Abdominal cavity

The abdominal cavity is the largest body cavity in humans[1] and many animals, and holds the bulk of the viscera. It is located below (inferior to) the thoracic cavity, and above the pelvic cavity. Its dome-shaped roof is the thoracic diaphragm (a thin sheet of muscle under the lungs), and its oblique floor is the pelvic inlet (the superior opening of the pelvis). It is a part of the abdominopelvic cavity.[2] It is well connected with the pleural (thoracic) cavity.

Organs

Organs of the abdominal cavity include the stomach, liver, gallbladder, spleen, pancreas, small intestine, kidneys, large intestine, and adrenal glands.

Peritoneum

Main article: Peritoneum

The abdominal cavity is lined with a protective membrane termed the peritoneum. The inside wall is covered by the parietal peritoneum. The kidneys are located in the abdominal cavity behind the peritoneum, in the retroperitoneum. The viscera are also covered by visceral peritoneum.

Between the visceral and parietal peritoneum is the peritoneal cavity, which is a potential space. It contains serous fluid that allows motion. This motion is apparent of the gastrointestinal tract. The peritoneum, by virtue of its connection to the two (parietal and visceral) portions, gives support to the abdominal organs.

The peritoneum divides the cavity into numerous compartments. One of these the lesser sac is located behind the stomach and joins into the greater sac via the foramen of Winslow.[1] Some of the organs are attached to the walls of the abdomen via folds of peritoneum and ligaments, such as the liver and others use broad areas of the peritoneum, such as the pancreas. The peritoneal ligaments are actually dense folds of the peritoneum that are used to connect viscera to viscera or viscera to the walls of the abdomen.[1] They are named in such a way as to show what they connect typically. For example the gastrocolic ligament connects the stomach and colon and the splenocolic ligament connects the spleen and the colon, or sometimes by their shape as the round ligament or triangular ligament.[1]

Mesentery

Mesenteries are folds of peritoneum that are attached to the walls of the abdomen and enclose viscera completely. They are supplied with plentiful

amounts of blood. The three most important mesenteries are mesentery for the small intestine, the transverse mesocolon, which attaches the back portion of the colon to the abdominal wall, and the mesosigmoid which enfolds the sigmoid portion of the colon.[1]

Omenta

The omentum are specialized folds of peritoneum that enclose nerves, blood vessels, lymph channels, fatty tissue, and connective tissue. There are two omenta. First, is the greater omentum that hangs off of the small intestine and greater curvature of the stomach. The other is the lesser omentum that extends between the stomach and the liver.[1]

Clinical significance

Ascites

When fluid collects in the abdominal cavity it is called ascites. This is usually not noticeable until enough has collected to distend the abdomen. The collection of fluid will cause pressure on the viscera, veins, and the thoracic cavity. Treatment is directed at the cause of the fluid accumulation. One method is to decrease the portal vein pressure, especially useful in treating cirrhosis. Chylous ascites heals best if the lymphatic vessel involved is closed. Heart failure can cause recurring ascites.

Inflammation

Another disorder is called peritonitis which usually accompanies inflammatory processes elsewhere. It can be caused by damage to an organ, or from a contusion to the abdominal wall from the outside or by surgery. It may be brought in by the bloodstream or the lymphatic system. The most common origin is the gastrointestinal tract. Peritonitis can be acute or chronic, generalized, or localized, and may be have one origin or multiple origins. The omenta can help control the spread of infection; however without treatment, the infection will spread throughout the cavity. An abscess may form as a secondary reaction to an infection. Antibiotics have become an important tool in fighting abscesses; however external drainage is usually required also.

Kidneys

The kidneys (L., ren; Gk, nephros; hence the adjectives renal and nephric) belong to the urinary system, maintain the ionic balance of the blood, and excrete waste products as urine. They are reddish-brown organs covered by a thin, glistening, fibromuscular capsule that normally can be stripped off easily. Each kidney has anterior and posterior surfaces, upper and lower poles, and

lateral and medial borders. The medial border is indented at the hilus, where blood vessels enter and leave, and there the ureter emerges. Each kidney is composed of a paler cortex and a darker medulla (fig. 29-1). The kidneys lie obliquely along the vertebral column, abutting the psoas major muscles.

Relations (fig. 29-2).

The upper pole of the kidney is covered by the suprarenal gland. Anteriorly, the right kidney is related to the liver, duodenum, ascending colon or right colic flexure, and small intestine. The left is related to the spleen, stomach, pancreas, descending colon or left colic flexure, and small intestine. Posteriorly, the kidneys are related to rib 12 and the diaphragm, psoas major, quadratus lumborum, and transversus abdominis (see fig. 29-5).

The upper part of the kidney is usually separated by the diaphragm from the pleura and lung. In the vertebrocostal trigone, however, the kidney and pleura may be separated only by connective tissue (see fig. 25-13B).

Peritoneal relations.

The kidneys are retroperitoneal. Certain areas of each kidney are covered in anteriorly by peritoneum, whereas others are "bare" (fig. 29-2).

Surface Anatomy.

In the erect position, the kidneys are opposite the first four lumbar vertebrae; they are one vertebral level higher when the subject is recumbent. The right kidney is frequently a little lower than the left (probably because of the liver), and its lower pole may be palpable. The levels alter with respiration as well as with posture.

Hilus.

The hilus for the renal vessels and ureter is situated on the medial border and leads into a recess termed the renal sinus. The sinus contains the renal vessels and an expansion of the ureter termed the pelvis. Within the sinus, the ureteric pelvis usually divides into two or three short tubes, the major calices, each of which subdivides into 7 to 14 minor calices (fig. 29-3). Each minor calyx receives the openings of collecting tubules on papillae that project into the calices (see fig. 29-1).

Renal Pedicle.

The ureter and renal vessels near the hilus form the pedicle, important variations of which are common. The renal vein (figs. 29-2 and 29-4) is anterior, the ureter is posterior, and the arteries more or less between.

Renal Fascia (fig. 29-5).

The kidney is enclosed in a condensation of the extraperitoneal tissue termed the renal fascia. Its anterior layer continues across the median plane, whereas the posterior layer merges with the prevertebral connective tissue. The two layers are fused strongly superior to, and weakly inferior to the suprarenal gland. Perirenal (or perinephric) fat lies between the fascia and the renal capsule. Pararenal fat is situated external to the renal fascia.

Blood Supply and Lymphatic Drainage.

The renal arteries arise from the aorta, and the right one passes posterior to the inferior vena cava (see figs. 29-2 and 29-4). Renal segments based on the arterial distribution have been identified (fig. 29-6). The left renal vein, which is longer than the right, passes anteiro to the aorta and drains not only the kidney but also the suprarenal gland, gonad, diaphragm, and body wall (see fig. 29-4). Lymphatic drainage is into adjacent nodes and thence into lumbar nodes.

