Introduction:

There are 206 bones that make up the organs of the skeletal system in an adult human. These bones are connected to each other with cartilage, ligaments and tendons forming joints or articulations.

The bones may be categorized by their shape. These categories include long, short, irregular and flat. Most bones of the body are long bones; that is, these bones are longer than they are wide. Examples of long bones include the femur, humerus, bones of the antebrachium and phalanges. Short bones are about the same length as width; these include bones of the carpals, tarsals and patella. Flat bones include the sternum and cranium. Irregular bones include vertebrae and many facial bones.

As with other body systems, there are many different tissues that contribute to the structure of each organ. There are two types of bone tissue, compact bone and spongy bone. Connective tissues of hyaline and fibrocartilage cover bone surfaces to decrease friction and help to form joints or articulations. The bones are pulled on by skeletal muscle to produce movements. Many skeletal muscles are attached to bones by dense fibrous connective tissue called tendons; and bones can also be held together by ligaments composed of dense fibrous connective tissue.
Activity 1: Anatomy of a Long Bone

The anatomical features common to long bones begin with the periosteum, a tough fibrous connective tissue covering continuous with ligaments and tendons attached to the bone’s diaphysis. The periosteum is vascular allowing for blood vessels to enter the bone to make exchanges with bone cells.

The ends, expanded portions, of the bone are the epiphyses. The shaft between the epiphysys is the diaphysis. Within the diaphysis, is the medullary cavity filled with yellow marrow (adipose tissue).

Both compact bone and spongy bone are found in long bones. The epiphysis is composed of spongy bone internally covered with compact bone externally. The spongy bone has spaces containing red bone marrow which is the sight of blood cell formation. The epiphysis is often covered with hyaline or articular cartilage. The articular cartilage decreases friction between adjacent bones during movements. The diaphysis of a long bone is primarily compact bone. (See the cross section of the diaphysis in the photo).

Observe the longitudinal section of a long bone and you will see a line of bone, the epiphyseal plate, which is the location of bone growth allowing for the bone to lengthen.

PreLab Activity:

1) In your notebook, draw a diagram of a typical long bone and label the different parts of the long bone. Your textbook includes a labeled diagram, also.

2) Complete the table in your lab notebook, by identifying the different body tissues that make up the structures of a typical long bone.

3) Complete the table in your lab notebook describing the other categories of bones and providing specific examples for each.
Activity 2: Histology Review

During lab, observe the model of compact bone tissue and examine a prepared slide of compact bone and identify the following structures. Update your histology atlas to include the following level of detail (labels).

1. **osteon**: a cylindrical unit of compact bone.
2. **lamellae**: the concentric rings of matrix (calcium salts and proteins).
3. **lacunae**: spaces between the lamellae that house **osteocytes**.
4. **central canal**: space in the center of each osteon where **blood vessels** and nerves pass through the bone.
5. **canaliculi**: tiny tubules that allow osteocytes a passageway for exchange.

Examine a prepared slide of hyaline cartilage and identify the following structures. Update your histology atlas to include the following level of detail (labels).

1. **matrix**: the flexible, ‘glassy’ substance between the cells consisting primarily of proteins.
2. **lacunae**: the spaces within the matrix that house the **chondrocytes**.
Activity 3: The Bones of the Axial Skeleton and Appendicular Skeleton

Not only can the bones be categorized by shape, the bones of the skeleton can be categorized into two divisions. The **axial skeleton** which includes the bones, that form the long axis of the body—skull, vertebrae, ribs and sternum; and, the bones of the **appendicular skeleton** include the bones that make up the appendages and their **girdles**.

PreLab Activity:

1. Use figure 5.6 *The human skeleton* of your textbook, page 144, to complete the list of bones that make up the axial and appendicular skeletons in your lab notebook.

2. During Lab, practice identifying the different bones of the axial and appendicular skeleton on the complete skeletons.

