

Practical Animal Biology

CHAPTER I

The Protozoa are the simplest and most primitive animals. They live either singly or in colonies. Some are parasitic. They are usually defined as "unicellular" animals.

Amoeba

Habitat: freshwater ponds.

Means of locomotion: pseudopodia.

Reproduction mechanism: asexually by binary fission, and under unfavourable conditions it encysts.

Shape and characteristics: quite irregular in shape; the body changes its shape constantly with the formation and withdrawal of the pseudopodia.

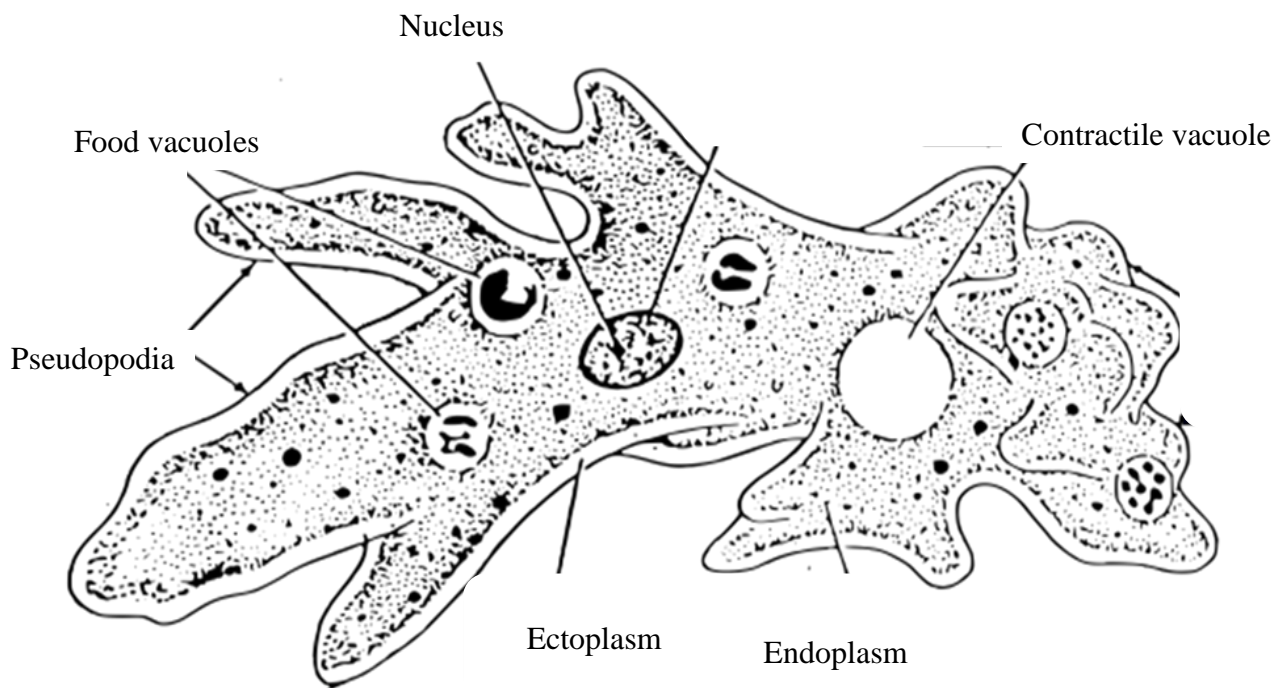
Kingdom :Protista

Phylum: Sarcomastigophora

Subphylum: Sarcodina

Genus : *Amoeba*

Species : *proteus*



Draw:

Draw under the microscope:

Entamoeba coli* & *Entamoeba histolytica

1. ***Entamoeba histolytica***: causes amoebic dysentery.

Life cycle:

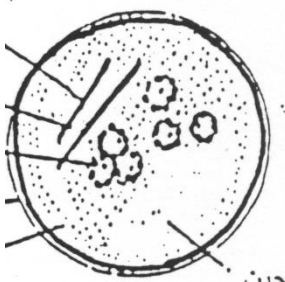
- a) **The trophozoite**: (feeding-dividing form). It has one pseudopodia.
- b) **Cyst**: have 4 nuclei (infective stages).

- **Infective stage**: Cyst.
- **Mode of infection**: contamination of food and water with cyst.
- **Characteristic features**: Cyst have 4 nuclei.

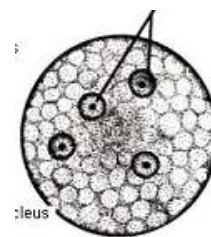
2. ***Entamoeba coli***: does not cause any known disease.

Habitat: large intestine of human.

Characteristics: mature cysts have 8 nuclei



***Entamoeba coli* Cyst**



***Entamoeba histolytica* Cyst**

Kingdom :Protista

Phylum: Sarcomastigophora

Subphylum: Sarcodina

Genus: *Entamoeba*

Species: *Entamoeba coli*

Speices: *Entamoeba histolytica*

Draw:

Entamoeba coli Cyst

Entamoeba histolytica Cyst

Draw under the microscope:

Entamoeba coli Cyst

Entamoeba histolytica Cyst

Euglena

Habitat: ponds and stagnant water.

Characteristics: Green in colour (have chloroplasts)

Means of locomotion: flagellum

Reproduction: asexually by longitudinal binary fission and is able to form a cyst.

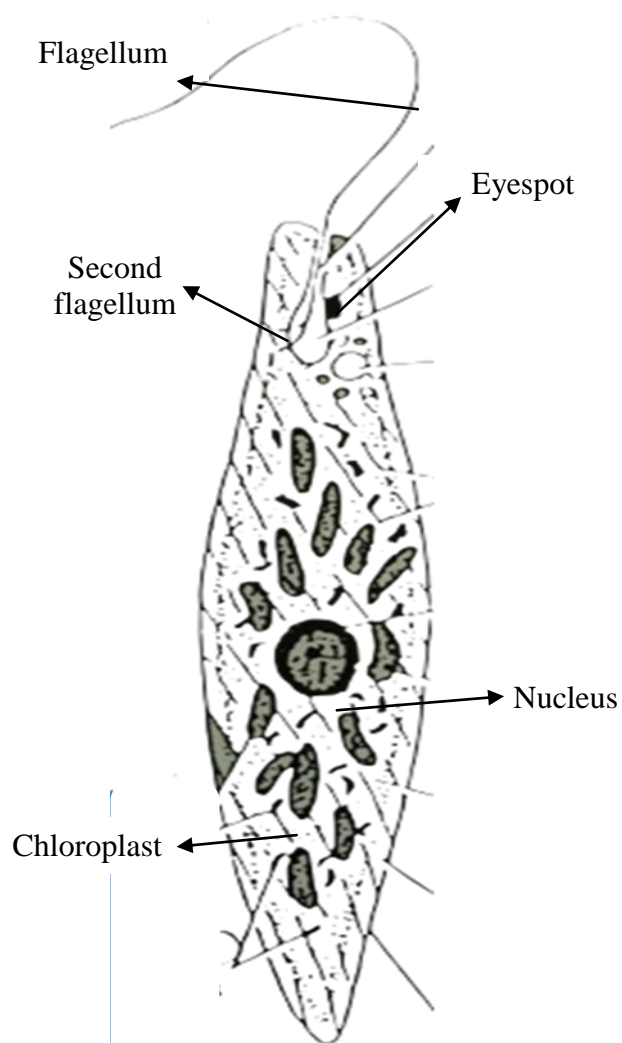
Kingdom :Protista

Phylum : Sarcomastigophora

Subphylum : Mastigophora

Class : Phytomastigophora

Genus : *Euglena*



Draw:

Draw under the microscope:

Paramecium

Means of locomotion: cilia

Habitat: freshwater ponds where decaying organic matter is abundant, feeding on it and on bacteria and other micro-organisms.

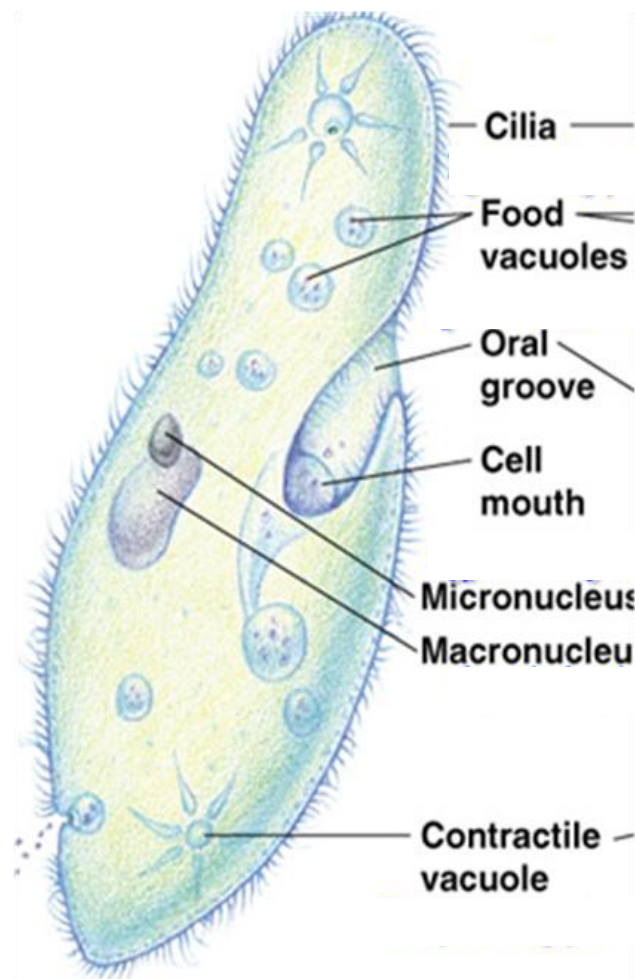
Reproduction: asexually by transverse binary fission, and sexually by conjugation .

Characteristics: the numerous cilia covering the whole surface of the body. They have two contractile vacuoles and two nuclei: a large oval macronucleus (for vegetative functions), and a small micronucleus (for reproduction).

Kingdom : Protesta

Phylum: Ciliophora

Genus: *Paramecium*



Draw:

Draw under the microscope:

Trypanosoma

Intermediate host: insect or leech

Habitat in intermediate host: alimentary canal

Definite host: human.

Habitat in definite host: blood of man

Causes the disease: sleeping sickness.

General body form:

Means of locomotion: flagellum.

Feeding habits: absorbing the nutrient substances from the host.

Reproduction: reproduce asexually by longitudinal binary fission.

Major characteristics: long slender, undulating a whip-like flagellum.

Kingdom : Protista

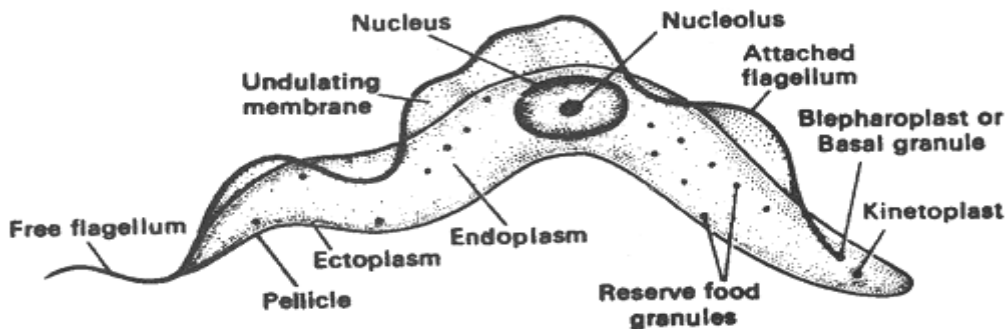
Phylum: Sarcomastigophora

Supylum: Mastigophora

Class: Zoomastigophora

Genus: *Trypanosoma*

Species: *gambiense*



Trypanosoma gambiense

Draw:

Draw under the microscope:

Plasmodium malariae

Trophozoite:

Habitat: live intracellularly in the blood corpuscles of its vertebrate host.