Innervation.

Extensions of the celiac (aorticorenal) and intermesenteric plexuses accompany the renal arteries, and the splanchnic nerves supply branches that include pain fibers from the ureteric pelvis (see figs. 30-4 and 32-6).

Congenital Anomalies.

Congenital anomalies of the kidneys include lobation (which is normally evident at birth), so-called accessory (e.g., polar) arteries, duplications (e.g., of ureters), ectopia and malrotation (e.g., pelvic kidney and horseshoe kidney), and cystic disease.

Ureters (see figs. 26-1, 29-1, and 29-3)

The ureter is a retroperitoneal, distensible muscular tube that connects the kidney with the bladder. In position, the upper half is abdominal, the lower half pelvic. The ureter commences as a dilatation, the pelvis, posterior to the renal vessels, and it descends on the psoas major. It crosses anterior to the bifrucation of the common iliac artery, courses along the lateral wall of the pelvis, and turns medially to reach the bladder. Near the ischial spine, the ureter turns downward, anteriorward, and medially just inferior to the uterine vessels, about 2 cm from the cervix (where it may be endangered in hysterectomy).

The ureter may be constricted (1) at the narrowing of the ureteric pelvis, (2) where it crosses the pelvic inlet, and (3) during its course through the wall of the bladder. These are potential sites of obstruction or for kidney stones to lodge.

The ureter is supplied by nearby arteries (renal, gonadal, and vesical) and from adjacent nervous plexuses (renal and hypogastric). Obstruction by a renal calculus (stone) causes acute distension and severe pain (renal colic). Depending on the level of obstruction, the pain of renal (actually ureteric) colic may be referred to the lumbar or the hypogastric region or to the external genitalia.

Suprarenal glands

The suprarenal glands are paired endocrine organs situated superior to the kidneys (hence suprarenal; c.f. epinephrine).

Each suprarenal gland consists of two distinct endocrine organs, the cortex and the medulla. Some of their hormones are essential to life. Each suprarenal gland is surrounded by renal fascia and lies on the superomedial aspect of the front of the kidney (see fig. 29-2). The right gland is in contact with the bare area of the liver and projects posterior to the inferior vena cava (see fig. 30-3). The left gland, a little different in shape, is related in front to the lesser sac, the splenic artery, and the pancreas (see fig. 26-6). Both glands lie against the diaphragm.

Accessory cortical tissue may sometimes be found near the kidney or in the pelvis. The suprarenal medulla is part of the chromaffin system, other portions of which are found near sympathetic ganglia along the abdominal aorta and are termed paraganglia or para-aortic bodies.

Blood Supply (see fig. 29-4).

The suprarenal glands are supplied by multiple and variable arteries (from the inferior phrenic and renal arteries and the aorta). The suprarenal vein emerges from a hilus and enters the inferior vena cava (right side) or the renal vein (left side).

Innervation.

The celiac plexus and splanchnic nerves supply branches. Most of the fibers are preganglionic sympathetic and synapse directly with the cells of the medulla.

Additional reading

Fourman, J., and Moffat, D. B., The Blood Vessels of the Kidney, Blackwell, Oxford, 1971. Renal vasculature in relation to function.

Graves, F. T., The Arterial Anatomy of the Kidney, Wright, Bristol, 1971. Anatomical studies as a basis for surgical technique.

Questions

29-1 Which level of the vertebral column would be crossed by a line joining the hili of the kidneys?

29-2 How may the kidney be approached surgically from the posterior side?

29-3 Where would a perinephric abscess be situated?

29-4 List some congenital anomalies of the kidneys.

29-5 Where is a ureter likely to be obstructed?

29-6 To where is the pain of renal colic referred?

29-7 The suprarenal glands are found posterior to which structures?

29-8 What are the cortical and chromaffin systems?

Figure legends

Figure 29-1 Coronal section of a kidney. (From Yokochi, C, Photographic Anatomy of the Human Body, Igaku Shoin, Ltd., Tokyo, 1971.)

Figure 29-2 Anterior relations of the kidneys. The areas covered by peritoneum are shown in blue. In addition to the renal vessels, the origins of the celiac, superior mesenteric, gonadal (testicular or ovarian), and inferior mesenteric arteries are included, as are the terminations of the gonadal veins.

Figure 29-3 Intravenous pyelogram. Note the calices, some of which are seen from the side and others end-on, and the pelves of the ureters, which differ in shape and level. (Courtesy of Sir Thomas Lodge, Sheffield, England.)

Figure 29-4 Renal and related vessels. A large area is drained by the left renal vein, which receives tributaries from the back, abdominal wall, diaphragm, suprarenal gland, and gonad.

Figure 29-5 Horizontal section through the abdomen to show renal fascia, as described in the text. The arrow indicates the lumbar approach to the kidney. Other features shown include the rectus sheath. (Cf. fig. 25-6.) See also fig. 40-1. (After Symington.)

Figure 29-6 Arterial segments of right kidney. The left is similar. (After Fourman and Moffat.) Interpretation of the posterior segment as two units (upper dorsal and lower dorsal) would provide a total of six arterial segments. The relationship between these and the four to nineteen lobes of the kidney has been examined in detail by Inke (in Vidrio, E. A., and Galina, M. A., eds., Advances in the Morphology of Cells and Tissues, Liss, New York, 1981, pp. 71-78).

Tendon vs. ligament

Tendons are strong and tough fibres that attach muscles to bones. Muscles move bones by pulling on tendons. Tendons allow you to move a bone by moving the muscle to which it is attached. For example, the Achilles tendon links the muscles in the lower leg to the heel. To move the heel, you simply contract the muscles in your lower leg. Tendons themselves do not stretch.

A tendon is a fibrous connective tissue which attaches muscle to bone. Tendons may also attach muscles to structures such as the eyeball. A tendon serves to move the bone or structure. A ligament is a fibrous connective tissue which attaches bone to bone, and usually serves to hold structures together and keep them stable.

The human skeletal system consists of 206 bones plus the muscles, joints, and the tissues that connect them all together.

The skeleton of an adult human consists of 206 bones. It is composed of 270 bones at birth, which decreases to 206 bones by adulthood after some bones have fused together.[1] Together, these bones form the axial skeleton and the appendicular skeleton. Many small and often variable bones, such as sesamoid bones and ossicles, are not included in this count.

The figure of 206 bones is commonly repeated, but does have some peculiarities in its method of counting. It is taken of an adult human—the number of bones in the skeleton changes with age, as multiple bones fuse, a process which typically reaches completion in the third decade of life. In addition, the bones of the skull and face are counted as separate bones, despite being fused naturally. Some reliablesesamoid bones such as the pisiform are counted, while others, such as the hallux sesamoids, are not.

Individuals may have more or fewer bones than this owing to anatomical variations. The most common variations include additional (i.e. supernumerary) cervical ribs or lumbar vertebrae. Sesamoid bone counts also may vary among individuals.

