

ZOO 366 - COMPARATIVE VERTEBRATE ANATOMY

MODULE	TOPIC
1.	GENERAL INTRODUCTION: -What is Anatomy? - Vertebrate Body Plan - Principa Body Axes -Principal Anatomical Planes -The Big Four Vertebrate Characteristics -Fate of Germ layers & Extraembryonic membrane
2.	SYSTEMS FOR SUPPORT PROTECTION & MOVEMENT: - Integumentary System (Integument proper & derivatives) - Skeletal System [Connective tissues, joints, dermal skeleton, endoskeleton (axial & appendicular skeletons)] - Muscular System [muscular tissues, Parietal Musculature (hypobranchial, eye muscles, appendicular musculature, diaphragm), Branchial musculature, Visceral musculature, Dermal musculature)
3.	INTEGRATING SYSTEMS: 1. NERVOUS SYSTEM: [CNS (Spinal cord & Brain), PNS (spinal nerves & cranial nerves-acousticolateralis system, branchial nerves, special sensory nerves, others) - Autonomic N.S. - Sympathetic N.S. - Parasympathetic N.S. 2. ENDOCRINE ORGANS: (Pituitary, Thyroid, Parathyroid, Adrenal glands, Testes, Ovaries, Placenta) 3. SENSE ORGANS: -Sight (eye); Hearing & equilibrium (ear), Olfactory (Nose), Taste (taste buds), Touch
4.	REPRODUCTIVE SYSTEM: -Reproductive Organs [Female organs (ovaries, oviducts), Male organs (testes, male ducts, copulatory organs, sperm types)
PRACTICALS ON MODULES 1 - 4	
5.	RESPIRATORY SYSTEM: 1. Respiratory Organs (Nasal passages, Pharyngeal pouches & gills, swim bladder, lungs & air ducts, trachea & bronchi) 2. Respiration Types (Pulmonary, Branchial, Cutaneous, Buccopharyngeal, Rectum & Cloaca) 3. Pharyngeal Derivatives (Non respiratory – thyroid, thymus & parathyroid glands, tonsils, middle ear & Eustachian tube)
6.	DIGESTIVE SYSTEM: (GENERAL STRUCTURE) - Mouth and its associated structures (lips, oral glands, tongue, teeth) - Pharynx – Oesophagus, Stomach (types & function), Intestine (differentiation into distinct regions), Digestive glands (liver, pancreas)
7.	EXCRETORY SYSTEM: - Major Excretory Organ [Kidney & types – Archinephros, Anamniote kidneys (Pronephros & Opisthonephros), Amniote Kidneys (Mesonephros & Metanephros)

	-Salt glands
8.	CIRCULATORY SYSTEM: <ul style="list-style-type: none"> - Hearts (morphogenesis and types) - Blood Vascular System (closed type), Lymphatic system, Blood & lymph, Blood forming tissues - Arterial System (Aortic Arches) - Venous system - Portal Circulation (hepatic, renal, hypophysio) - Fetal Circulation
PRACTICALS ON MODULES 5 – 8	
CONTINUOUS ASSESSMENT TEST (CAT)-ALL MODULES	

COMPARATIVE VERTEBRATE ANATOMY- PRACTICAL CLASSES

MODULE 1: VERTEBRATE CHARACTERISTICS: (Refer to your notes)

EXERCISE

1. Trace what becomes of the NOTOCHORD in the different vertebrates provided.
2. What becomes of the PHARYNGEAL POUCHES in the different vertebrates provided.
3. Examine Specimens A(dogfish) , B (tilapia)
 - (i) What is the modification of the pelvic fins of the males of specimen A called? Make a labelled diagram of the pelvic fins.
 - (ii) Which type of scales are found on specimen A? Make a labelled diagram of the scales
 - (iii) In what position is the mouth located on specimen A?
 - (iv) What is the fate of the first gill slit?
 - (v) What type of Caudal fin is present in specimen A? Make a labelled diagram of the caudal fin.
 - (vi) Specimen A belongs to Class _____
 - (vii) Where are the gill slits location in specimen B. Make a labelled diagram of the gill slits in specimen B
 - (viii) Which type of scale are found on the skin of specimen B. Make a labelled diagram of the scales.
 - (ix) Which type of caudal fin is present in specimen B. Make a labelled diagram of the caudal fin
 - (x) Specimen B belongs to Class _____

MODULE 2: TERMS FOR LOCATION/DIRECTION: Examine the diagrams provided and answer the questions below using the terms supplied CRANIAL, CAUDAL, SUPERIOR, INFERIOR, DORSAL, POSTERIOR, ANTERIOR, VENTRAL, LATERAL (Refer to your notes)

EXERCISE:

- a. In the cat the ears are _____ in location while this same structure in man are _____ in location.