Causes the disease: malaria fever to man.

Vector: a mosquito belonging to the genus Anopheles.

Life cycle:

1. Ring stage
2. Trophozoite
3. Merzoites stage
4. Release of merozoites.

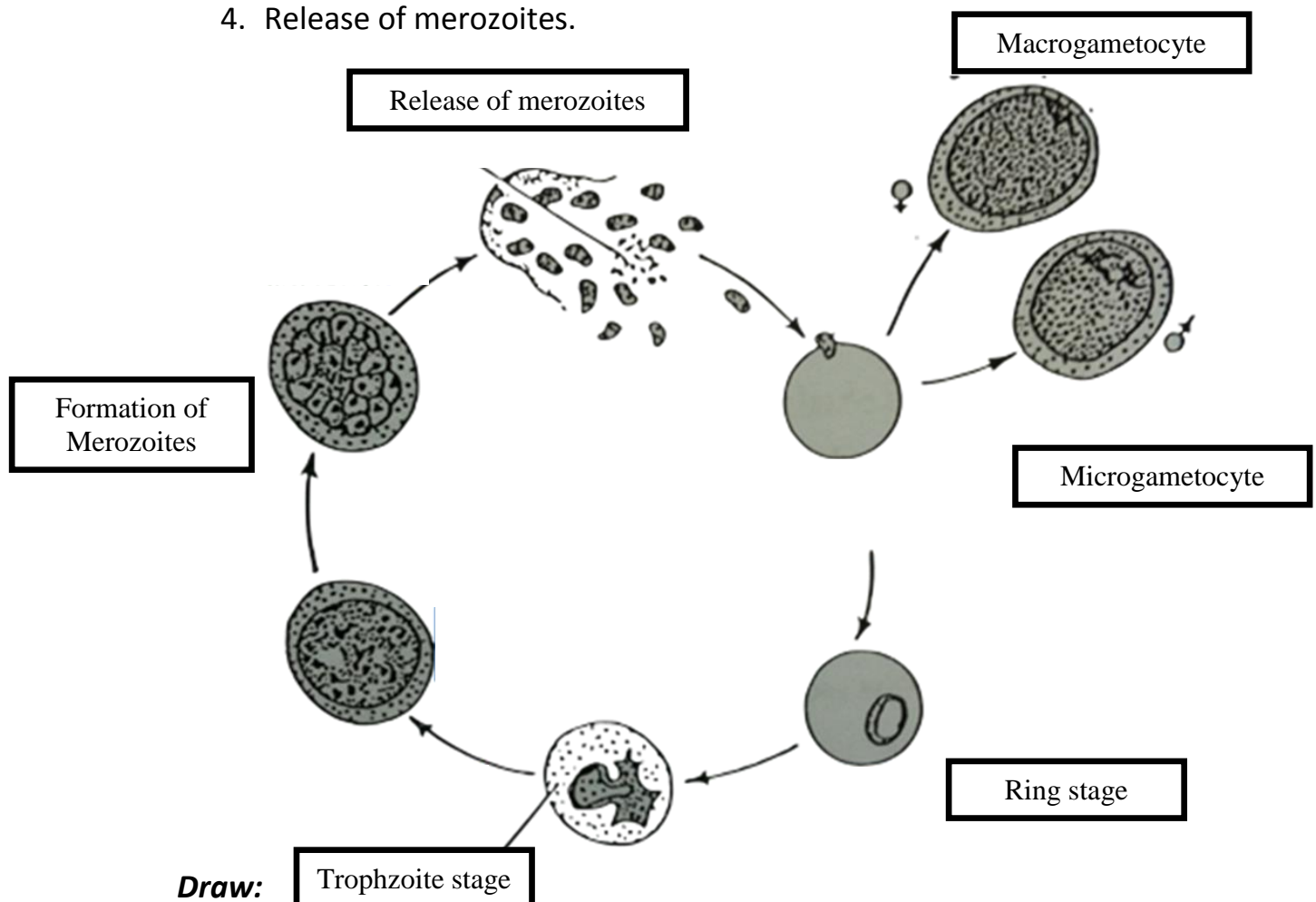
Kingdom: protista

Phylum: Apicomplexa

Class: Sporozoa

Genus: plasmodium

Species: *Plasmodium malariae*



Draw under the microscope:

Sponges

Features:

- Sponges are sessile with porous bodies and choanocytes
- The germ layers of sponges are not really tissues because the cells are relatively unspecialized.
- Sponges lack nerves or muscles.
- Most sponges are marine and some live in fresh water.
- The body of a sponge consists of two cell layers separated by a gelatinous region, the mesohyl.
- Most sponges are hermaphrodites, with each individual producing both sperm and eggs.
- The body of a simple sponge resembles a sac perforated with holes.
- Nearly all sponges are suspension feeders, collecting food particles from water.
- **types of sponges**
- There are 3 types: the ascon, sycon and leucon types, according to the structural complexity of the body, the first being the simplest

Kingdom: Animalia

Sub Kingdom: Parazoa

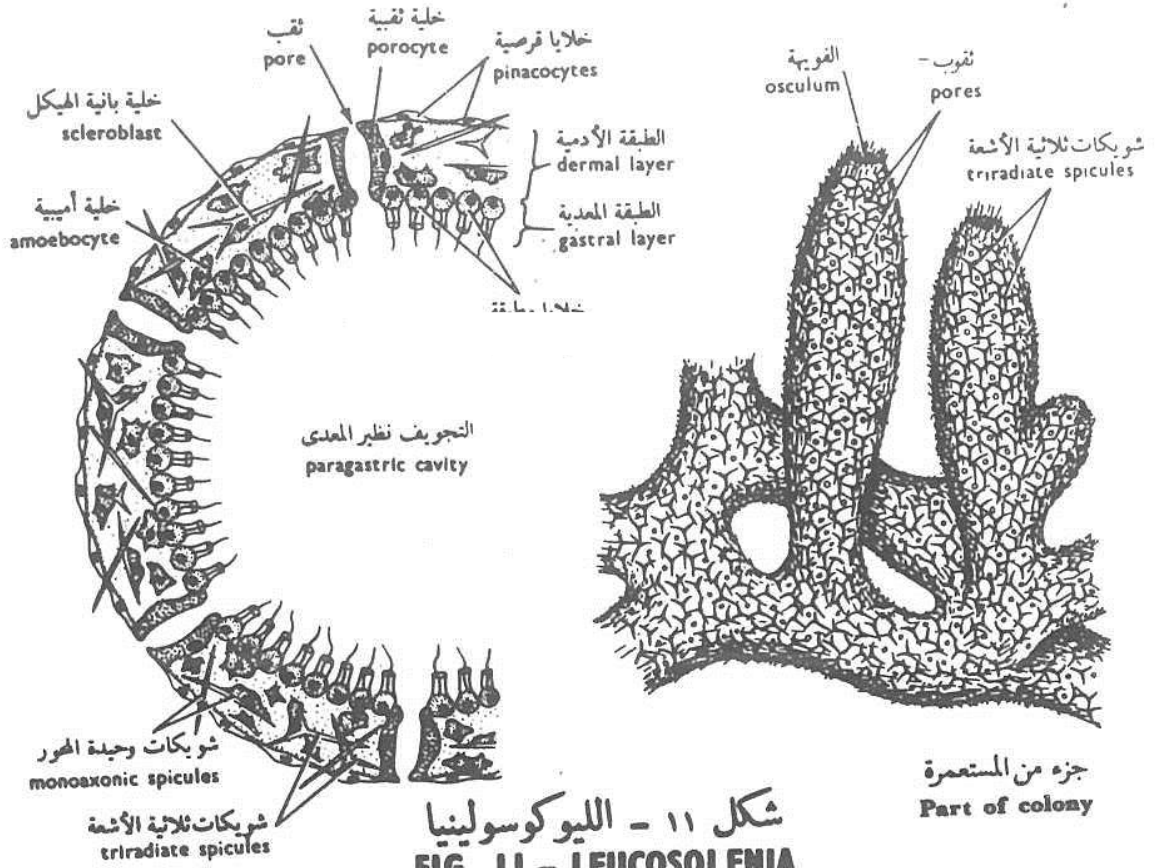
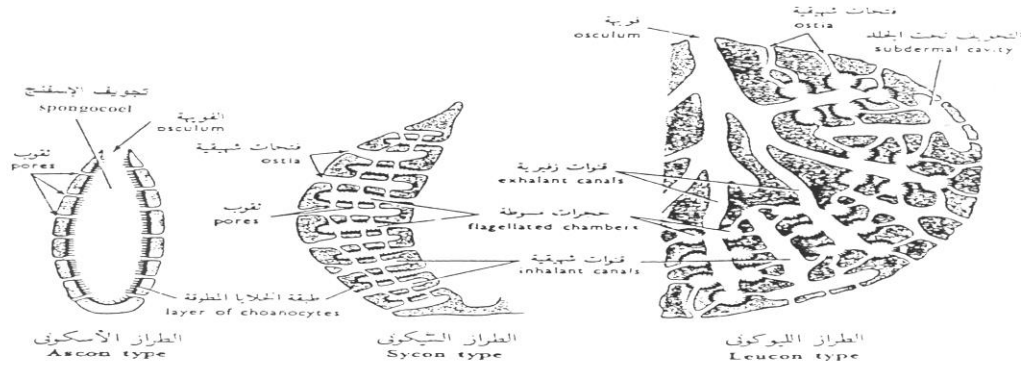
Phylum: Porifera

Example: Sponges

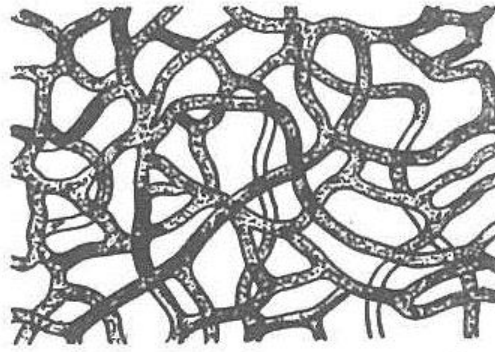
أشكال طرز الإسفنج الثلاثة



تركيب طرز الإسفنج الثلاثة الرئيسية



Draw:



الألياف الإسفنجية من إسفنج الحمام
Spongin fibres from bath sponge

Draw under the microscope:

Hydra

belong to the subkingdom Metazoa. They are radial symmetrical animals, mostly marine, solitary or colonial and sedentary or free-swim. They are also diplobiastic, that is, their body is built up of two cellular layers only, an outer ectoderm and an inner endoderm,.