Skeletal System Anatomy

The skeletal system in an adult body is made up of 206 individual bones. These bones are arranged into two major divisions: the axial skeleton and the appendicular skeleton. The axial skeleton runs along the body's midline axis and is made up of 80 bones in the following regions:

- Skull
- Hyoid
- Auditory ossicles
- Ribs
- Sternum
- Vertebral column

The appendicular skeleton is made up of 126 bones in the folowing regions:

- Upper limbs
- Lower limbs
- Pelvic girdle
- Pectoral (shoulder) girdle

Skull The skull is composed of 22 bones that are fused together except for the mandible. These 21 fused bones are separate in children to allow the skull and brain to grow, but fuse to give added strength and protection as an adult. The mandible remains as a movable jaw bone and forms the only movable joint in the skull with the temporal bone.

The bones of the superior portion of the skull are known as the cranium and protect the brain from damage. The bones of the inferior and anterior portion of the skull are known as facial bones and support the eyes, nose, and mouth.

Hyoid and Auditory Ossicles The hyoid is a small, U-shaped bone found just inferior to the mandible. The hyoid is the only bone in the body that does not form a joint with any other bone—it is a floating bone. The hyoid's function is to help hold the trachea open and to form a bony connection for the tongue muscles.

The malleus, incus, and stapes—known collectively as the auditory ossicles—are the smallest bones in the body. Found in a small cavity inside of the temporal bone, they serve to transmit and amplify sound from the eardrum to the inner ear.

Vertebrae Twenty-six vertebrae form the vertebral column of the human body. They are named by region:

• Cervical (neck) - 7 vertebrae

• Thoracic (chest) - 12 vertebrae

• Lumbar (lower back) - 5 vertebrae

• Sacrum - 1 vertebra

• Coccyx (tailbone) - 1 vertebra

With the exception of the singular sacrum and coccyx, each vertebra is named for the first letter of its region and its position along the superior-inferior axis. For example, the most superior thoracic vertebra is called T1 and the most inferior is called T12.

Ribs and Sternum The sternum, or breastbone, is a thin, knife-shaped bone located along the midline of the anterior side of the thoracic region of the skeleton. The sternum connects to the ribs by thin bands of cartilage called the costal cartilage.

There are 12 pairs of ribs that together with the sternum form the ribcage of the thoracic region. The first seven ribs are known as “true ribs” because they connect the thoracic vertebrae directly to the sternum through their own band of costal cartilage. Ribs 8, 9, and 10 all connect to the sternum through cartilage that is connected to the cartilage of the seventh rib, so we consider these to be “false ribs.” Ribs 11 and 12 are also false ribs, but are also considered to be “floating ribs” because they do not have any cartilage attachment to the sternum at all.

Pectoral Girdle and Upper Limb The pectoral girdle connects the upper limb (arm) bones to the axial skeleton and consists of the left and right clavicles and left and right scapulae.

The humerus is the bone of the upper arm. It forms the ball and socket joint of the shoulder with the scapula and forms the elbow joint with the lower arm bones. The radius and ulna are the two bones of the forearm. The ulna is on the medial side of the forearm and forms a hinge joint with the humerus at the elbow. The radius allows the forearm and hand to turn over at the wrist joint.

The lower arm bones form the wrist joint with the carpals, a group of eight small bones that give added flexibility to the wrist. The carpals are connected to the five metacarpals that form the bones of the hand and connect to each of the fingers. Each finger has three bones known as phalanges, except for the thumb, which only has two phalanges.

Pelvic Girdle and Lower Limb Formed by the left and right hip bones, the pelvic girdle connects the lower limb (leg) bones to the axial skeleton.

The femur is the largest bone in the body and the only bone of the thigh (femoral) region. The femur forms the ball and socket hip joint with the hip bone and forms theknee joint with the tibia and patella. Commonly called the kneecap, the patella is special because it is one of the few bones that are not present at birth. The patella forms in early childhood to support the knee for walking and crawling.

The tibia and fibula are the bones of the lower leg. The tibia is much larger than the fibula and bears almost all of the body's weight. The fibula is mainly a muscle attachment point and is used to help maintain balance. The tibia and fibula form the ankle joint with the talus, one of the seven tarsal bones in the foot.

The tarsals are a group of seven small bones that form the posterior end of the foot and heel. The tarsals form joints with the five long metatarsals of the foot. Then each of the metatarsals forms a joint with one of the set of phalanges in the

toes. Each toe has three phalanges, except for the big toe, which only has two phalanges.

Microscopic Structure of Bones The skeleton makes up about 30-40% of an adult's body mass. The skeleton's mass is made up of nonliving bone matrix and many tiny bone cells. Roughly half of the bone matrix's mass is water, while the other half is collagen protein and solid crystals of calcium carbonate and calcium phosphate. Living bone cells are found on the edges of bones and in small cavities inside of the bone matrix. Although these cells make up very little of the total bone mass, they have several very important roles in the functions of the skeletal system. The bone cells allow bones to:

• Grow and develop

• Be repaired following an injury or daily wear

• Be broken down to release their stored minerals

Types of Bones All of the bones of the body can be broken down into five types: long, short, flat, irregular, and sesamoid.

• Long. Long bones are longer than they are wide and are the major bones of the limbs. Long bones grow more than the other classes of bone throughout childhood and so are responsible for the bulk of our height as adults. A hollow medullary cavity is found in the center of long bones and serves as a storage area for bone marrow. Examples of long bones include the femur, tibia, fibula, metatarsals, and phalanges.

• Short. Short bones are about as long as they are wide and are often cubed or round in shape. The carpal bones of the wrist and the tarsal bones of the foot are examples of short bones.

• Flat. Flat bones vary greatly in size and shape, but have the common feature of being very thin in one direction. Because they are thin, flat bones do not have a medullary cavity like the long bones. The frontal, parietal, and occipital bones of the cranium—along with the ribs and hip bones—are all examples of flat bones.

• Irregular. Irregular bones have a shape that does not fit the pattern of the long, short, or flat bones. The vertebrae, sacrum, and coccyx of the spine—as well as the sphenoid, ethmoid, and zygomatic bones of the skull—are all irregular bones.

• Sesamoid. The sesamoid bones are formed after birth inside of tendons that run across joints. Sesamoid bones grow to protect the tendon from stresses and strains at the joint and can help to give a mechanical advantage to muscles pulling on the tendon. The patella and the pisiform bone of the carpals are the only sesamoid bones that are counted as part of the 206 bones of the body. Other sesamoid bones can form in the joints of the hands and feet, but are not present in all people.