- b. A structure towards the tail of cat is _____ while the same structure in man is located _____.
- c. The spinal cord in cat is _____ in location, while it is _____ in man.
- d. The nipples, ribs and sternum are _____ located in cat, while these same structures are located _____ in man.
- e. The limbs are located _____ in both cat and man

MODULE 3: PLANES AND SECTIONS OF THE BODY: These two terms are closely related. A section is a cut surface, while a plane is the abstract space where a section is cut through. A section/plane is defined by any two axes of the body. **SAGITTAL SECTION:** A longitudinal, vertical section from dorsal to ventral that passes through the median longitudinal axis of the body. **TRANSVERSE OR CROSS SECTION** is a cut across the body from dorsal to ventral and at right angles to the longitudinal axis. **FRONTAL or CORONAL SECTION** is one lying in the longitudinal axis and passing horizontally from side to side. (Check your notes)

EXERCISE

- a. Using the definitions above, cut a sagittal, transverse and frontal section through the trunk and tail region of the specimen C (fish).
- b. Make a labelled diagram of the cut surface.
- c. Examine the mammals provided (specimen D-rats, rabbits). What constitutes the facial region of the head?
- d. What constitutes the cranial region of the head?
- e. What are the covering of the eyes on the outside called. If this covering are cut away in a living mammal what happens to the eye and why?
- f. Where is the ear located on the mammals and what is the advantage of the positioning?
- g. What is the most conspicuous integumentary derivative in the mammals provided? What function does it perform?
- h. Eyelashes (cilia) are modifications of hair located on the _____
- i. Identify the brachium, antebrachium and manus in the pectoral appendage
- j. Identify femur, crus and pes in the pelvic appendageMs.

MODULE 4: INTEGUMENT (DERIVATIVES)

FISH: Major derivatives of the fish integument are chromatophores, scattered mucous gland cells and hardened dermal structures (bony scales). (Check your notes)

EXERCISE

- a. Remove the skin of the bony fish provided and observe under the low and higher magnifications of the microscope
- b. Identify what you see. Make a labelled diagram.
- c. Run your hand anteriorly over the surface of the dogfish provided. What can you feel?
- d. Use a hand lens to examine the skin of the dogfish. What do you see? And What are the tiny minute structures called?

MAMMALS: The integument of mammals has many derivatives. There are many gland cells – alveolar-shaped sebaceous glands, tubular sweat glands (sudoriferous glands) and mammary glands.

EXERCISE

- a. What are the modifications on the edges of eyelids called?
- b. What are the modifications around the snout of rabbit, rat and cat called?
- c. What are the modifications on the upper lip of man called?
- d. What are the modification on the chin of man called?
- e. Make a labelled diagram to show the first two modifications
- f. Stretch out your fingers. Observe and make a labelled diagram of your nails. N:B The word nail is derived from the Greek word *ungulae*
- g. Draw and label the hooves provided
- h. What does your nail nails have in common with the hooves?

MODULE 5: SKELETAL SYSTEM (PREPARATION OF VERTEBRATE SKELETON): Skeleton/bone preparation is both technical and artistic especially if the end result is to be articulated skeleton. In this practical session use mature specimens of rat, cat, bird (life or freshly killed). If life you need to sacrifice (kill) the animal as humanely as possible.

1. Skin and dismember the specimen, removing the head and legs
2. Cut off larger masses of flesh from the bones as much as possible
3. Immerse the whole specimen in simmering water or in a soap solution
N:B: Preparation of Soap solution
Ammonia (strong) 150ml
Hard Soap 75g
Potassium Nitrate 12g
Water 2000ml
4. Remove the specimen from the solution unto a dissecting board
5. Brush or scrape away the rest of the flesh
N:B: If you are interested in articulated skeleton (by ligaments). Check the skeleton frequently to be sure that the muscles are soft enough to be scraped off. If you are interested in disarticulated skeleton then there is no need for this constant check.
6. Degrease the bones for a day in turpentine, benzene or CCl₄ (this is poisonous so care should be taken)
7. Bleach the bones for a day or two in Hydrogen Peroxide.
8. After satisfactory cleaning and bleaching stretch out or mount the skeleton in the desired position before the preparation dries.