Kingdom: Animalia

Subkingdom: Metazoa

Division: Diplobiastic

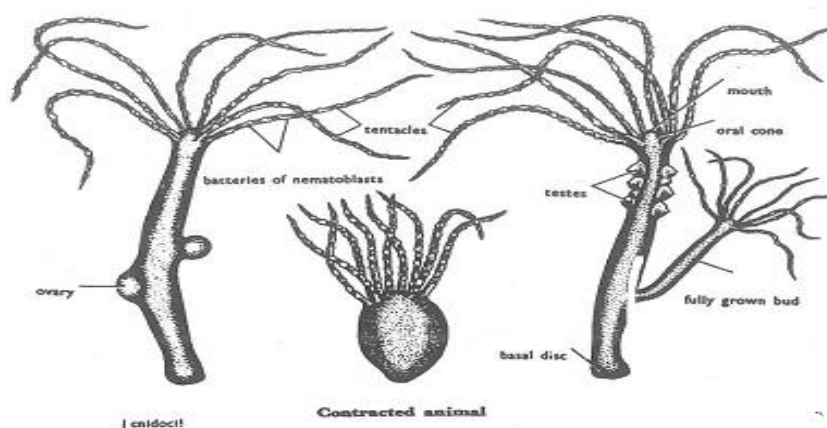
Phylum: Coelenterata

Class: Hydrozoa

Ex. Hydra

External Features:

- a) They have a relatively simple body construction.
- b) The basic body plan is a sac with a central digestive compartment, the gastrovascular cavity.
- c) Hydra exist only in the polyp form.
- d) When environmental conditions are favorable, a hydra reproduces asexually by budding.
- e) When conditions deteriorate, hydra can reproduce sexually, forming resistant zygotes.
- f) Hydra has testes at the upper part and ovary at the lower part of the body.



Hydra

Draw:

Draw under the microscope:

Fasciola

Speices: *Fasciola gigantica*

They called liver-flukes because they live in the bile ducts of cattle and other mammals. leaf-like shape usually have two suckers, an anterior or oral sucker which encloses the mouth, and a posterior or ventral. The alimentary canal begins with the mouth opening. This leads into a short muscular pharynx. is followed by the intestine which divides

into 2, right and left, branches. The excretory system to consist of a great number of small canals which collect into a main excretory canal opens to the outside by the excretory pore. The male genital system consists of two testes lying approximately in the centre of the body branched and each gives off a vas deferens. The female genital system consists of a single branched ovary. *Limnaea cailliaudi*, the intermediate host of *Fasciola*

**Kingdom : Animalia
Eumetazoa**

Dvision: Triploblastica

Sub Division: Acoelomates

Phylum: Platyhelminthes

Class :Trematoda

Genus: *Fasciola*

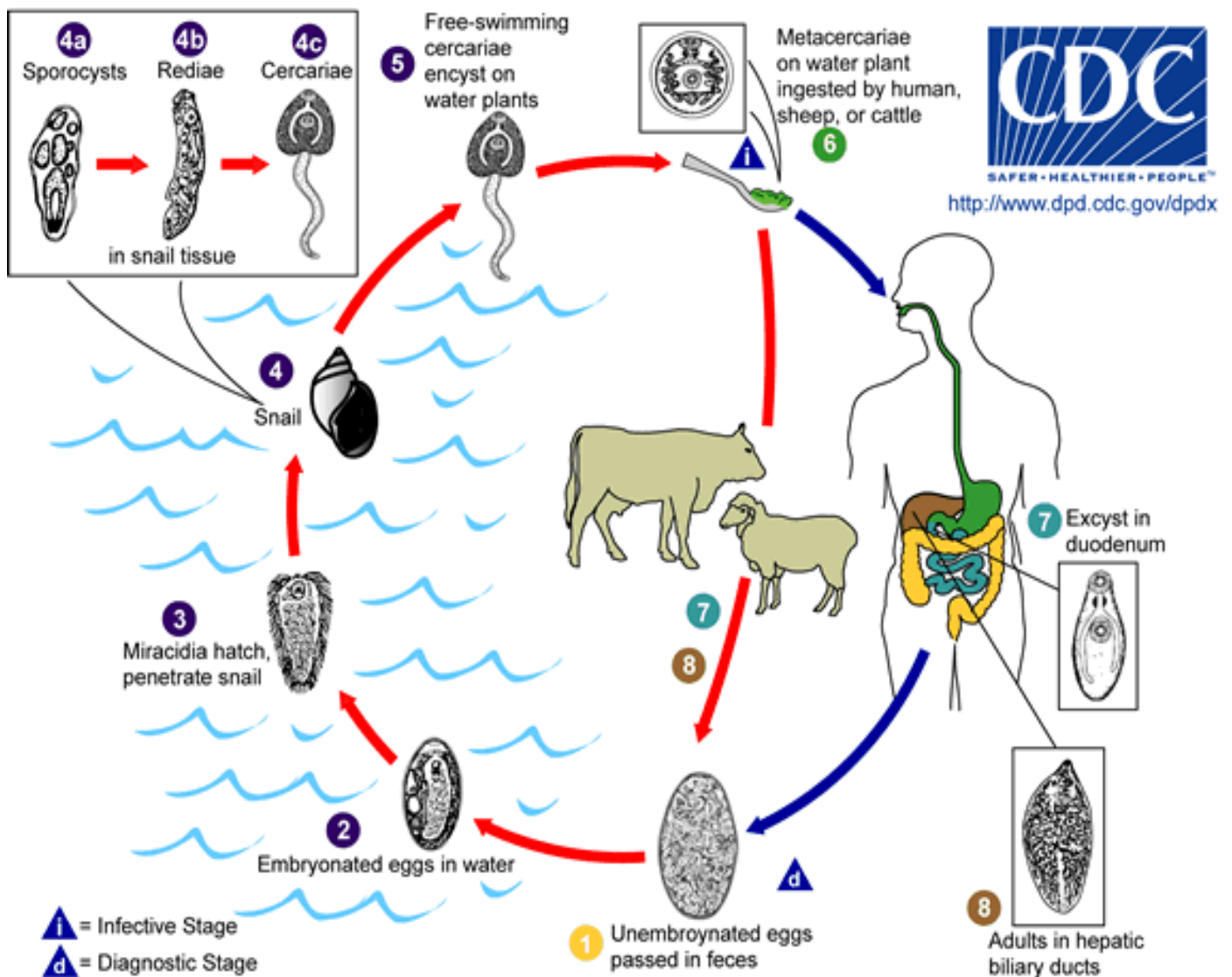
Speices: *Fasciola aiaantica*

Fasciola

Stages in the Life history

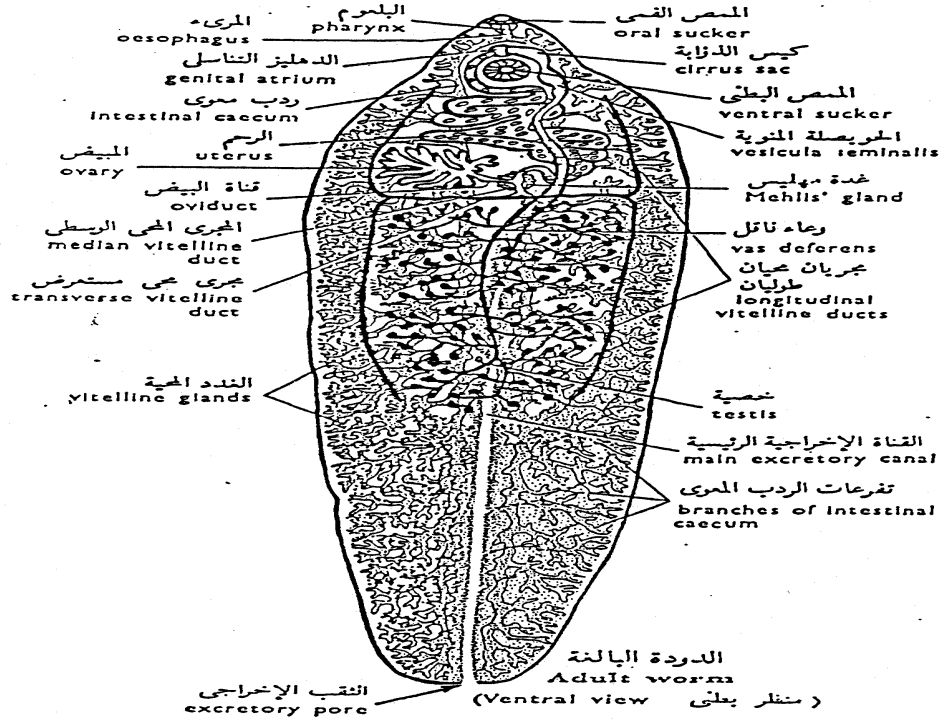
- 1- eggs and note the chitinous eggshell with its operculum
- 2- The miracidium is a minute free-living larva with an elongated conical body entirely covered by cilia. Penetrates the eggshell.
- 3- The sporocyst is sac-like, covered by epidermis and thin cuticle.
- 4- The redia has an elongated body with an anterior projecting

- 5- The cercaria has a heart-shaped body, a long unforked tail, and rudiments of most of the adult organs: two suckers, a pharynx
- 6- The metacercaria or encysted cercaria has lost the tail and is enclosed in a thick cyst secreted by the cystogenous cells.