Parts of Bones The long bones of the body contain many distinct regions due to the way in which they develop. At birth, each long bone is made of three individual bones separated by hyaline cartilage. Each end bone is called an epiphysis (epi = on; physis = to grow) while the middle bone is called a diaphysis (dia = passing through). The epiphyses and diaphysis grow towards one another and eventually fuse into one bone. The region of growth and eventual fusion in between the epiphysis and diaphysis is called the metaphysis (meta = after). Once the long bone parts have fused together, the only hyaline cartilage left in the bone is found as articular cartilage on the ends of the bone that form joints with other bones. The articular cartilage acts as a shock absorber and gliding surface between the bones to facilitate movement at the joint.

Looking at a bone in cross section, there are several distinct layered regions that make up a bone. The outside of a bone is covered in a thin layer of dense irregular connective tissue called the periosteum. The periosteum contains many strong collagen fibers that are used to firmly anchor tendons and muscles to the bone for movement. Stem cells and osteoblast cells in the periosteum are involved in the growth and repair of the outside of the bone due to stress and injury. Blood vessels present in the periosteum provide energy to the cells on the surface of the bone and penetrate into the bone itself to nourish the cells inside of the bone. The periosteum also contains nervous tissue and many nerve endings to give bone its sensitivity to pain when injured.

Deep to the periosteum is the compact bone that makes up the hard, mineralized portion of the bone. Compact bone is made of a matrix of hard mineral salts reinforced with tough collagen fibers. Many tiny cells called osteocytes live in small spaces in the matrix and help to maintain the strength and integrity of the compact bone.

Deep to the compact bone layer is a region of spongy bone where the bone tissue grows in thin columns called trabeculae with spaces for red bone marrow in between. The trabeculae grow in a specific pattern to resist outside stresses with the least amount of mass possible, keeping bones light but strong. Long bones have a spongy bone on their ends but have a hollow medullary cavity in the middle of the diaphysis. The medullary cavity contains red bone marrow during childhood, eventually turning into yellow bone marrow after puberty.

Articulations An articulation, or joint, is a point of contact between bones, between a bone

and cartilage, or between a bone and a tooth. Synovial joints are the most common type of articulation and feature a small gap between the bones. This gap allows a free range of motion and space for synovial fluid to lubricate the joint. Fibrous joints exist where bones are very tightly joined and offer little to no movement between the bones. Fibrous joints also hold teeth in their bony sockets. Finally, cartilaginous joints are formed where bone meets cartilage or where there is a layer of cartilage between two bones. These joints provide a small amount of flexibility in the joint due to the gel-like consistency of cartilage.

Skeletal System Physiology

Support and Protection The skeletal system’s primary function is to form a solid framework that supports and protects the body's organs and anchors the skeletal muscles. The bones of the axial skeleton act as a hard shell to protect the internal organs—such as the brain and theheart—from damage caused by external forces. The bones of the appendicular skeleton provide support and flexibility at the joints and anchor the muscles that move the limbs.

Movement The bones of the skeletal system act as attachment points for the skeletal muscles of the body. Almost every skeletal muscle works by pulling two or more bones either closer together or further apart. Joints act as pivot points for the movement of the bones. The regions of each bone where muscles attach to the bone grow larger and stronger to support the additional force of the muscle. In addition, the overall mass and thickness of a bone increase when it is under a lot of stress from lifting weights or supporting body weight.

Hematopoiesis Red bone marrow produces red and white blood cells in a process known as hematopoiesis. Red bone marrow is found in the hollow space inside of bones known as the medullary cavity. Children tend to have more red bone marrow compared to their body size than adults do, due to their body’s constant growth and development. The amount of red bone marrow drops off at the end of puberty, replaced by yellow bone marrow.

Storage The skeletal system stores many different types of essential substances to facilitate growth and repair of the body. The skeletal system’s cell matrix acts as our calcium bank by storing and releasing calcium ions into the blood as needed. Proper levels of calcium ions in the blood are essential to the proper function of the nervous and muscular systems. Bone cells also release osteocalcin, a hormone that helps regulate blood sugar and fat deposition. The yellow bone marrow inside of our hollow long bones is used to store energy in the form of lipids. Finally, red bone marrow stores some iron in the form of the molecule ferritin and uses this iron to form hemoglobin in red blood cells.

Growth and Development The skeleton begins to form early in fetal development as a flexible skeleton made of hyaline cartilage and dense irregular fibrous connective tissue. These tissues act as a soft, growing framework and placeholder for the bony skeleton that will replace them. As development progresses, blood vessels begin to grow into the soft fetal skeleton, bringing stem cells and nutrients for bone growth. Osseous tissue slowly replaces the cartilage and fibrous tissue in a process called calcification. The calcified areas spread out from their blood vessels replacing the old tissues until they reach the border of another bony area. At birth, the skeleton of a newborn has more than 300 bones; as a person ages, these bones grow together and fuse into larger bones, leaving adults with only 206 bones.

Flat bones follow the process of intramembranous ossification where the young bones grow from a primary ossification center in fibrous membranes and leave a small region of fibrous tissue in between each other. In the skull these soft spots are known as fontanels, and give the skull flexibility and room for the bones to grow. Bone slowly replaces the fontanels until the individual bones of the skull fuse together to form a rigid adult skull.

Long bones follow the process of endochondral ossification where the diaphysis grows inside of cartilage from a primary ossification center until it forms most of the bone. The epiphyses then grow from secondary ossification centers on the ends of the bone. A small band of hyaline cartilage remains in between the bones as a growth plate. As we grow through childhood, the growth plates grow under the influence of growth and sex hormones, slowly separating the bones. At the same time the bones grow larger by growing back into the growth plates. This process continues until the end of puberty, when the growth plate stops growing and the bones fuse permanently into a single bone. The vast difference in height and limb length between birth and adulthood are mainly the result of endochondral ossification in the long bones.

skull

the skeletal structure of the head, composed of the facial and cranial bones. The skull houses and protects the brain and most of the chief sense organs; i.e., the eyes, ears, nose, and tongue. Among humans, some 14 bones shape the face, most occurring in symmetrical pairs. They are the lacrimals at the inner sides of the eyes, the nasals and nasal conchae of the nose, the palatines (palate), the zygomatics, or malars at the cheeks, the vomer (nasal septum), and the maxillae, or upper jaw. The mandible, or lower jaw, is not technically part of the skull. The adult human cranium, or braincase, is formed of fused skull bones: the parietals, temporals, ethmoid, sphenoid, frontal, and occipital.

These are separate plates of bone in the fetus, but by birth they have generally grown sufficiently for most of their edges to meet. The remaining separations are known as fontanels, the most prominent being the soft spot atop a newborn's

head. By the age of two years, all of these fontanels have been closed over by the growing cranial bones. However, the seams, or sutures, between the bones do not completely knit until the age of 20. The occipital bone at the base of the skull forms a complex joint with the first vertebra of the neck, known as the atlas, permitting rotation and bending of the head (see spinal column). Study of the fossil skulls of humans and their precursors has made important contributions to evolutionary theory, and to the science of physical anthropology. Earlier skulls of human ancestors, for instance, have been shown to have markedly smaller cranial capacities, as well as more powerful jaws, than do the Homo sapiens species which exist today.