For further assistance check the STEP BY STEP GUIDE TO BONE ARTICULATION already given to you.

MODULE 6: SKELETAL SYSTEM: The SOMATIC or endoskeleton of vertebrates consists of AXIAL SKELETON (Skull, vertebral column, ribs, sternum and skull) + APPENDICULAR SKELETON (skeleton of the appendages).

EXERCISE 1: SKULL

- a. Examine the skulls provided. Identify the bones present in the skulls of crocodile, rabbit, monkey. Make labelled diagrams of frontal, lateral, dorsal, ventral and posterior views of the skulls.
- b. Identify premaxilla, maxilla, nasal, prefrontal, frontal, incisive, lacrimal, postorbital, ethmoid, temporal, coronoid process, parietal, squamosal, quadrotjugal, occipital, palatine, pterygoid, quadrate, tympanic bulla, foramen magnum, foramen rotundum, foramen ovale.
- c. What is the purpose of this structure?
- d. What is the purpose of the foramen magnum?
- e. Using a saw, cut a sagittal section through the midline of the skulls. Make a labelled diagram of this view. Identify cribiform plate and nasal conchae (turbinates). What are their functions in the vertebrates?
- f. Examine the lower jaw of rabbit and monkey. Make a labelled dorso-lateral and lateral views of the lower jaw. Compare and Contrast the two lower jaws.

EXERCISE 2: VERTEBRAL COLUMN: These are the bones in the longitudinal axis of the body of vertebrates excluding the skull, ribs, sternum and girdles.

- a. Kill the specimen (fish and reptile) provided. Tease as much of the muscles away from the vertebral column as possible. Separate the bones of the vertebral column.
- b. What are these bones called?
- c. Make labelled diagram of one of the bone from the trunk of fish and reptile.
- d. Identify the similarities and differences noted among the bones.
- e. Separate an intact vertebral column of rat into cervical, thoracic, lumbar, sacral and caudal
- f. Make labelled diagram of one bone from each section, identifying transverse processes, Diapophyses and parapophyses, prezygapophyses and postzygapophyses. Note similarities and differences.
- g. Kill the specimen (bird) provided. Dissect and tease the muscles away from the skeleton.
- h. Make a labelled diagram of the lateral view of the intact skeleton provided showing arrangement of the bony elements.
- i. Locate the intervertebral discs. Relate its function to its location.
- j. Differentiate between atlas and axis cervical.
- k. Identify the two girder structures, synsacrum and sternum (with keel). With the aid of a labelled diagram, trace their line of opposing force to show how they help to provide balance for the bird.
- l. Using a saw cut a T.S. of the long bones of the rabbit and bird. With the aid of a magnifying lens, make a labelled diagram of the cut surface.

EXERCISE 3: RIBS: The bone of the rib is called COSTA (=pl – COSTAE)

- a. Examine the mounted skeletons of cat, rabbit and bird
- b. How many ribs are present in each?
- c. How many of the their ribs are true ribs (vertebrosternal)?

- d. How many of their ribs are vertebrocostal ribs?
- e. How many of their ribs are vertebral ribs?
- f. Make labelled diagrams of different types of ribs

EXERCISE 4: STERNUM: The bony elements of the sternum are called STERNEBRAE

- a. Draw and label the sterna bone of the mounted skeletons provided. Identify the MANUBRIUM, THE BODY, XIPHISTERNUM, XIPHOID PROCESS.
- b. In many mammals the clavicles of the pectoral girdle articulate with the cranial end of the manubrium but not in cat. What advantage will this give to the cat during locomotion?

EXERCISE 5: GIRDLE: The girdle provide support for the appendages and brace it against the vertebral column. The two types of girdles are PECTORAL AND PELVIC GIRDLES.

- a. Gently tease out the pectoral and pelvic girdle and fin of fish provided. Make labelled diagrams
- b. Make labelled diagrams of Scapula with the forelimb attached to it from the mounted skeleton of dog provided.
- c. Draw the lateral view of the pelvis showing ilium, ischium, pubis, acetabulum and obturator foramen.
- d. Draw the anterior view of the pelvis showing the pubic symphysis. What is the importance of this joint in vertebrates.