*Note: The skeletons are REAL and extremely fragile. Please be aware of the skeleton as you move about the room.*
Activity 4: Bones of the Skull

The bones of the skull include the **cranium** and **facial bones**. The cranium, include bones that house the brain while the facial bones are anterior, involved in producing movements (expressions, speech and ingestion), as well as, provide passageways for blood vessels and nerves.

In this activity you will practice identifying the different bones of the skull. Most bones of the skull form **articulations** (joints) with other bones through immovable joints called **sutures**.

Lateral view

Internal view

Posterior View

Internal View
Procedure: Observe a Skull

Use your textbook, 5.8 and 5.9 of the *Human Skull* as an aid to practice your identifications of the bones of the cranium. The advantage of your textbook diagrams is that each skull bone is its own color and from one diagram to the next, the same color is used. On the preceding page are several different views of real human skulls, there are more pictures available OnLine in the Photoalbums.

Using a skull in lab identify the various bones and bone markings as described below. NOTE: Whether the skull is real or a model, they are fragile. NEVER insert a pencil or pen into any space of the skull. Pipe cleaners are flexible and soft and may be used to help you ‘point’.

Identify 8 bones of the cranium
1) frontal bone
2) (2) parietal bones
3) (2) temporal bones
4) occipital bone
5) sphenoid bone
6) ethmoid bone

There are several sutures, immovable joints composed of connective fibrous tissue holding two bones together. Identify the line marking the coronal suture between the frontal and parietal bones, the sagittal suture between the parietal bones, and the lambdoid suture between the parietal bones and the occipital bone.

You will also notice as you rotate the skull in lab, that there are numerous openings in the skull. These openings allow for a variety of structures to pass through, like blood vessels and nerves. The lateral view of the skull, there is an opening, the external auditory canal or external acoustic meatus. This canal is where sound passes from the outer ear (pinna) to the middle ear. A very large opening seen from the inferior view of the skull is the foramen magnum (large hole). This is where the spinal cord passes through the skull to connect with the brain.

The facial bones includes 14 bones, 12 are paired, only the mandible and vomer are single. Use fig. 5.11 Human Skull, page 148, to help you practice identifying the facial bones on the skull.

Identify the following facial bones on a skull in lab:
1) maxillae
2) palatine
3) zygomatic
4) nasal
5) lacrimal
6) vomer
7) mandible
8) hyoid

Of all the bones of the skull, the hyoid bone is the only bone of the entire body that does not directly articulate with a other bone of the body. Use your textbook to help you complete your lab notebook and identify the different bones and sutures on the skull during lab.
Activity 5: Vertebrae and Rib Cage

Use your text book to complete the table in your lab notebook by identifying the different regions of the vertebrae and the number of individual vertebrae of each region.

There will be several different complete skeletons in lab. Identify the cervical, thoracic, lumbar, sacral (sacrum) and coccyx regions and vertebrae. Count the number of vertebrae in the different skeletons. Do all the skeletons have the expected number of vertebrae for each region?

Use your text book to answer the questions regarding the rib cage. When you get to lab, try to identify each costal as true, false or floating rib by viewing its attachment to the sternum.

The sternum is a flat bone that results from the fusion of three bones—the manubrium, body and xiphoid process. Compare the sternum on the adult human skeleton to the sternum on the fetal skeleton. Describe your observations in your lab notebook.
Activity 6 Appendicular Skeleton

The pectoral girdle includes the clavicle and scapula. These two bones attach the arm to the axial skeleton. The shoulder is a ball and socket joint where the glenoid cavity (glenoid fossa) of the scapula articulates with the head of the humerus. The shoulder girdle is light, poorly reinforced with ligaments, loosely attached which allows for an exceptional amount of free movements.

Identify the following bones on the skeleton:

1) scapula
2) clavicle
3) humerus
4) radius
5) ulna
6) carpals
7) metacarpals
8) phalanges

As you observe the radius and ulna, gently rotate the hand and watch the rotation of these antebrachium bones move during the rotation. The difficulty in identification on the skeleton is ensuring that the skeleton is in correct anatomical position.

