

Please do not identify these structures through clothing.

**THE HYOID BONE (Figure 8.16)**

 This is the only bone in the human body that does not articulate with another bone. It serves as an attachment for muscles which move the tongue and larynx

**IDENTIFY THE HYOID BONE ON A COMPLETE SKELETON:**

**IDENTIFY THE HYOID BONE ON YOURSELF AND/OR ANOTHER PERSON**

**THE PELVIS (Figures 8.35 - 8.37)**

 The bones of the pelvis surround and protect the organs of the pelvic cavity, transmit weight from the vertebrae to the legs, and provide attachment for muscles which move both the legs and the body. Although in the adult they form a single, solid structure on each side called the **coxal bone**, each coxal bone is considered to consist of the three individual bones seen earlier in growth and development.

**IDENTIFY THE ILIUM AND ITS FOLLOWING MARKINGS**:

 Iliac crest Iliac fossa

 Anterior superior iliac spine Anterior inferior iliac spine

 Posterior superior iliac spine Posterior inferior iliac spine

 Greater sciatic notch

**IDENTIFY THE ISCHIUM AND ITS FOLLOWING MARKINGS**:

 Ischial ramus

 Ischial spine

 Ischial tuberosity

 Lesser sciatic notch

**IDENTIFY THE PUBIS AND ITS FOLLOWING MARKINGS**:

 Superior ramus

 Inferior ramus

Pubic tubercle on body of pubis

**IDENTIFY THE FOLLOWING:**

 Acetabulum

 Pubic symphysis

 Obturator foramen

 Pelvic brim

 Pelvic inlet

 Sacroiliac joint

 True (lesser) pelvis

 False (greater) pelvis

**ON YOURSELF AND/OR ANOTHER PERSON, IDENTIFY THE FOLLOWING:**

 Anterior superior iliac spines

 Posterior superior iliac spines

 Pubic symphysis

 Pubic tubercles

 Ischial tuberosities

 Iliac crests

 Sacroiliac joints

This will require removal of clothing and exposure of the skin of the pelvis so you should do this at home.

Please do not identify these structures through clothing.

**THE THORAX (Figures 8.27 - 8.29)**

**ON THE ARTICULATED SKELETON, IDENTIFY THE STERNUM AND ITS PARTS**

 Manubrium

 Body

 Xiphoid process

 Sternal angle

**ON THE ARTICULATED SKELETON, IDENTIFY RIBS 1 THROUGH 12 ON EACH SIDE**

 Examine their attachments to vertebrae and sternum

 Notice that: ribs 1 through 7 attach directly to the sternum through costal cartilages

 ribs 8 through 10 attach to the rib above through costal cartilages

 ribs 11 and 12 do not have an anterior attachment,

 For this reason: ribs 1 through 7 are called “true” ribs

 ribs 8 through 12 are called “false” ribs

 ribs 11 and 12 are called “floating” ribs

**EXAMINE AN ISOLATED RIB AND IDENTIFY THE FOLLOWING:**

 Head

 Neck

 Tubercle

 Angle

 Costal groove

**ON YOURSELF AND/OR ANOTHER PERSON, IDENTIFY THE FOLLOWING:**

 Sternum

 Sternal angle

 Xiphoid process

 Angles of ribs

 Costal cartilages

 Follow each rib from its posterior attachment to its anterior attachment

This will require removal of clothing and exposure of the skin of the thorax so you should do this at home.

Please do not identify these structures through clothing.

**THE UPPER LIMB (Figures 8.30 - 8.34)**

 Bones of the upper limb provide attachments for the muscles which move the arm and which attach the upper limb (part of the appendicular skeleton) to the axial skeleton. Note that it includes not only bones of the arm, forearm and hand, but also the scapula and the clavicle. Thus, the **sternoclavicular joint** separates the axial skeleton from the appendicular skeleton of the upper limb.