EXERCISE 6: APPENDAGES:

- a. Identify the following bones humerus, ulna and radius. Give reasons for your identification.
- b. Make a labelled diagram of the caudal view of humerus and radius and lateral view of ulna.
- c. Identify the femur, tibia and fibula with reasons
- d. Make a labelled diagram of the caudal view of femur; cranial view of tibia and lateral view of fibula.

EXERCISE 7: MANUS (HAND):

- a. Study the Manus (hand) of the rat or cat
- b. Make labelled diagrams showing the different regions and bones. The bones include the following:
 - i. Carpus (Wrist) - two rows of carpal bones; first row consist of large medial SCAPHOLUNAR in cat (which is made up of fused radiale, intermedium and a central) and smaller TRIQUETRUM (ulnare) and a large laterally placed caudally projecting PISIFORM (sesamoid bone)
 - ii. Distal row - checking from medial to lateral: TRAPEZIUM (distal carpal 1), TRAPEZOID (distal carpal 2), CAPITATE (distal carpal 3) and HUMATE (distal carpal 4)
 - iii. Five metacarpals (these formed the palm)

- iv. Phalanges (free parts of fingers). The general formula of digits starting at the thumb is 2,3,4,5,3.

EXERCISE 8: PES (FOOT):

- a. Study the PES (foot) of the rat or cat
- b. Make labelled diagrams showing different regions and bones. The bones include the following:
 - i. Tarsus (Ankle) – consisting of TALUS (articulates with tibia and fibula and is homologous to tibiale, intermedium and one central); CALCANEOUS (heel bone – fibulare, caudally projecting); NAVICULAR (centrale, lies distal to the talus);
 - ii. A row of four bones distal to navicular and calcaneous which are arranged from medial to lateral in this fashion – MEDIAL CUNEIFORM (distal tarsal 1); INTERMEDIATE CUNEIFORM (distal tarsal 2); LATERAL CUNEIFORM (distal tarsal 3); CUBOID (distal tarsal 4)
 - iii. Five elongated METATARSALS (sole of the foot)
 - iv. PHALANGES (toes) – the first toe is lost in the cat and its metatarsal reduced to a small nubbin of bone articulated with the medial cuneiform.

MODULE 7: LOCOMOTION

EXERCISE 1: FLIGHT: The bird and bat are the only group of vertebrates that possess the true power of flight.

- a. Examine the bird and bat provided carefully. Extend the wing and study it in conjunction with the diagrams provided.
- b. What modifications occur in the manus for flight to occur.
- c. How has the general body shape suited these vertebrates to this mode of locomotion viz wind dynamics.

EXERCISE 2: TERRESTRIAL LOCOMOTION: Terrestrial locomotion among vertebrates can be categorized into crawling, hopping, walking and running. Hence animals are grouped accordingly into CRAWLERS, CURSORS (bipedal and quadripedal, WALKERS, TROTTERS), SALTATORS (JUMPERS – pushing off the ground with the hindlimb and landing on the forelimb), RICOCHETAL (pushing of the ground with and landing on the hindlimb without forelimb touching the ground). Furthermore, based on their standing and walking posture they can be grouped into PLANTIGRADE (sole walker), DIGITIGRADE (toe walkers) and UNGULIGRADE (hoof walker)

- a. Examine the skeleton of cat, rabbit, dog and the diagrams provided.
- b. Categorise their postures and walking style and locomotion type using the above terms

EXERCISE 3: GRASPING: If the thumb is removed will grasping be possible? Examine the diagrams provided, which of the hands will enable the bearer to climb well and easily?

MODULE 8: MUSCULAR SYSTEM: Muscles can be classified as STRIATED VS SMOOTH based on direction of fibres or histological structure; VOLUNTARY VS INVOLUNTARY based on general type of

innervations and **SKELETAL VS NON-SKELETAL** based on phylogeny or their mode of embryonic development in lower vertebrates.

For the purpose of anatomical studies this last method of grouping muscles is adopted, hence we have

- a. **SOMATIC MUSCLES (Parietal)** or skeletal muscles associated with outer tubes of the body and are correlated to the somatic skeleton. The **SOMATIC MUSCLES** are further subdivided into **AXIAL** and **APPENDICULAR**.
- b. **VISCERAL MUSCLES (Non-skeletal)** associated with the inner tube of the body and are correlated to the visceral skeleton

EXERCISE 1 FISHES (TRUNK MUSCLES): The bulk of the musculature of fishes belong to the axial group of somatic muscles of the trunk and tail.