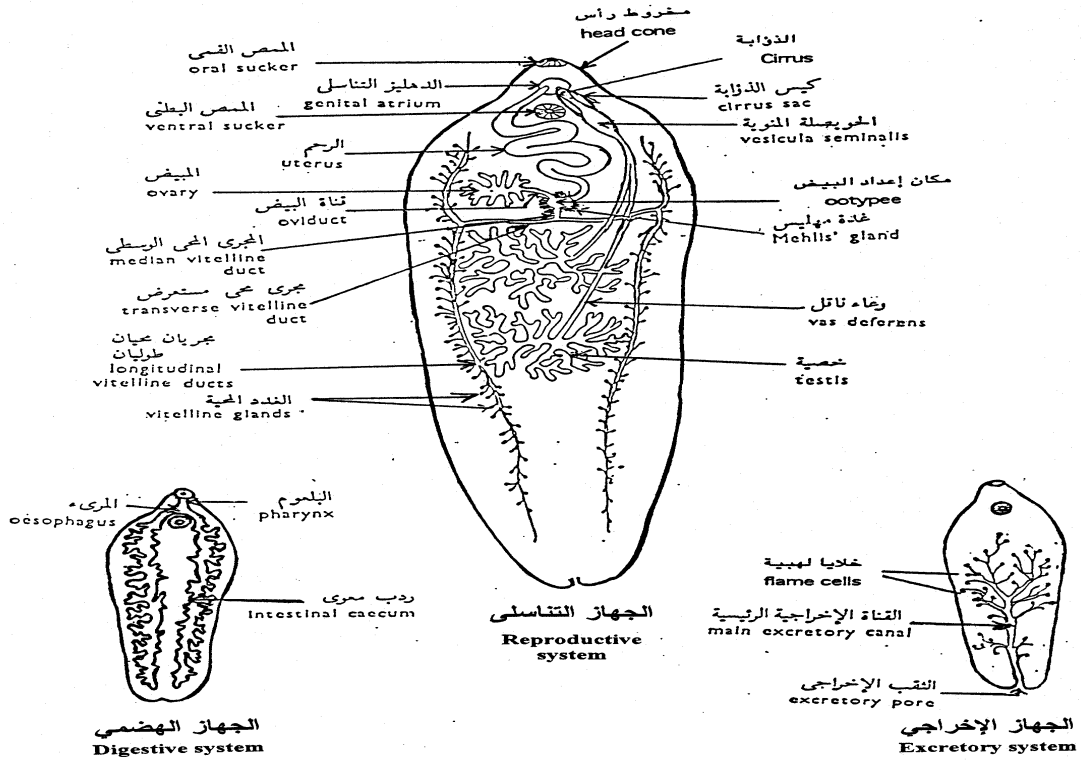


The Life of *Fasciola*

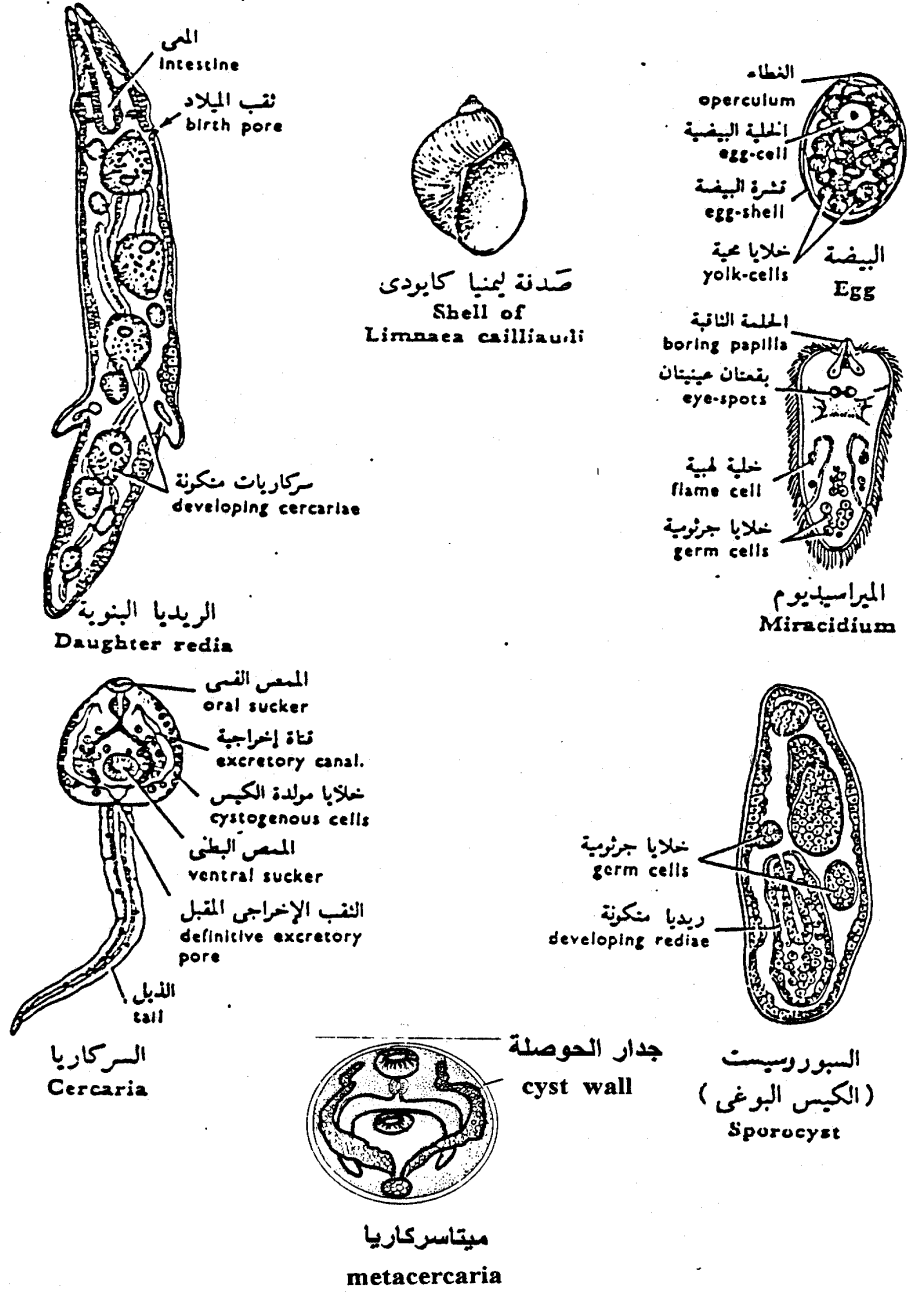
فاسيولا جيجانتিকা FASCIOLA GIGANTICA



فاسيولا جيجانتিকা FASCIOLA GIGANTICA



الأطوار المختلفة فى دورة حياة فاسيولا جيجانتিকা



The stages in *Fasciola*:

Draw:

Draw under the microscope:

Taenia

This class comprises the tapeworms, all of which are endoparasites and lack an alimentary canal throughout life. They have a great power of reproduction, both asexual and sexual. Infection acquired by the ingestion of raw or undercooked meat of infected animals.

Although many species exist, but the two species which infect man are *T. saginata* and *T. solium*

Kingdom: Animalia
Subkingdom: Eumetazoa
Division: Triploblastica
Subdivision: Acoelomates
Class: Cestoda
Order: Cyclophillidea
Genus: *Taenia*
Species: *Taenia saginata* (beef tapeworm)

External Features: *Taenia saginata* has four large muscular suckers; no mouth or hooks exist. Scolex of *T. solium* is relatively smaller and has a rounded prominent rostellum with a double row of chitinous hooks

Morphology

T. saginata

- Definitive host: human.
- Intermediate host: cattle
- Larvae are found in the cow after ingestion of the worm eggs.

T. solium

- Definitive host: human.
- Intermediate host: pig (accidental host: human)
- Larvae -found in the muscles or subcutaneous tissues of their intermediate host (generally, pigs).

The Mature Proglottis: contains the uterus (unbranched), ovary, genital pore, and testes

The Gravid Proglottids: the uterus in *T. saginata* is branched and is filled with eggs. (20-30 main branches on each side). *T. solium* uterus is less branched (7-to main branches on each side).

Eggs are similar

Life Cycle

The life cycles of *T. saginata* and *T. solium* are very similar. Life cycle differences include possible autoinfection route in *T. solium*, and the different intermediate hosts for each parasite.

T. saginata

1. Feces of humans contain the eggs of the tapeworm.
2. Egg is ingested by cattle.
3. Eggs hatch to release hexacanth (six-hooked) larvae in small intestine.
4. Larvae migrate through the intestinal and enters the blood, lymph system.
5. Larvae is carried to tissues such as heart and other muscles to develop cysticercus.
6. Man is infected by ingesting uncooked meat containing cysticercus.
7. Once ingested, the scolex of parasite attaches to the intestinal wall and grow into a mature tapeworm which sheds eggs in the feces of the infected human.

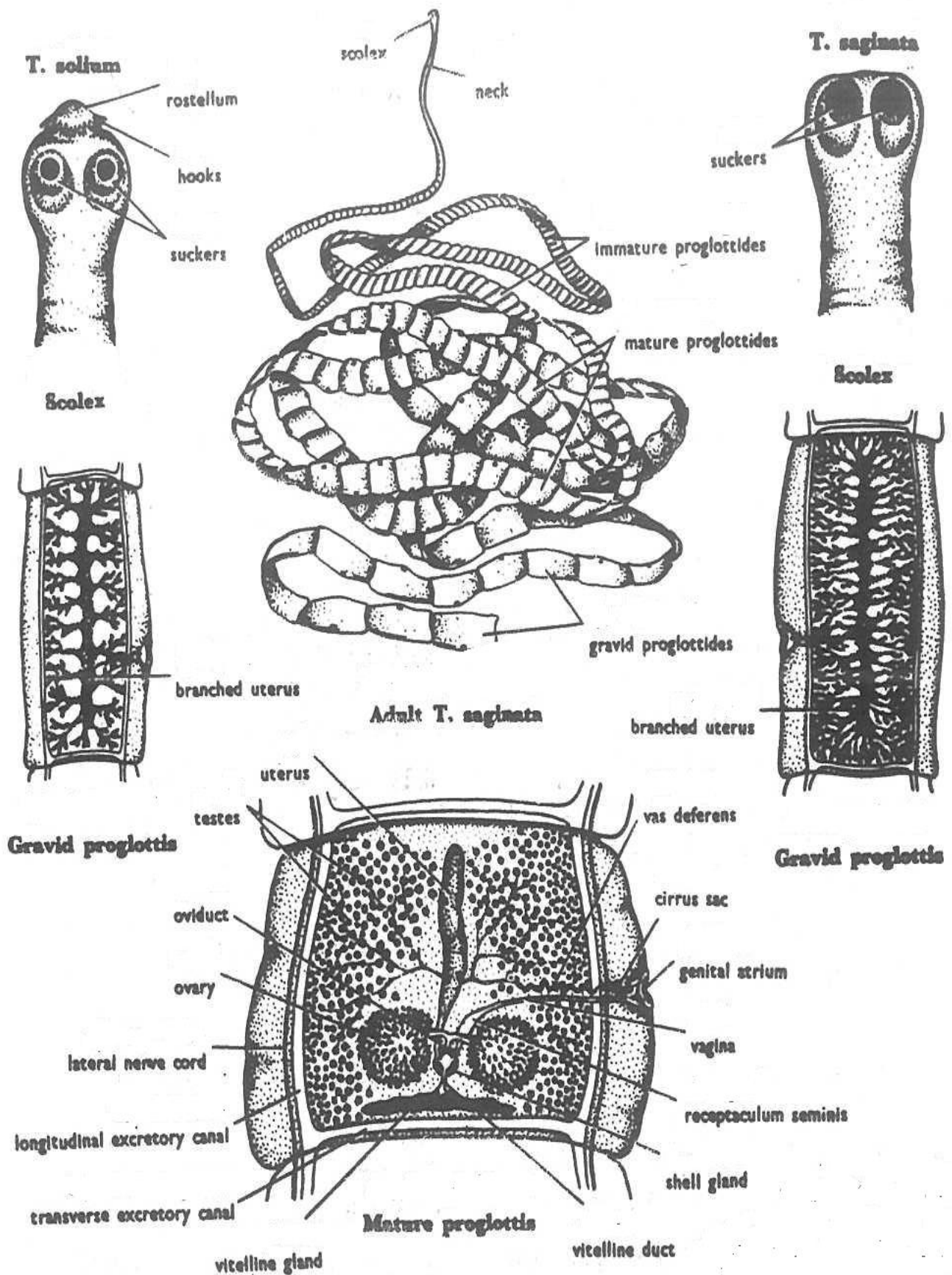


Figure1. Shows 1. Scolex of *T. saginata* – 2. Scolex of *T. solium*- 3. Adult *T. saginata* – 4. Gravid proglottis of *T. saginata* – 5. Gravid proglottis of *T. solium*- 6. Mature proglottis