**IDENTIFY THE CLAVICLE AND ITS FOLLOWING MARKINGS:**

 Medial (sternal) epiphysis

 Lateral (acromial) epiphysis

**IDENTIFY THE SCAPULA AND ITS FOLLOWING MARKINGS:**

 Spine

 Coracoid process

 Acromion process

 Subscapular fossa

 Supraspinous fossa

 Infraspinous fossa

 Glenoid cavity

 Superior, medial, and lateral borders

**IDENTIFY THE HUMERUS AND ITS FOLLOWING MARKINGS:**

 Head

 Greater tubercle and Lesser tubercle

 Intertubercular (bicipital) groove

 Deltoid tuberosity

 Medial epicondyle

 Lateral epicondyle

 Trochlea

 Olecranon fossa

**IDENTIFY THE RADIUS AND ITS FOLLOWING MARKINGS:**

 Head

 Radial tuberosity

 Styloid process

**IDENTIFY THE ULNA AND ITS FOLLOWING MARKINGS:**

 Olecranon process

 Coronoid process

 Styloid process

 Trochlear notch

**IDENTIFY THE CARPAL BONES ON EACH HAND:**

 Trapezium

 Trapezoid

 Capitate

 Hamate

 Scaphoid

 Lunate

 Triquetrum

 Pisiform

**IDENTIFY THE METACARPAL BONES ON EACH HAND**

 These are named 1 through 5 from the thumb (called the pollex) toward the little finger

**IDENTIFY THE PHALANGES ON EACH HAND**

 The thumb has a proximal phalanx and a distal phalanx

 Each of the other fingers has a proximal phalanx, a middle phalanx, and a distal phalanx

**ON YOURSELF AND/OR ANOTHER PERSON, LOCATE THE FOLLOWING:**

 Clavicle (entire length)

 Acromion process of scapula

 Sternoclavicular joint

 Coracoid process of scapula

 Spine of scapula

 Greater tubercle of humerus

 Medial epicondyle of humerus

 Lateral epicondyle of humerus

 Olecranon process of ulna

 Posterior border of ulna (entire length)

 Styloid process of radius

 Styloid process of ulna

 All eight carpals on posterior wrist

 All five metacarpals

 All fourteen phalanges of the hand

This will require removal of clothing and exposure of the skin of the limb so you should do this at home.

Please do not identify these structures through clothing.

**THE LOWER LIMB (Figures 8.38 - 8.42)**

 Bones of the lower limb provide attachments for the muscles which move the leg and which attach the lower limb (part of the appendicular skeleton) to the axial skeleton. Note that it includes not only bones of the thigh, lower leg, and foot, but also the coxal bones of the pelvis. Thus, the sacroiliac joint separates the axial skeleton from the appendicular skeleton of the lower limb.

**IDENTIFY THE FEMUR AND ITS FOLLOWING MARKINGS:**

 Head

 Neck

 Greater trochanter

 Lesser trochanter

 Gluteal tuberosity

 Medial condyle

 Lateral condyle

 Medial epicondyle

 Lateral epicondyle

 Patellar surface

**IDENTIFY THE TIBIA AND ITS FOLLOWING MARKINGS:**

 Medial condyle

 Lateral condyle

 Tibial tuberosity

Anterior crest or border :

 Medial malleolus

**IDENTIFY THE FIBULA AND ITS FOLLOWING MARKINGS:**

 Head

 Lateral malleolus

**IDENTIFY THE PATELLA**

**IDENTIFY THE TARSAL BONES OF EACH FOOT:**

 Calcaneus

 Talus

 Cuboid

 Navicular

 Medial cuneiform

 Intermediate cuneiform

 Lateral cuneiform

**IDENTIFY THE METATARSAL BONES ON EACH FOOT**

 These are named 1 through 5 from the large toe (called the hallux) toward the smallest toe

**IDENTIFY THE PHALANGES ON EACH FOOT**

 The big toe has a proximal phalanx and a distal phalanx

 Each of the other toes has a proximal phalanx, a middle phalanx, and a distal phalanx

**ON YOURSELF AND/OR ANOTHER PERSON, LOCATE THE FOLLOWING:**

 Greater trochanter of femur

 Medial epicondyle of femur

 Lateral epicondyle of femur

 Patella

 Medial condyle of tibia

 Lateral condyle of tibia

 Head of fibula

 Medial malleolus of tibia

 Lateral malleolus of fibula

 All seven tarsals on posterior foot

 All five metatarsals

 All fourteen phalanges of the foot

This will require removal of clothing and exposure of the skin of the limb so you should do this at home.

Please do not identify these structures through clothing.