- a. Remove a wide strip of skin from the posterior portion of the tail and another from the front of the trunk between the pectoral and anterior dorsal fins from middorsal to mid ventral lines of the body.
- b. Study and make labelled diagram of the lateral view of the group of myomeres
- c. Remove one myomere and draw a labelled diagram of it.
- d. identify the **EPAXIAL** and **HYPAXIAL** muscles in your myomeres.
- e. How do you arrive at your identification?

EXERCISE 2 LIZARDS (TRUNK MUSCLES)

- a. Kill and dissect the lizards and rats provided.
- b. Remove the skin very carefully to expose the musculature and eyeball. Study the musculature in-situ (in place)
- c. Draw the lateral view of the skinned lizard, identifying the following muscles: **EXTERNAL OBLIQUE, INTERNAL OBLIQUE, TRANSVERSE ABDOMINAL MUSCLE, TRAPEZIUS, DORSALIS SCAPULAE, LATISSIMUS DORSI,**

EXERCISE 3 MAMMALS – RATS, RABBITS or CATS:

- a. Lay your specimen on its belly. Make a middorsal incision through the skin extending from back of the head to the base of the tail.
- b. Make additional cut (incision) from this cut above around the neck; around the tail, anus and external genitals down the lateral surface of each leg and around the wrists and ankles.
- c. Gradually separate the skin from the underlying muscles by tearing through the superficial fascia with a pair of blunt forceps.
- d. Notice the **CUTANEOUS TRUNCI** (brown line that adhere to the undersurface of skin and **CUTANEOUS BLOOD VESSELS** and **NERVES** (cut them).
- e. Complete your skinning and clean away excessive fat and superficial muscles of the caudal trunk.

EXERCISE 4: HYPAXIAL MUSCLES OF THE CAUDAL TRUNK:

- a. Identify the **HYPAXIAL** muscles of the caudal trunk: The muscles are as follows:

- i. THORACOLUMBAR FASCIA (the wide tough sheet covering the lumbar region on the back).
 - ii. EXTERNAL OBLIQUE (the outermost layer of the abdominal muscle) – its fibres extend obliquely caudally and ventrally to insert by an APONEUROSIS along the length of the LINEA ALBA.
 - III. INTERNAL OBLIQUE (lies beneath the external oblique) – fibres extend obliquely ventrally and slightly cranial at right angles to the fibres of the external oblique and lead into a wide aponeurosis that inserts along the linea alba.
 - iv. TRANSVERSUS ABDOMINIS – fibres extend ventrally and slightly caudally to insert along the linea alba by a narrow aponeurosis
 - v. RECTUS ABDOMINIS – longitudinal band of muscle lying lateral to the midventral line under the internal oblique.
- b. Make a labelled diagram of the ventral view of the abdominal muscle layer on the left side of the cat
 - c. What are the functions of these muscles?

EXERCISE 5: PECTORALIS GROUP OF MUSCLES:

- a. identify the PECTORALIS GROUP of muscles: they are as follows:
 - i. CLEIDOBRACHIALIS muscle (front of shoulder cranial to the pectoral complex)
 - ii. PECTORALIS SUPERFICIALIS (PECTORALIS MAJOR in man)
 - iii. PECTORALIS PROFUNDUS (PECTORALIS MINOR in man)
 - iv. PECTORALIS DESCEDENS
 - V. PECTORALIS TRANSVERSUS
- b. Make a labelled diagram of the ventral view of the pectoral and neck muscles.
- c. Which of the two muscles, pectoralis superficialis and profundus, is the largest in rat?
- d. What are the major functions of these pectoralis complex muscles?

EXERCISE 6: TRAPEZIUS and STERNOCLEIDOMASTOID GROUP OF MUSCLES

- a. Identify the TRAPEZIUS and STERNOCLEIDOMASTOID GROUP and they are as follows:
 - i. THORACIC TRAPEZIUS - a thin sheet of muscle covering the cranial part of the LATISSIMUS DORSI.
 - ii. CERVICAL TRAPEZIUS – lies cranial to the thoracic trapezius, its fibres converge to insert on the ventral portion of the scapula spine and its metacromion process
 - iii. CLEIDOBRACHIALIS
 - iv. STERNOMASTOID – arises from MANUBRIUM, extends cranially and dorsally to insert on the mastoid region of the skull.
 - v. CLEIDOMASTOID – extending from the clavicle to the mastoid region of the skull
- b. What are the functions of this group of muscles?
- c. Make a labelled diagram of the lateral view of the pectoral, neck and head muscles of the rat or cat.