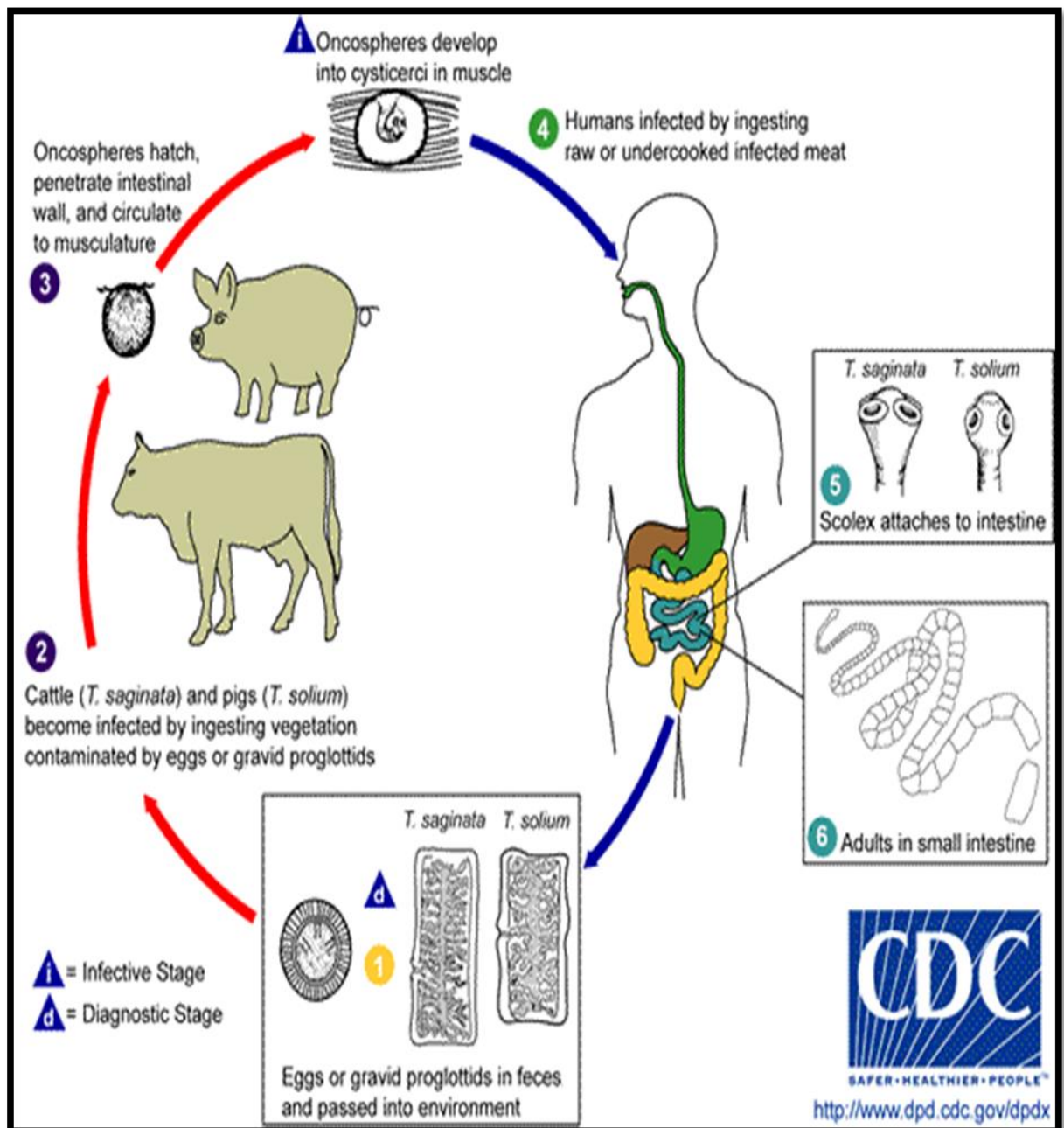


Figure 2. Shows life cycle

1- Scolex of T. saginata

Draw

Draw under the microscope:

2- Scolex of T. Solium

Draw

Draw under the microscope:

**3- Gravid proglottidia of
T. saginata**

4- *Draw*

Draw under the microscope:

4- Gravid proglottia of T. solium

Draw

Draw under the microscope:

5- Mature proglottia

Draw

Draw under the microscope:

Ascaris:

Some species of this genus are among the largest round worms known. *A. lumbricoides* lives in the small intestine of man. Their life history is remarkable in that the female lays about 200,000 eggs daily, which pass out with the faeces; each develops an embryo which molts inside the egg shell and is then ready to infect a new host



Kingdom: Animalia
Phylum: Nematoda (Roundworms)
Class: Rhabditea
Order: Ascariida
Family: Ascariidae
Genus: *Ascaris*
Species: *lumbricoides*
Ascaris lumbricoides

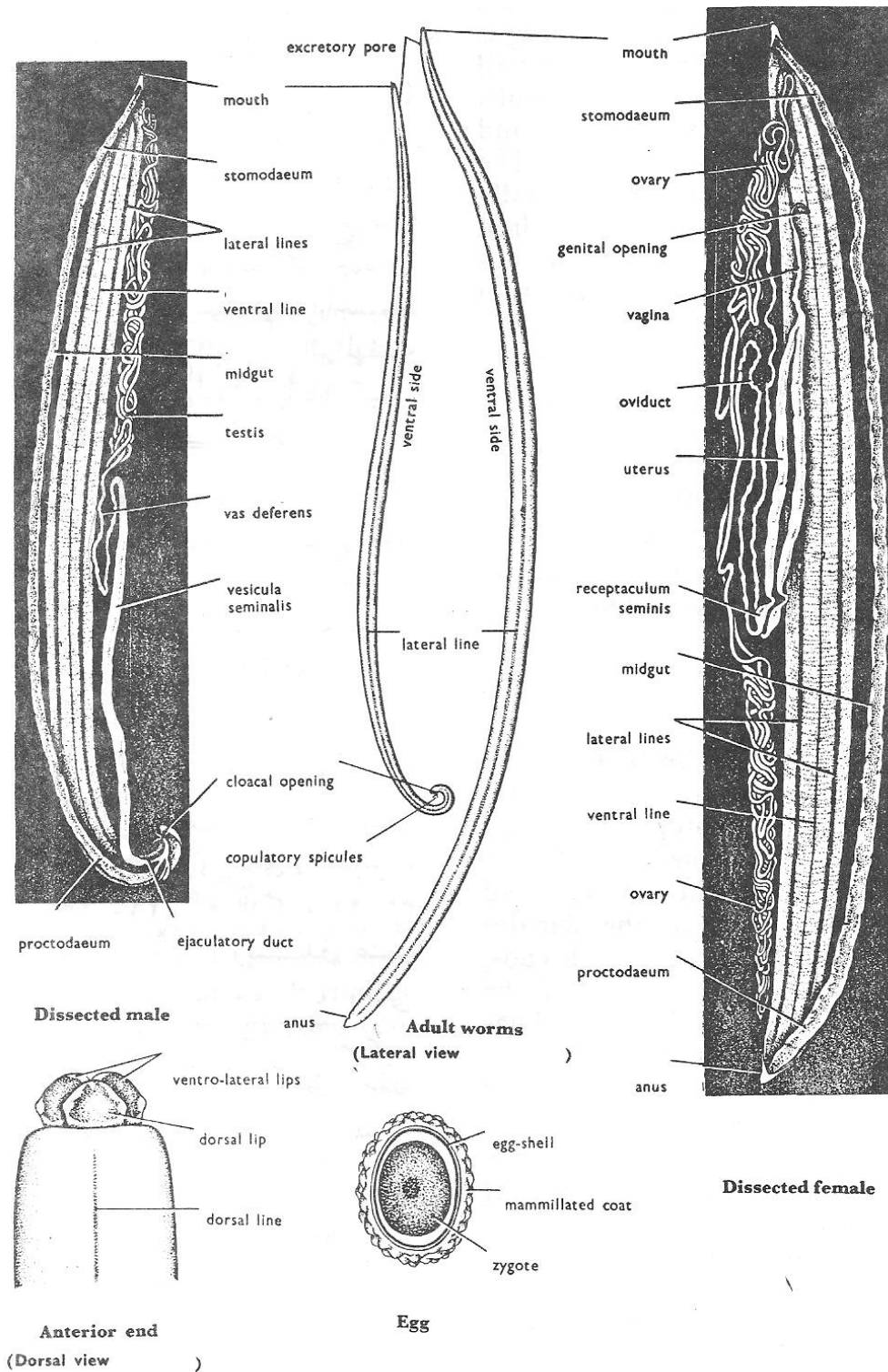
External Features.

The body form, is cylindrical, long (length varies according to species and sex being in *A. vitulorum* 15-26 cm in the male and 22-30 cm in the female) and tapering at both ends. The sexes are separate ; the female is the larger, and has a straight posterior end, while the male is more slender and has its posterior end sharply curled ventrally.

Four longitudinal streaks run the entire length of the body, 2 thin white dorsal and ventral lines, and 2 broader and darker lateral lines.

The mouth lies at the anterior end of the body and is guarded by three finely papillated lips, one dorsal and two ventro-lateral. The minute excretory pore lies on the ventral side, 2 mm behind the mouth.

The genital aperture in the female is situated on the ventral side some distance from the anterior end (at about one third the length of the body in *A. lumbricoides*. In the male, the genital duct joins the hind gut and both open by a common cloaca a short distance from the posterior end. A pair of minute copulatory spicules project from the latter aperture. The female has a separate slit-like anus.



ASCARIS

Make labelled drawings of the dorsal and ventral views of the Ascaris to show its external features.

The Earthworm – Allolobophora:

Earthworms live in damp . soil which is not too acid.; They abound in the fields and gardens where they build burrows, engulfing earth particles mixed with organic matter, which latter they digest. The defecated earth collects on the sides and also at the mouths of burrows forming worm casts, thus aerating the soil and enriching it with nitrogen-containing compounds.

Earthworms are nocturnal, that is, they become active by night, and retire to their burrows during the day. A very common earthworm in Egypt is *A. caliginosa*.

Kingdom: Animalia

Phylum: Annelida

Class: Oligochaeta

Genus: Allolobophora (Earthworm)

1-Species: *caliginosa*

Allolobophora caliginosa

External Features,

The body form is cylindrical pointed anteriorly and dorso-ventrally flattened posterior-ly. The dorsal surface is somewhat darker in colour. The mouth and anus open terminally at the anterior and posterior ends respectively. The body is divided into a great number of segments, separated by conspicuous inter-segment-al grooves.

The clitellum (secret-es the cocoon) is the thick-ened skin of segments 26--34, and lies on the dorsal and lateral sides concealing the segments. These, how-ever, are distinct on the ventral side, where the edges of the clitellum are thick-ened on segments 31-33 forming two puberty crests.

The head is composed of a peristomium (first segment) surrounding the mouth and a prostomium which is dorsal and forms an upper lip that

extends in front of the mouth; the prostomium is not to be considered a segment.

The chaetae or setae are minute chitinous structures which can be felt by passing the finger from behind forwards on the ventral surface of the worm (preferably preserved). Every segment, except the first and the last, carries four pairs of chaetae, two pairs on the ventral surface and one pair on each lateral side. Use a hand-lens to see that the chaetae are directed backwards.

The female openings are two small openings which lie ventro-laterally on segment 14.

The male openings are two slit-like apertures with thickened lips. They lie on the ventro-lateral sides of segment 15.

The spermathecal pores are two pairs of minute openings which lie on the ventral side in the inter-segmental grooves between segments 9/10 and 10/11. They are surrounded by three pairs of copulatory papillae on segments 9, 10 and 11.

The dorsal pores are minute single pores which communicate the coelom with the outside. They lie mid dorsally on the inter-segmental grooves starting with 8/9 to the posterior end.

The excretory pores or nephridiopores are the minute pores of the nephridia to the outside. They are ventral in position, two per segment, except the first three and the last segment where they are absent.