Together, the brain and spinal cord form the central nervous system. This complex system is part of everything we do. It controls the things we choose to do -- like walk and talk -- and the things our body does automatically -- like breathe and digest food. The central nervous system is also involved with our senses -- seeing, hearing, touching, tasting, and smelling -- as well as our emotions, thoughts, and memory.

The brain is a soft, spongy mass of nerve cells and supportive tissue. It has three major parts: the cerebrum, the cerebellum, and the brain stem. The parts work together, but each has special functions.

The cerebrum, the largest part of the brain, fills most of the upper skull. It has two halves called the left and right cerebral hemispheres. The cerebrum uses information from our senses to tell us what's going on around us and tells our body how to respond. The right hemisphere controls the muscles on the left side of the body, and the left hemisphere controls the muscles on the right side of the body. This part of the brain also controls speech and emotions as well as reading, thinking, and learning.

The cerebellum, under the cerebrum at the back of the brain, controls balance and complex actions like walking and talking.

The brain stem connects the brain with the spinal cord. It controls hunger and thirst and some of the most basic body functions, such as body temperature, blood pressure, and breathing.

The brain is protected by the bones of the skull and by a covering of three thin membranes called meninges. The brain is also cushioned and protected by cerebrospinal fluid. This watery fluid is produced by special cells in the four hollow spaces in the brain, called ventricles. It flows through the ventricles and in spaces between the meninges. Cerebrospinal fluid also brings nutrients from the blood to the brain and removes waste products from the brain.

The spinal cord is made up of bundles of nerve fibers. It runs down from the brain through a canal in the center of the bones of the spine. These bones protect the spinal cord. Like the brain, the spinal cord is covered by the meninges and cushioned by cerebrospinal fluid.

Spinal nerves connect the brain with the nerves in most parts of the body. Other nerves go directly from the brain to the eyes, ears, and other parts of the head. This network of nerves carries messages back and forth between the brain and the rest of the body

The brain serves many important functions. It gives meaning to things that happen in the world surrounding us. Through the five senses of sight, smell, hearing, touch and taste, the brain receives messages, often many at the same time.

The brain controls thoughts, memory and speech, arm and leg movements, and the function of many organs within the body. It also determines how people respond to stressful situations (i.e. writing of an exam, loss of a job, birth of a child, illness, etc.) by regulating heart and breathing rates. The brain is an organized structure, divided into many components that serve specific and important functions.

The weight of the brain changes from birth through adulthood. At birth, the average brain weighs about one pound, and grows to about two pounds during childhood. The average weight of an adult female brain is about 2.7 pounds, while the brain of an adult male weighs about three pounds.

The Nervous System

The nervous system is commonly divided into the central nervous system and the peripheral nervous system. The central nervous system is made up of the brain, its cranial nerves and the spinal cord. The peripheral nervous system is composed of the spinal nerves that branch from the spinal cord and the autonomous nervous system (divided into the sympathetic and parasympathetic nervous system).

The Cell Structure of the Brain

The brain is made up of two types of cells: neurons and glial cells, also known as neuroglia or glia. The neuron is responsible for sending and receiving nerve impulses or signals. Glial cells are non-neuronal cells that provide support and nutrition, maintain homeostasis, form myelin, and facilitate signal transmission in the nervous system. In the human brain, glial cells outnumber neurons by

about 50 to one. Glial cells are the most common cells found in primary brain tumors.

When a person is diagnosed with a brain tumor, a biopsy may be done, in which tissue is removed from the tumor for identification purposes by a pathologist. Pathologists identify the type of cells that are present in this brain tissue, and brain tumors are named based on this association. The type of brain tumor and cells involved impact patient prognosis and treatment.

The Meninges

The brain is housed inside the bony covering called the cranium. The cranium protects the brain from injury. Together, the cranium and bones that protect the face are called the skull. Between the skull and brain is the meninges, which consist of three layers of tissue that cover and protect the brain and spinal cord. From the outermost layer inward they are: the dura mater, arachnoid and pia mater.

In the brain, the dura mater is made up of two layers of whitish, nonelastic film or membrane. The outer layer is called the periosteum. An inner layer, the dura, lines the inside of the entire skull and creates little folds or compartments in which parts of the brain are protected and secured. The two special folds of the dura in the brain are called the falx and the tentorium. The falx separates the right and left half of the brain and the tentorium separates the upper and lower parts of the brain.

The second layer of the meninges is the arachnoid. This membrane is thin and delicate and covers the entire brain. There is a space between the dura and the arachnoid membranes that is called the subdural space. The arachnoid is made up of delicate, elastic tissue and blood vessels of varying sizes.

The layer of meninges closest to the surface of the brain is called the pia mater. The pia mater has many blood vessels that reach deep into the surface of the brain. The pia, which covers the entire surface of the brain, follows the folds of the brain. The major arteries supplying the brain provide the pia with its blood vessels. The space that separates the arachnoid and the pia is called the subarachnoid space. It is within this area that cerebrospinal fluid flows.

Cerebrospinal Fluid

Cerebrospinal fluid (CSF) is found within the brain and surrounds the brain and the spinal cord. It is a clear, watery substance that helps to cushion the brain and spinal cord from injury. This fluid circulates through channels around the spinal cord and brain, constantly being absorbed and replenished. It is within hollow

channels in the brain, called ventricles, that the fluid is produced. A specialized structure within each ventricle, called the choroid plexus, is responsible for the majority of CSF production. The brain normally maintains a balance between the amount of CSF that is absorbed and the amount that is produced. However, disruptions in this system may occur.

The Ventricular System

The ventricular system is divided into four cavities called ventricles, which are connected by a series of holes called foramen, and tubes.

Two ventricles enclosed in the cerebral hemispheres are called the lateral ventricles (first and second). They each communicate with the third ventricle through a separate opening called the Foramen of Munro. The third ventricle is in the center of the brain, and its walls are made up of the thalamus and hypothalamus.

The third ventricle connects with the fourth ventricle through a long tube called the Aqueduct of Sylvius.

CSF flowing through the fourth ventricle flows around the brain and spinal cord by passing through another series of openings.

Brain Components and Functions

Brainstem – The brainstem is the lower extension of the brain, located in front of the cerebellum and connected to the spinal cord. It consists of three structures: the midbrain, pons and medulla oblongata. It serves as a relay station, passing messages back and forth between various parts of the body and the cerebral cortex. Many simple or primitive functions that are essential for survival are located here.

The midbrain is an important center for ocular motion while the pons is involved with coordinating eye and facial movements, facial sensation, hearing and balance.