EXERCISE 7: APPENDICULAR MUSCLES (BRACHIAL MUSCLES):

- a. Identify the following BRACHIAL MUSCLES:
 - i. TENSOR FASCIAE ANTEBRACHII – closely associated with the TRICEPS BRACHII
 - ii. TRICEPS BRACHII – has three main heads, long head, lateral head and medial head.
 - iii. BICEPS BRACHII – on the anteromedial surface of the humerus
 - iv. BRACHIORADIALIS
 - v. EXTENSOR CARPI RADIALIS COMPLEX – longus and brevis
 - vi. EXTENSOR CARPI ULNARIS
 - vii. EXTENSOR DIGITORIUM COMMUNIS
 - viii. EXTENSOR DIGITORIUM LATERALIS
 - ix. FLEXOR DIGITORIUM PROFUNDUS (ulnar head)
 - x. ABDUCTOR POLLICIS LONGUS
- b. Make a labelled diagram of the lateral and medial view of the extensor and flexor muscles of the forearm of the rat or cat.
- c. What are their functions?

EXERCISE 8: APPENDICULAR MUSCLES (PELVIC and THIGH MUSCLES):

- a. Identify the following PELVIC and THIGH muscles:
 - i. SARTORIUS – a band extending from the crest and ventral border of the ilium (origin) to the patella and medial side of the thigh.
 - ii. TENSOR FASCIAE LATAE – lies on the lateral surface of the thigh.
 - iii. BICEPS FEMORIS – covers the lateral surface of the thigh caudal to fascia lata.
 - iv. SEMITENDINOSUS – lies caudal to the origin of the biceps.
 - v. CAUDOFEMORALIS – cranial and dorsal to the origin of biceps
 - vi. GLUTEUS SUPERFICIALIS – arises from the sacral fascia and from the spinosus processes of sacral and anterior caudal vertebrae
 - vii. GLUTEUS MEDIUS – lies partly or entirely deep to the superficialis, arises from the crest and lateral surface of the ilium and adjacent vertebrae
 - viii. GLUTEUS PROFUNDUS (corresponds to the gluteus minimus of man)
- b. Make a labelled diagram of the lateral view of the pelvic and thigh muscle of cat or rat.
- c. What are their functions?

EXERCISE 9: APPENDICULAR MUSCLES (QUADRICEPS FEMORIS COMPLEX):

- a. Identify the following muscles:
 - i. GRACILLIS
 - ii. SEMIMEMBRANOSUS PROPRIUS
 - iii. PECTINEUS
 - iv. ADDUCTOR LONGUS
 - v. ADDUCTOR BREVIS ET MAGNUS

- vi. VASTUS MEDIALIS
- vii. RECTUS FEMORIS
- viii. VASTUS INTERMEDIUS
- b. Make a labelled diagram of the medial view of the thigh muscles of cat or rabbit
- c. What are the functions of these muscles?

EXERCISE 10: HEAD and NECK MUSCLES:

- a. identify the following HEAD and NECK muscles:
 - i. TEMPORALIS
 - ii. MASSETER
 - iii. CLEIDO-OCCIPITALIS
 - iv. CLEIDOMASTOIDEUS
 - v. STERNOMASTOIDEUS
 - vi. DIGASTRICUS

MODULE 9: LEVER SYSTEMS IN OUR BODY: As in Physical Science, movement by animals, vertebrates in this case is also dependent on lever systems of arrangement bones, joints and muscles. Hence terms like axis, fulcrum, load can be applicable to motion in vertebrates too.

EXERCISE 1: LEVER OF THE FIRST CLASS:

- a. Nod your head as in saying yes or agreement to something
 - i. What makes this above movement possible?
 - ii. Where is the FULCRUM of this lever?
 - iii. Where is the LOAD or RESISTANCE?
 - iv. Where is the EFFORT

EXERCISE 2: LEVER OF THE SECOND CLASS:

- a. Lift your heels off the ground and stand on the balls of your feet.
 - i. Where is the fulcrum?
 - ii. Where is the load or resistance?
 - iii. Where is the effort?

EXERCISE 3: LEVER OF THE THIRD CLASS:

- a. Lift a weight with your lower arm and bend the arm at the elbow
 - i. Where is the fulcrum?
 - ii. Where is the load?
 - iii. Where is the effort?

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