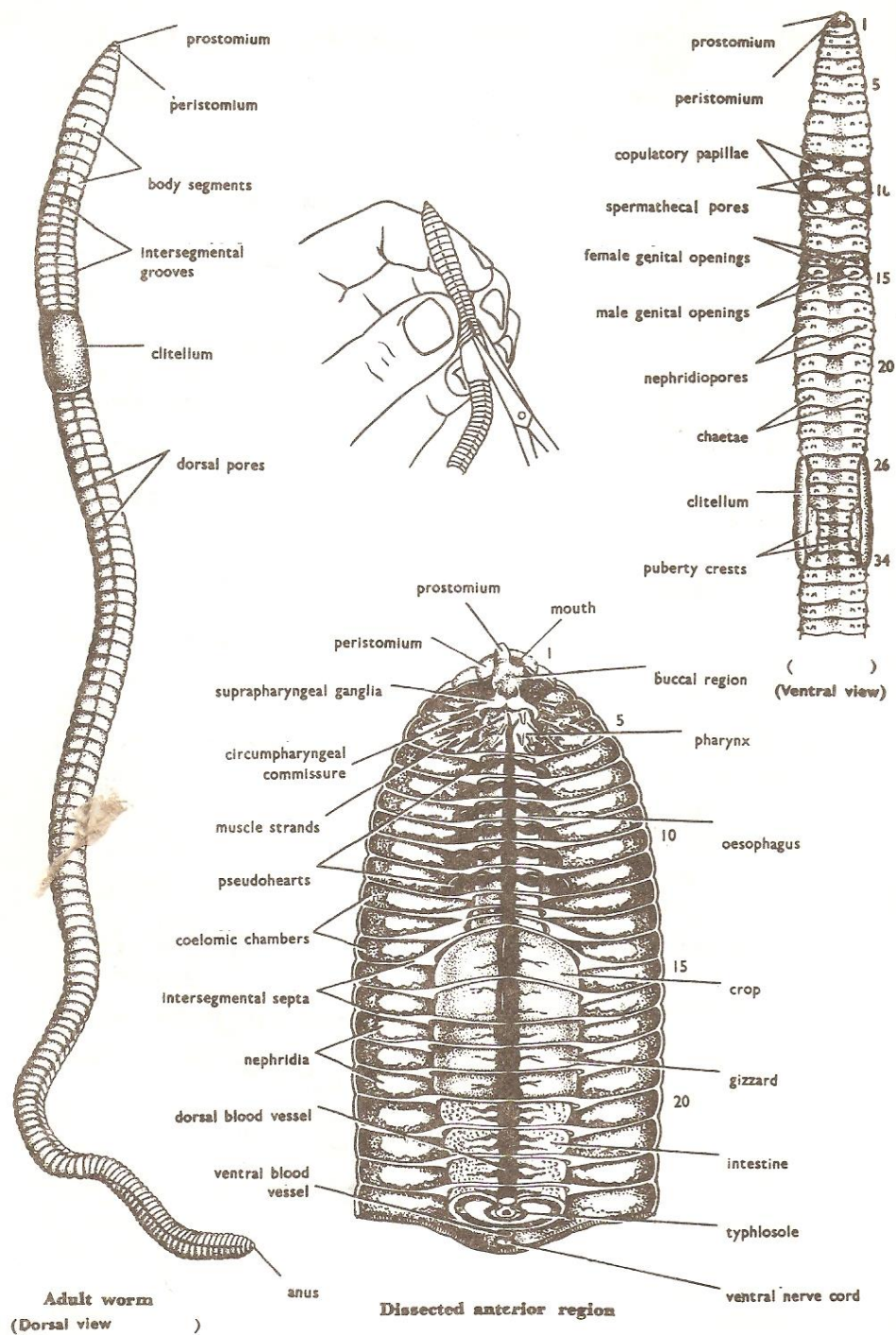


FIG. 27 - ALLOLOBOPHORA CALIGINOSA

Make labelled drawings of the earthworm as seen from the dorsal and ventral sides.

Hirudo:

The medical leech *Hirudo medicinalis* (5-10 cm in length) lives on the blood of vertebrates which go down to where it lives in water, of ponds, marshes and streams. Man has long made use of this power of the leech by letting it suck the "blood of patients, and so is called the medical leech, and has been introduced from Europe to various continents. It swims in the water by vertical undulations and by the help of the suckers; its body loops as it swims. Once it has taken a meal of blood by sucking it from a vertebrate, it can live with it for months. It lays eggs in cocoons which hatch out of young; no larval stage is known.

Kingdom: Animalia

Phylum: Annelida

Class: Hirudinea (leeches)

Genus: *Hirudo*

Species: *medicinalis*
Hirudo medicinalis.

External Features.

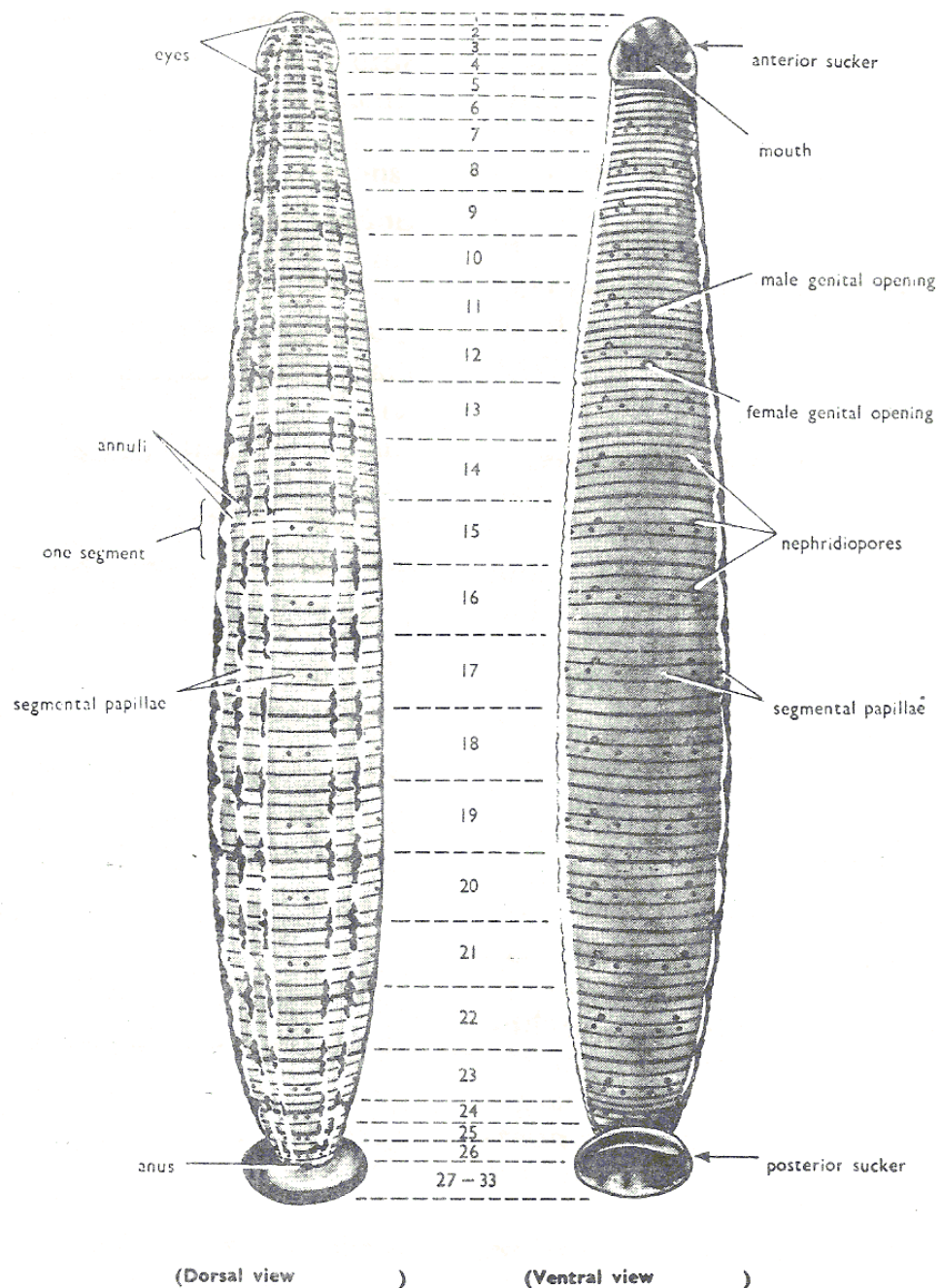
Body form and colour, dorsoventrally flattened (not rounded) with a greenish-brown colour, paler below than above. The dorsal surface is marked with yellowish longitudinal bands spotted with black pigment, while the ventral surface is irregularly mottled.

The suckers: a cup-shaped anterior sucker with the mouth opening in its middle, and a larger imperforated disc-like posterior sucker, both are ventrally directed.

External annulation: The body is externally divided into a large number of rings or annuli which are actually more numerous than the true internal segments. The animal has a fixed number of segments, only 33. Every 5 annuli correspond to one true segment except at the anterior and hind ends where the number of annuli per segment is less.

The eyes are five pairs on the dorsal surface of the first 5 segments. The nephridiopores are 17 pairs of minute openings on the ventral surface, one pair in each of the segments 7-23 inclusive, and located on the annulus immediately in front of the one bearing the papillae. The male genital opening lies in the mid-ventral line on the 4th annulus of

segment 11. The female genital opening lies in the mid-ventral line on the 4th annulus of segment 12. The anus opens mid-dorsally at the point of junction between segment 26 and the posterior sucker.



HIRUDO MEDICINALIS

Make labelled drawings of the dorsal and ventral views of the leech to show its external features.

The cuttlefish – *Sepia*:

The cuttlefish, *Sepia savignyi*, is a common animal in our seas and its shell (the cuttle-bone) is a common object to be found along the sea shores. It is either seen singly or in small groups, swimming close to the surface and has a great power of changing its color with great rapidity. It swims forwards but can retreat with its rear, and when attacked it jerks quickly backwards and emits a cloud of ink behind enabling it to escape from view.

Kingdom: Animalia

Phylum: Mollusca

Class: Cephalopoda

Genus: *Sepia*

Species: *savignyi*

Sepia savignyi

External Features.

The body is mainly divided into a distinct head and a conical visceral hump, separated from one another by a short neck.

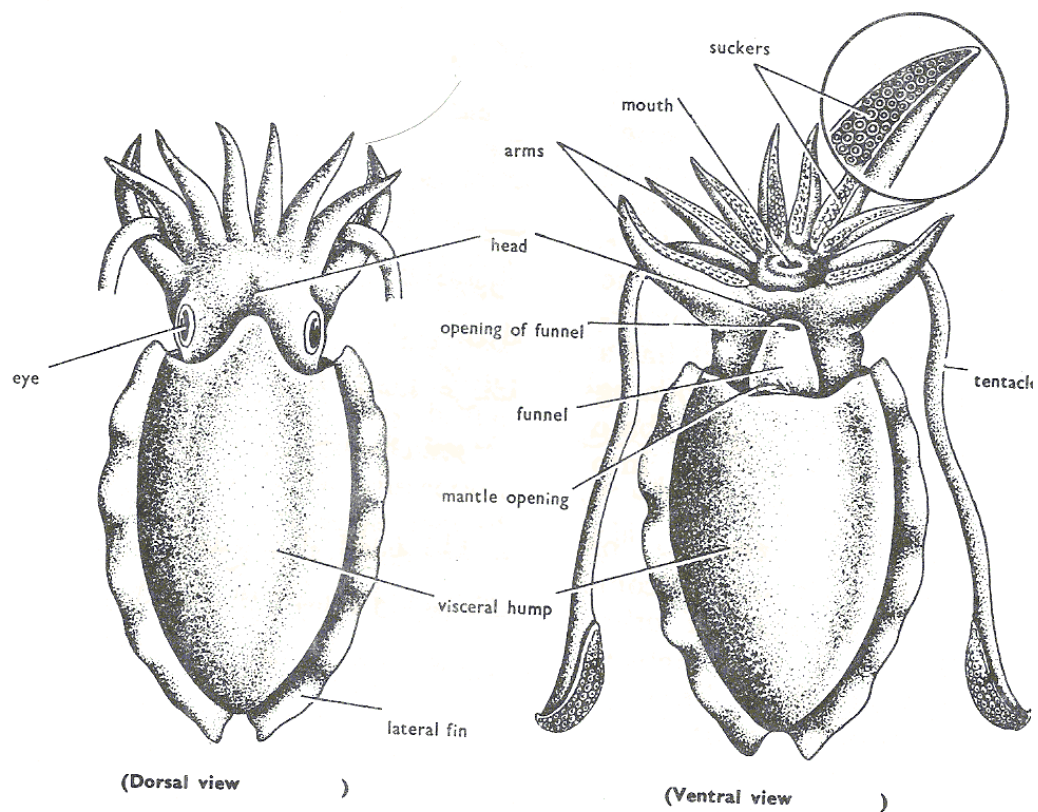
The head carries 2 large eyes, similar to those of vertebrates. It bears anteriorly the mouth opening surrounded by a prominent circular lip, and 2 large horny jaws project from it.