The medulla oblongata controls breathing, blood pressure, heart rhythms and swallowing. Messages from the cortex to the spinal cord and nerves that branch from the spinal cord are sent through the pons and the brainstem. Destruction of these regions of the brain will cause "brain death." Without these key functions, humans cannot survive.

The reticular activating system is found in the midbrain, pons, medulla and part of the thalamus. It controls levels of wakefulness, enables people to pay attention to their environments, and is involved in sleep patterns.

Originating in the brainstem are 10 of the 12 cranial nerves that control hearing, eye movement, facial sensations, taste, swallowing and movements of the face, neck, shoulder and tongue muscles. The cranial nerves for smell and vision originate in the cerebrum. Four pairs of cranial nerves originate from the pons: nerves 5 through 8.

Cerebellum – The cerebellum is located at the back of the brain beneath the occipital lobes. It is separated from the cerebrum by the tentorium (fold of dura). The cerebellum fine tunes motor activity or movement, e.g. the fine movements of fingers as they perform surgery or paint a picture. It helps one maintain posture, sense of balance or equilibrium, by controlling the tone of muscles and the position of limbs. The cerebellum is important in one's ability to perform rapid and repetitive actions such as playing a video game. In the cerebellum, right-sided abnormalities produce symptoms on the same side of the body.

Cerebrum – The cerebrum, which forms the major portion of the brain, is divided into two major parts: the right and left cerebral hemispheres. The cerebrum is a term often used to describe the entire brain. A fissure or groove that separates the two hemispheres is called the great longitudinal fissure. The two sides of the brain are joined at the bottom by the corpus callosum. The corpus callosum connects the two halves of the brain and delivers messages from one half of the brain to the other. The surface of the cerebrum contains billions of neurons and glia that together form the cerebral cortex.

The cerebral cortex appears grayish brown in color and is called the "gray matter." The surface of the brain appears wrinkled. The cerebral cortex has sulci (small grooves), fissures (larger grooves) and bulges between the grooves called gyri. Scientists have specific names for the bulges and grooves on the surface of the brain. Decades of scientific research have revealed the specific functions of the various regions of the brain. Beneath the cerebral cortex or surface of the brain, connecting fibers between neurons form a white-colored area called the "white matter."

The cerebral hemispheres have several distinct fissures. By locating these landmarks on the surface of the brain, it can effectively be divided into pairs of "lobes." Lobes are simply broad regions of the brain. The cerebrum or brain can be divided into pairs of frontal, temporal, parietal and occipital lobes. Each hemisphere has a frontal, temporal, parietal and occipital lobe. Each lobe may be divided, once again, into areas that serve very specific functions.

The lobes of

the brain do not function alone – they function through very complex relationships with one another.

Messages within the brain are delivered in many ways. The signals are transported along routes called pathways. Any destruction of brain tissue by a tumor can disrupt the communication between different parts of the brain. The result will be a loss of function such as speech, the ability to read, or the ability to follow simple spoken commands. Messages can travel from one bulge on the brain to another (gyri to gyri), from one lobe to another, from one side of the brain to the other, from one lobe of the brain to structures that are found deep in the brain, e.g. thalamus, or from the deep structures of the brain to another region in the central nervous system.

Research has determined that touching one side of the brain sends electrical signals to the other side of the body. Touching the motor region on the right side of the brain, would cause the opposite side or the left side of the body to move. Stimulating the left primary motor cortex would cause the right side of the body to move. The messages for movement and sensation cross to the other side of the brain and cause the opposite limb to move or feel a sensation. The right side of the brain controls the left side of the body and vice versa. So if a brain tumor occurs on the right side of the brain that controls the movement of the arm, the left arm may be weak or paralyzed.

Cranial Nerves – There are 12 pairs of nerves that originate from the brain itself. These nerves are responsible for very specific activities and are named and numbered as follows:

1. Olfactory: Smell

2. Optic: Visual fields and ability to see

3. Oculomotor: Eye movements; eyelid opening

4. Trochlear: Eye movements

5. Trigeminal: Facial sensation

6. Abducens: Eye movements

7. Facial: Eyelid closing; facial expression; taste sensation

8. Auditory/vestibular: Hearing; sense of balance

9. Glossopharyngeal: Taste sensation; swallowing

10. Vagus: Swallowing; taste sensation

11. Accessory: Control of neck and shoulder muscles

12. Hypoglossal: Tongue movement

Hypothalamus – The hypothalamus is a small structure that contains nerve connections that send messages to the pituitary gland. The hypothalamus handles information that comes from the autonomic nervous system. It plays a role in controlling functions such as eating, sexual behavior and sleeping; and

regulates body temperature, emotions, secretion of hormones and movement. The pituitary gland develops from an extension of the hypothalamus downwards and from a second component extending upward from the roof of the mouth.

The Lobes

Frontal Lobes – The frontal lobes are the largest of the four lobes responsible for many different functions. These include motor skills such as voluntary movement, speech, intellectual and behavioral functions. The areas that produce movement in parts of the body are found in the primary motor cortex or precentral gyrus. The prefrontal cortex plays an important part in memory, intelligence, concentration, temper and personality.

The premotor cortex is a region found beside the primary motor cortex. It guides eye and head movements and a person’s sense of orientation. Broca's area, important in language production, is found in the frontal lobe, usually on the left side.

Occipital Lobes – These lobes are located at the back of the brain and enable humans to receive and process visual information. They influence how humans process colors and shapes. The occipital lobe on the right interprets visual signals from the left visual space, while the left occipital lobe performs the same function for the right visual space.

Parietal Lobes – These lobes interpret simultaneously, signals received from other areas of the brain such as vision, hearing, motor, sensory and memory. A person's memory and the new sensory information received, give meaning to objects.

Temporal Lobes – These lobes are located on each side of the brain at about ear level, and can be divided into two parts. One part is on the bottom (ventral) of each hemisphere, and the other part is on the side (lateral) of each hemisphere. An area on the right side is involved in visual memory and helps humans recognize objects and peoples' faces. An area on the left side is involved in verbal memory and helps humans remember and understand language. The rear of the temporal lobe enables humans to interpret other people's emotions and reactions.

Limbic System – This system is involved in emotions. Included in this system are the hypothalamus, part of the thalamus, amygdala (active in producing aggressive behavior) and hippocampus (plays a role in the ability to remember new information).

Pineal Gland – This gland is an outgrowth from the posterior or back portion of the third ventricle. In some mammals, it controls the response to darkness and light. In humans, it has some role in sexual maturation, although the exact function of the pineal gland in humans is unclear.