Observe the bones of the hand. Make notes in your lab notebook about how to differentiate between the metacarpals and phalanges. Note the number of phalanges that contributes to the structure of each digit of the hand.

The bony pelvis includes the sacrum of the vertebrae and the coxal bones. The coxal bones are three fused bones: ilium, pubic and ischium bones. The pubic symphysis is another immovable joint that connects the two coxal bones anteriorly. However, the pelvic girdle includes only the bones that make up the hip joint of the coxal bones.

The bony pelvis has several characteristics that enable identification of male or female. Review figure 5.24 The bony pelvis in your textbook, page 163. Observe the full skeletons or the bony pelvis in lab and try to identify each as male or female by using the flaring portions of the ilium, the inlet and the pubic arch. You will probably notice that some specimens are easy to identify as male or female while others are more difficult. The coxal bones contribute to the ball and socket joint of the hip. The acetabulum is the socket while the ball is located on the proximal end of the femur, the head.

Use your textbook to help you practice and identify the bones of the leg on the skeleton:

1) coxal
2) femur
3) tibia with medial malleolus
4) fibula with lateral malleolus
5) patella
6) tarsal
7) calcaneus
8) metatarsal
9) phalanges

In your lab notebook, briefly describe any of these bones that you found difficult to identify.
Activity 7 Bone Markings

As you observed and identified the bones of the skeleton and the individual bones in lab you have probably noticed that the bones are not smooth but have many ‘bumps, dents and holes’. These bone markings identify where muscles, tendons, ligaments are attached to the bone; and, where blood vessels and nerves pass through the bone. Review the following bone markings on the skeleton.

Projections (bumps) that allow for muscle and ligament attachment include:

1) **Tuberosity** a large rounded roughened projection. Observe the lateral aspect of the humerus of several of the skeletons in lab. There are differences in the size of the deltoid tuberosity between the male and female skeleton (see figures 5.22 Bones of the right arm and forearm in your text book p.161)

2) **Spine**: sharp, slender, often pointed projection. Observe the vertebrae from each region, note the different shapes of the vertebrae, the shape of the spinous process is often used to help identify vertebrae. (See the figure of the vertebrae in your textbook.)

Projections that help form joints.

1) **Head**: bony expansion carried on a narrow neck. Observe the head of the humerus, radius and femur.

Depressions and Openings allow blood vessels and nerves to pass from one area to another.

1) **Meatus**: canal-like passageway. The external acoustic meatus is an opening on the external surface of the temporal bone. On the internal surface is the opening for the facial and vestibulocochlear nerves (hearing).

2) **Fossa**: shallow depression often serving as an articular surface. The glenoid fossa provides a shallow depression which articulates with the head of the humerus to make the shoulder joint.

3) **Foramen**: round or oval opening through a bone. We observed the foramen magnum as a passageway for the spinal cord through the skull.

In your lab notebook, briefly describe these bone markings. As we looked at the skull, sternum, scapula, coxal, tibia and fibula, you were to identify several different types of bone markings on each, briefly describe in your notebook what markings were to be identified in the appropriate activities.
Activity 8 Fetal Skeleton

The fetal skeleton is quite different from an adult skeleton. There are many more bones of the fetal skeleton because the hyaline model has not ossified (been converted to bone). The fontanels are fibrous membranes connecting the bones of the cranium that allow more flexibility during birth and growth. Ossification centers are cone-like projections on various bones of the skull where there is great mitotic activity occurring increasing the size of the cranium to accommodate the growing brain.

Procedure: Observe the Fetal Skeleton

*Note: Do not handle the complete fetal skeleton, it is extremely fragile.*

Observe the fetal skeleton in lab. Observe the fontanels. Identify the Anterior, posterior, sphenoidal and mastoid fontanel. Use your textbook, figure 5.13 *The fetal skull* as an aid in your identifications.

Observe the sternum and the coxal bones on the fetal skeleton. Note the individual bones have not fused on the fetal skeleton.

Identify which bones of the cranium have cone-like projections, ossification centers.

Complete your observations and questions your lab notebook.