Eight pointed arms, each provided with 4 rows of suckers on its inner surface, and 2 much longer tentacles, carrying suckers only at their expanded tips, arise at the anterior end of the head, around the mouth opening (the tentacles are used in catching the prey and the arms for holding it while it is being devoured). The arms and tentacles probably represent the highly modified anterior part of the foot, and hence the name Cephalopoda.

The posterior part of the foot is modified to form the large muscular funnel which you see on the ventral side of the head (through which water is forced out of the mantle cavity, causing the animal to jerk quickly backwards). Note that it has a narrow anterior opening and a broad open base projecting backwards into the mantle cavity.

The trunk or visceral hump (comparable to that of other molluscs) is conical, dorsoventrally depressed and bluntly pointed. Its two lateral sides are extended into 2 thin lateral fins (by means of which the animal

swims forwards). The visceral hump is covered all over by the mantle, which terminates anteriorly in a free ridge surrounding the neck. Note that the dorsal side of the hump is hard due to the presence of an internal shell on this side, just beneath the integument. On the ventral side of the hump, the mantle forms a thick muscular wall which covers over a large mantle cavity, with a wide anterior mantle opening.



Make labelled drawings of the Sepia

The Starfish:

Astropecten relitaris is a large starfish commonly found in our seas from below tidemarks to great depths. It creeps about very slowly on the sea bottom, but on rest it lies partly buried in sand with the central part of its body raised into a cone above the sand.

External Features.

The body is star-shaped consisting of a central disc prolonged radially into 5 flexible triangular arms with tapering tips. The body is markedly flattened, with two distinct surfaces, a lower oral surface and an upper aboral surface.

On the oral surface, note the mouth opening in the centre, surrounded by a soft membranous area, the peristome. Five broadly open ambulacra grooves extend out from the mouth and pass each along the entire length of one of the arms. Note that a series of long conical structures known as the tube feet project in 2 rows along each ambulacral groove (organs of loco-motion which are capable of great extension and contraction during life). The terminal tube foot or tentacle, which stands at the tip of each arm, has a pigmented spot, the eye, at its base (light sensitive).

Note that very small modified spines, known as pedicellariae, project around the spines (serve to clean the body surface and ambulacral grooves from detritus and foreign objects). Each has 2 distal ossicles working opposite each other like pincer blades, and a 3rd basal ossicle as a stalk.

Kingdom: Animalia

Phylum: Echinodermata

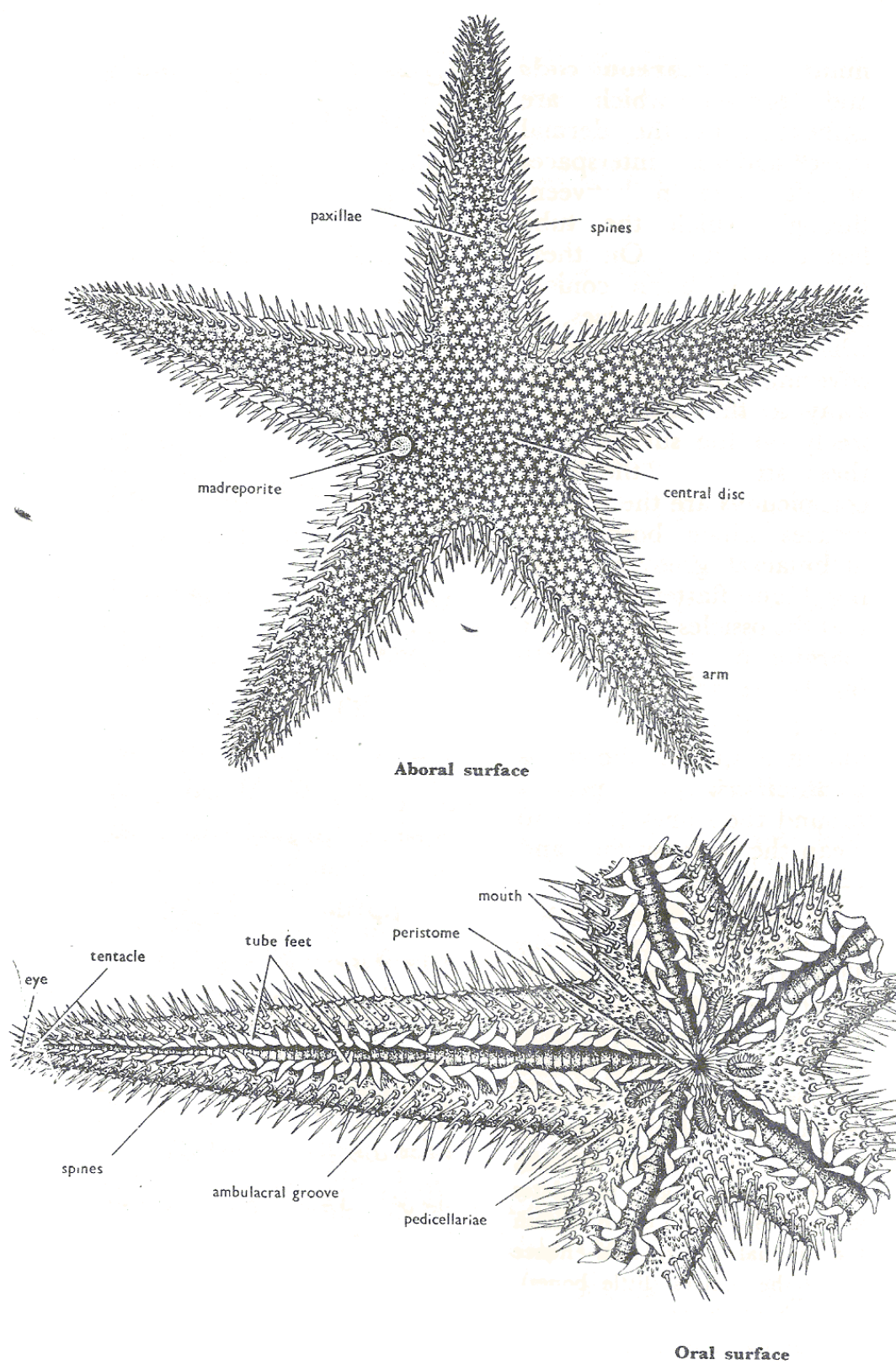
Class: Asteroidea

Genus: *Astropecten*

Species: *relitaris*

Astropecten relitaris

(See star).



ASTROPECTEN RELITARIS

Anatomy

THE RAT

Rattus rattus

EXTERNAL FEATURE, GENERAL VISCERA

The rat has a long cylindrical body, a long, thin tail and very short legs. This shape is well suited to running on narrow burrows or squeezing through small holes.

External Features:

*The outer surface of the body is almost completely covered with hair, which is devoid of pigmentation in the albino rat.

*The body is divided into the head, neck, trunk, with two pairs of limbs, and the tail.

The head:

* The head has a pointed mobile nose (a characteristic of mammals), with 2 slit-like

nostrils at the edge of a hairless zone called the rhinarium.

*The mouth is anterior, narrow, with a short lower jaw, and bounded by two mobile

soft lips (a characteristic of mammals). The upper lip is divided by a median cleft.

*The two small beady eyes are set so that they look diagonally forwards and

sideways.

*On the anterior region of the head are numerous long whiskers or vibrissae.

*The two ear pinnae are rounded, and freely movable (a mammalian characteristic).

The neck:

* The neck is short and connects the head with the trunk.

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Rodentia

Family: Muridae

Genus: *Rattus*

Species: *Rattus rattus*

The Trunk:

***The trunk** is very little wider than the head, and consists of the thorax and abdomen. There is considerable flexibility of the spine so that the body can be bent well over to either side or backwards when.

***The thorax** is strengthened by the ribs and sternum, and the abdomen is large.

*At the base of the tail is the anus, and in front of it is the urogenital aperture.

***In the male** the common urogenital aperture is at the tip of a retractile organ called the penis, surrounded by a free fold of skin called the prepuce. Behind the penis are two very large scrotal sacs in which the two testes lie outside the body cavity.

***In the female**, the urinary and genital apertures are separate and anterior to the anus on the ventral surface of the hind end of the abdomen. The urethra opens at the base of the clitoris which is a small projecting homologue of the penis enclosed in a little prepuce. The vagina lies between the clitoris and the anus-nearer to the former, and is closed by a membrane during the first ten weeks of life, that is, until puberty.

***In the female**, along the ventral surface of the thorax and abdomen there are usually 6 pairs of teats on the tips of which open the ducts of the mammary glands. These teats include three thoracic, one abdominal and two inguinal pairs. Sometimes one of the second thoracic teats may be lacking.

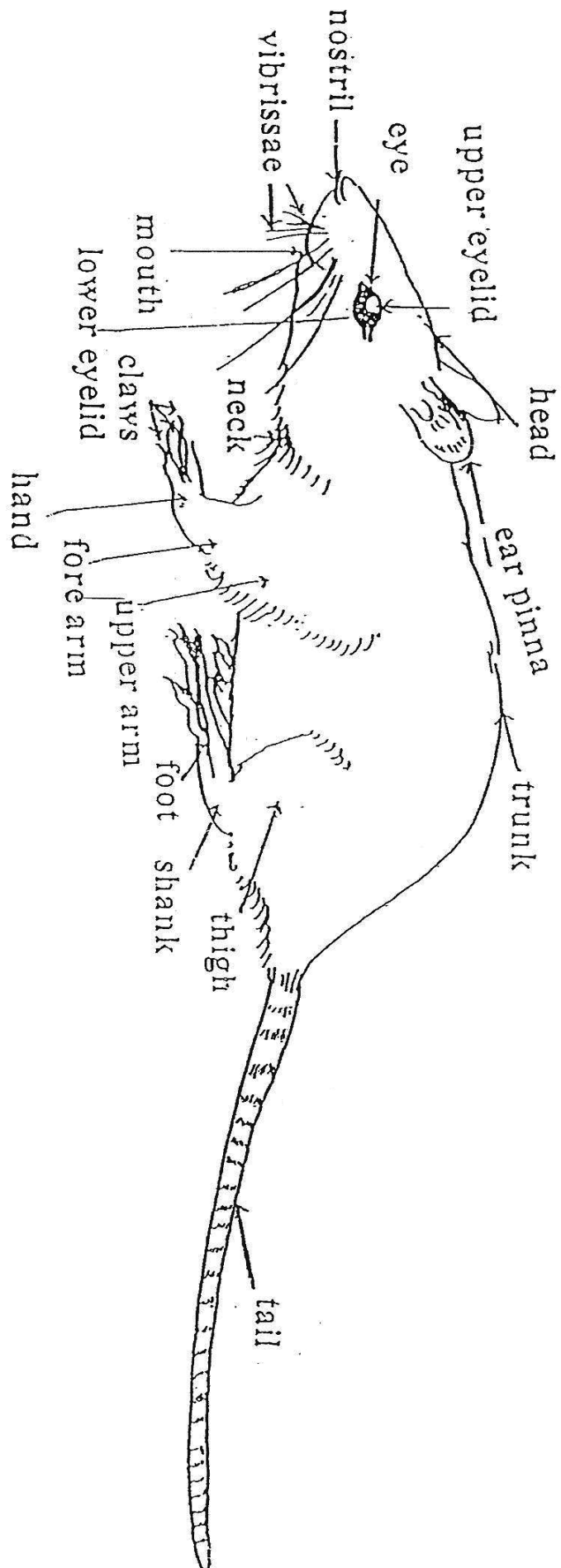
***The limbs** are built up on the same plan as in the other tetrapods. In **the fore-limb** are the upper arm, fore-arm and fore-foot (hand), while in **the hind-limb** are the thigh, shank and hind-foot. The fore-limbs are shorter than the hind-limbs. But both pairs are well flexed so that the body is only slightly raised off the ground.