Pituitary Gland – The pituitary is a small gland attached to the base of the brain (behind the nose) in an area called the pituitary fossa or sella turcica. The pituitary is often called the "master gland" because it controls the secretion of hormones. The pituitary is responsible for controlling and coordinating the following:

- Growth and development
- The function of various body organs (i.e. kidneys, breasts and uterus)
- The function of other glands (i.e. thyroid, gonads, and adrenal glands)

Posterior Fossa – This is a cavity in the back part of the skull which contains the cerebellum, brainstem, and cranial nerves 5-12.

Thalamus – The thalamus serves as a relay station for almost all information that comes and goes to the cortex. It plays a role in pain sensation, attention and alertness. It consists of four parts: the hypothalamus, the epythalamus, the ventral thalamus, and the dorsal thalamus. The basal ganglia are clusters of nerve cells surrounding the thalamus.

Language and Speech Functions

In general, the left hemisphere or side of the brain is responsible for language and speech. Because of this, it has been called the "dominant" hemisphere. The right hemisphere plays a large part in interpreting visual information and spatial processing. In about one third of individuals who are left-handed, speech function may be located on the right side of the brain. Left-handed individuals may need specialized testing to determine if their speech center is on the left or right side prior to any surgery in that area.

Many neuroscientists believe that the left hemisphere and perhaps other portions of the brain are important in language. Aphasia is simply a disturbance of language. Certain parts of the brain are responsible for specific functions in language production. There are many types of aphasias, each depending upon the brain area that is affected, and the role that area plays in language production.

There is an area in the frontal lobe of the left hemisphere called Broca’s area. It is next to the region that controls the movement of facial muscles, tongue, jaw and throat. If this area is destroyed, a person will have difficulty producing the sounds of speech, because of the inability to move the tongue or facial muscles to form words. A person with Broca's aphasia can still read and understand spoken language, but has difficulty speaking and writing.

There is a region in the left temporal lobe called Wernicke's area. Damage to this area causes Wernicke's aphasia. An individual can make speech sounds, but they are meaningless (receptive aphasia) because they do not make any sense.

The ribs perform two functions in the body. They protects the heart and lungs, and (together with the diaphragm) control the movement of air in and out of the lungs. When the ribs move up, the chest cavity enlarges and air is sucked into the lungs. When they move down, air is forced out of the lungs.

The human rib cage is a component of the human respiratory system. It encloses the thoracic cavity, which contains the lungs. An inhalation is accomplished when the muscular diaphragm, at the floor of the thoracic cavity, contracts and flattens, while contraction of intercostal muscles lift the rib cage up and out.

Projection on the thoracic cage of the heart, the lungs and the diaphragm

Expansion of the thoracic cavity is driven in three planes; the vertical, the anteroposterior and the transverse. The vertical plane is extended by the help of the diaphragm contracting and the abdominal muscles relaxing to accommodate the downward pressure that is supplied to the abdominal viscera by the diaphragm contracting. A greater extension can be achieved by the diaphragm itself moving down, rather than simply the domes flattening. The second plane is the anteroposterior and this is expanded by a movement known as the 'pump handle.' The downward sloping nature of the upper ribs are as such because they enable this to occur. When the external intercostal muscles contract and lift the ribs, the upper ribs are able also to push the sternum up and out. This movement increases the anteroposterior diameter of the thoracic cavity, and hence aids breathing further. Finally, you have the transverse. In this situation, it involves mainly the lower ribs (some say it is the 7th-10th ribs in particular) with the diaphragm's central tendon acting as a fixed point. When the diaphragm contracts, the ribs are able to evert and produce what is known as the 'bucket handle' movement, facilitated by gliding at the costovertebral joints. In this way, the transverse diameter is expanded and the lungs can fill.

Breathing may be assisted by other muscles that can raise the ribs, such as sternocleidomastoid, pectoralis major and minor as well as the scalenes. While under most circumstances, individuals respire via eupnea(normal unlaboured breathing); exercise and other forms of physiological stress can cause the body

to require forced expiration, rather than the simple elastic recoil of the thoracic cage, lungs and diaphragm. In this case, muscles are recruited which can help depress the ribs and raise the diaphragm - such as the anterior abdominal wall muscles, excluding the transversus abdominis muscle. Latissimus dorsi can also aid deep, forced expiration.

Thoracic cage

Another way the thoracic cavity can expand during inhalation is called belly breathing. This also involves a contraction of the diaphragm, but the lower ribs are stabilized so that when the muscle contracts, rather than the central tendon remaining stable and lifting the ribs up, the central tendon moves down, compressing the sub-thoracic cavity and allowing the thoracic cavity and lungs room to expand downward.

These actions produce an increase in volume, and a resulting partial vacuum, or negative pressure, in the thoracic cavity, resulting in atmospheric pressure pushing air into the lungs, inflating them. An exhalation results when the diaphragm and intercostal muscles relax, and elastic recoil of the rib cage and lungs expels the air.

A bone is a rigid organ that constitutes part of the vertebralskeleton. Bones support and protect the various organs of the body, produce red and white blood cells, store minerals and also enable mobility. Bone tissue is a type of dense connective tissue. Bones come in a variety of shapes and sizes and have a complex internal and external structure. They are lightweight yet strong and hard, and serve multiple functions. Mineralized osseous tissue or bone tissue, is of two types – cortical and cancellous and gives it rigidity and a coral-like three-dimensional internal structure. Other types of tissue found in bones include marrow, endosteum, periosteum,nerves, blood vessels and cartilage.

In the human body at birth, there are over 270 bones,[1] but many of these fuse together during development, leaving a total of 206 separate bones in the adult,[2] not counting numerous smallsesamoid bones. The largest bone in the body is the thigh-bone (femur) and the smallest is the stapes in the middle ear.

Bone is not a uniformly solid material, but is mostly a matrix. The primary tissue of bone, osseous tissue, is relatively hard and lightweight. Its matrix is mostly made up of a composite material incorporating the inorganic mineral calcium phosphate in the chemical arrangement termed calcium hydroxylapatite (this is theosseous tissue that gives bones their rigidity) and organic collagen, an elastic protein which improves fracture resistance.[3] Bone is formed by the hardening of this matrix around entrapped cells. When these cells become entrapped from osteoblasts they become osteocytes.

The hard outer layer of bones is composed of cortical bone also called compact bone. Cortical referring to the outer (cortex) layer. The hard outer layer gives bone its smooth, white, and solid appearance, and accounts for 80% of the total bone mass of an adult skeleton.[citation needed]

Cortical bone consists of multiple microscopic columns, each called an osteon. Each column is multiple layers of osteoblasts andosteocytes around a central canal called the Haversian canal.Volkmann's canals at right angles connect the osteons together. The columns are metabolically active, and as bone is reabsorbed and created the nature and location of the cells within the osteon will change. Cortical bone is covered by a periosteum on its outer surface, and an endosteumon its inner surface. The endosteum is the boundary between the cortical bone and the cancellous bone.

Filling the interior of the bone is the cancellous bone also known as trabecular or spongy bone tissue.[4] It is an open cell porous network. Thin formations of osteoblasts covered in endosteum create an irregular network of spaces.[5] Within these spaces are bone marrow andhematopoietic stem cells that give rise to platelets, red blood cells andwhite blood cells.[5] Trabecular marrow is composed of a network of rod- and plate-like elements that make the overall organ lighter and allow room for blood vessels and marrow. Trabecular bone accounts for the remaining 20% of total bone mass but has nearly ten times the surface area of compact bone.

Bone marrow, also known as myeloid tissue, can be found in almost any bone that holds cancellous tissue. In newborns, all such bones are filled exclusively with red marrow, but as the child ages it is mostly replaced by yellow, or fatty marrow. In adults, red marrow is mostly found in the bone marrow of the femur, the ribs, the vertebrae and pelvic bones

Bone is a metabolically active tissue composed of several types of cells. These cells include osteoblasts, which are involved in the creation andmineralization of bone tissue, osteocytes, and osteoclasts, which are involved in the reabsorption of bone tissue. Osteoblasts and osteocytes are derived from osteoprogenitor cells, but osteoclasts are derived from the same cells that differentiate to form macrophages and monocytes.[7]Within the marrow of the

bone there are also hematopoietic stem cells. These cells give rise to other cells, including white blood cells, red blood cells, and platelets.

Calcium and phosphorous are minerals that give bones their strength. People must obtain these minerals from food. People who do not get enough of these minerals have brittle bones and they may become stooped when they grow old.

The consists of bones and cartilages of various types. Bones and cartilages are supporting connective tissues. They provide support, surface for the attachment of muscles and protection to many vital organs like brain, heart, eyes etc. and also give a definite form and shape of the body. Moreover the skeleton plays a vital role in locomotion and movements.

Cartilage is a more rubbery than bone witch is firm. It serves as a protective, cushioning layer where bones come together -- preventing them from rubbing against one another. Cartilage also makes a firm but flexible framework for the ear and respiratory passages, ensuring that these openings do not collapse.

Parts of a bone

The outer surface of a bone is called the periosteum. It is a very thin membrane that has nerves and blood vessels in it. They carry nutrients to the bones.

The compact bone is the smooth and very hard part of the bone. It is the part you see when you look at a skeleton.

Spongy bone is lighter than compact bone but it is still very strong. It looks like asponge or honeycomb with a lot of spaces in between.

The inside parts of a bone are hollow. They are filled with a jelly called bone marrow. In adults the long bones of the legs and arms are filled with yellow marrow. The ends have red marrow. It is the place where billions of new blood cells are produced every day.

When a child is born it has about 300 “soft” bones . As it grows up some of these bones grow together to form the 206 bones that a normal grown-up has. During childhood bones grow with the help of calcium. By the time you are about 20, bones stop growing.

The Spine and Chest

The spine is a special part of our skeleton. It has 26 small bones that look like rings and are linked together. These rings are called vertebrae. The spine lets you twistand bend your body and it holds your body upright. It also supports your head so that it can’t fall down. The spine protects the spinal cords which are the nerves that send information to the rest of your body.

Between each ring there are small soft discs. They keep the vertebrae fromrubbing against each other and act as a pillow, so when you jump into the air and come to the ground again it doesn’t hurt.

Ribs are a cage of bones that protect the most important organs: your heart, lungs,liver and others. You can feel your ribs by touching your chest.

Most people have twelve pairs of ribs that look the same on the right and left side. They are attached to the spine in the back. In the centre of your chest there is a strong bone called the sternum. It keeps your ribs in place, so that they don’t fall apart.

Skull

The bones in your head make up your skull. They protect your brain. Some bones in your skull are fixed, so that you can't move them. Others, like your jawbone can be moved. It opens and closes your mouth when you eat, talk or chew food.

Babies are born with spaces between the bones in their skull. As a baby grows thespaces disappear and the bones grow together.

Arms and hands

Your arms and hands make up a total of about 54 bones. They let you write, pick up things or throw a ball. Each arm is attached to a shoulder blade. There are two long bones in your arm which are connected through your elbow. These bones arewider at the ends and thinner in the middle.

The wrist connects the lower part of your arm with your hand. It is very flexible so you can twist it and turn it around in many directions. The hand is made up of smallseparate bones. Each finger has three bones, only your thumb has two.

Legs

A leg is made up of three bones. They are very large and strong and help supportthe weight of your body. They are connected to a group of bones called the pelvis, which supports the upper part of your body.

The longest bone of our body is the femur. It runs from the pelvis to the knee. The knee itself is protected by the kneecap. The ankle connects the lower part of your leg with your foot. The bones in your feet help you stand and balance your body.

Joints

A joint is a place that holds two bones together. Fixed joints don't move at all. Some of them are in your skull and in other parts of your body.

Moving joints allow you to twist, bend and move different parts of your body. Some of them let you move in only one direction, others allow you to move

freely in many directions. Joints have fluids in them, so they can work more easily and don't hurt.

Bone marrow is found in the hollow middle of bones. The cells of bone marrow -- the soft, fatty core of many bones -- produce red blood cells in the protected hollow space and release them into the bloodstream.

. The place where bones meet is called a joint. There are two basic kinds of joints. (1) Movable joints, such as the elbow, knee, and shoulder joints, permit varying degrees of motion. (2) Fixed joints do not permit any movement of the bones. The bones of the skull, except for the jawbones, meet in fixed joints.

Compact bone is the outer most part of the bone. It's dense, strong and made up of many layers. But bones are not solid all the way through- yellow marrow is found within the hallowed out walls of compact bone. Spongy bone is only found on the ends of bones. Spongy bone isn't really spongy; really it's hard but it has lots of holes- which gives it the appearance of a sponge. Spongy bone is where red marrow is kept. Spongy bone is where blood is made!

In compact bone, the cells are PACKED CLOSELY together, making the bone very strong. This is why compact bone is located at the outside of bones. Spongy bone cells are SPREAD APART, which allows canals filled with blood to run through the spongy bone. Spongy bone is found at the end of long bones. The difference between them is that they have different arrangement of bone cells.

Muscles are made up of many cell fibres joined together. These fibres can expand and contract, allowing the parts of the body to move.

. Muscles move the body only by pulling. They cannot push the tissues to which they are attached. Two sets of muscles control most movements -- one set of muscles pulls the bones in one direction, and the other set pulls the bones in the opposite direction. For example, one set of muscles pulls the forearm up, but it cannot push the forearm down. To lower the forearm, a second set of muscles must contract and pull it down.

Tendons are strong and tough fibres that attach muscles to bones. Muscles move bones by pulling on tendons. Tendons allow you to move a bone by moving the muscle to which it is attached. For example, the Achilles tendon links the muscles in the lower leg to the heel. To move the heel, you simply contract the muscles in your lower leg. Tendons themselves do not stretch.