*Each of the hands has 4 clawed digits and a small nodule which represents the pollex (thumb). The hairless sole of the fore-foot has a number of pads, a digital pad at the apex of each digit and five larger footpads on the palm.

***Each hind-foot** has 5 clawed digits, but the first hallux is much shorter than the others. The hairless surface of the sole extends to the tarsal joint. This joint corresponds to the ankle of man. There are 6 footpads on the sole.

***The tail** is almost as long or longer than the trunk. It is very narrow and tapers gradually toward the hind end. The entire surface of the tail is covered by rows of scales which overlap like roof-tiles. Three short bristles project from under the edge of each scale. The surface of the tail is covered with orange-yellow-waxy grease.

EXTERNAL FEATURES OF THE RAT
RATTUS NORVEGICUS



General Viscera

Dissection I:

- 1 .Take a rat killed by an overdose of an anesthetic chemical, such as chloroform or ether, and lay it on its back on the dissecting board. Fix it by tying the four limbs with the strings attached to nails on the dissection board.
- 2 .Wet the whole ventral surface of the rat with Dettol solution.
- 3 .Make a median longitudinal incision in the skin only, from the chin to the root of the tail, i.e. the full length of the ventral surface. Then cut at right angles to this along the fore limbs as far as the elbows, Make similar incisions along the hind limbs to about the level of the knee joint.
- 4 .With the help of your fingers or the handle of the scalpel (not its sharp edge). Separate the skin from the muscular body wall (note that the two are connected together by loose subcutaneous connective tissue). In doing this avoid damaging the superficial nerves and blood vessels, Reflect the skin flaps and nail them down on the dissection board.

Observations:

*Through the relatively thin abdominal musculature, the abdominal viscera can be seen. The most obvious of these are **the liver, stomach, caecum and small intestine**.

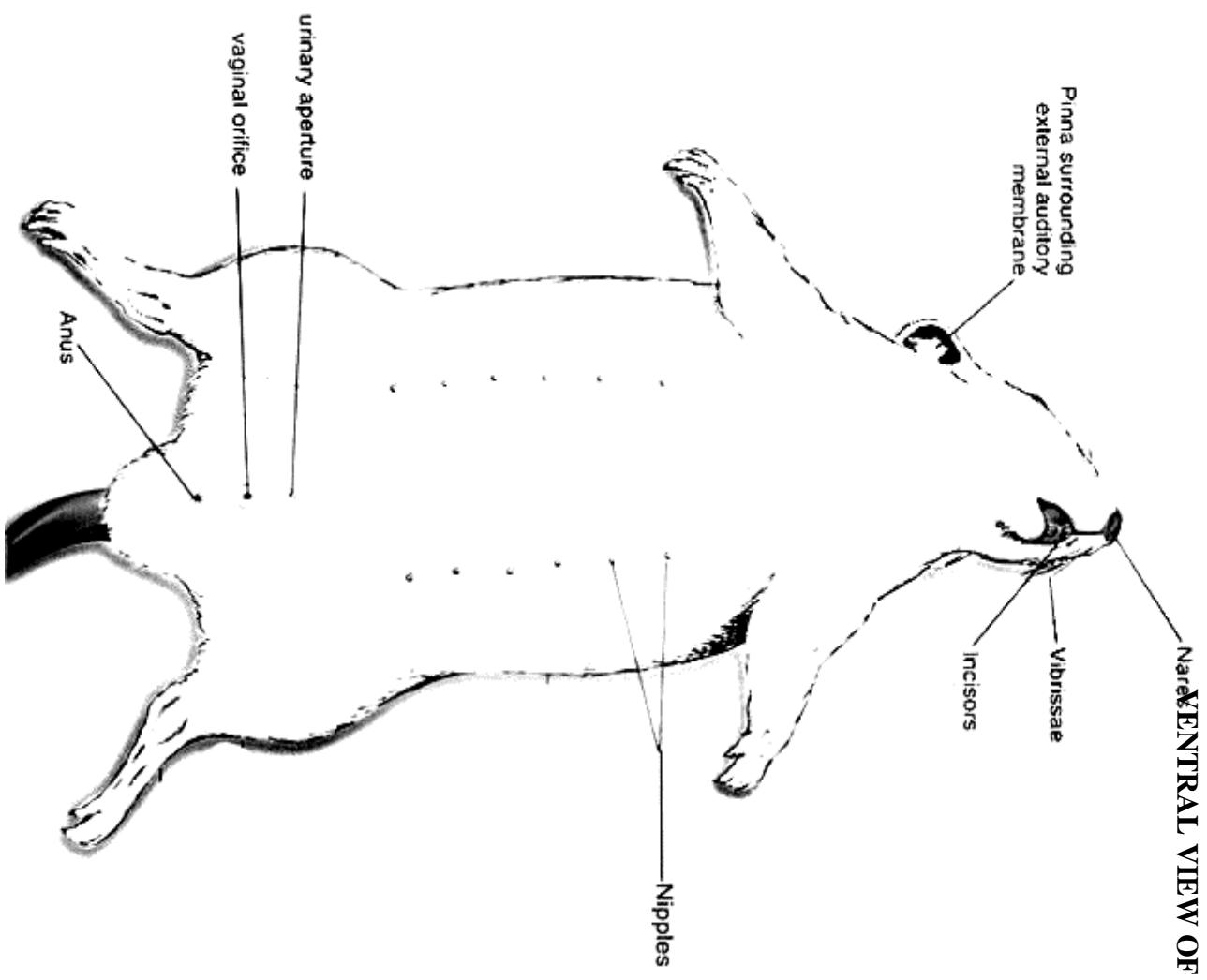
*In **the female**, the **mammary glands** can be seen intimately attached to the reflected skin. The mammary tissue consists of anterior and posterior portions. The anterior mass extends as far as the chin, and up the sides of the neck and the thorax. The posterior part is separated from the anterior by a space just behind the ribs. The tissues of the abdominal and inguinal glands are confluent. The mammary tissues appear red-brown in color but, if it is full of milk it appears paler and mottled with white.

*In the throat region, the salivary glands can be seen. The most obvious from the ventral aspect are the sub maxillary glands, which are in contact along the mid-ventral line, and cover most of the ventral surface of the neck. The major sublingual gland is closely applied to the anterior-lateral surface of the sub maxillary gland. The parotid gland is a less compact structure which extends from the ventral surface behind the jaw to the ear.

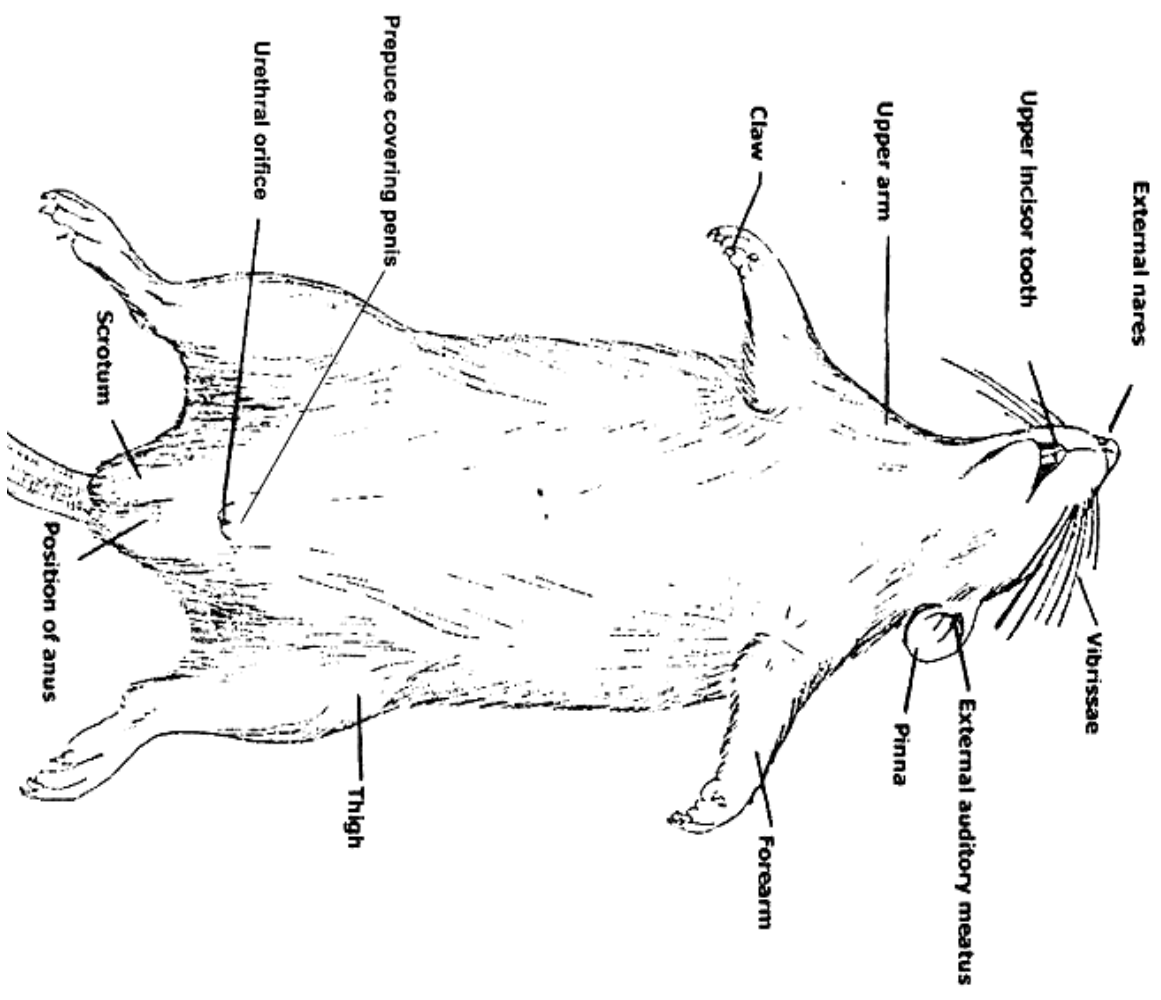
Dissection II: * In the mid-line of the neck dissect away the glands and muscles to expose the length of the trachea, the larynx and the thyroid.

Observations: * The trachea appears as a tubular structure supplied with a series of cartilaginous rings. * The larynx consists of a number of cartilaginous plates which forms the voice box.

VENTRAL VIEW OF THE DISSECTED MALE AND FEMALE RATS

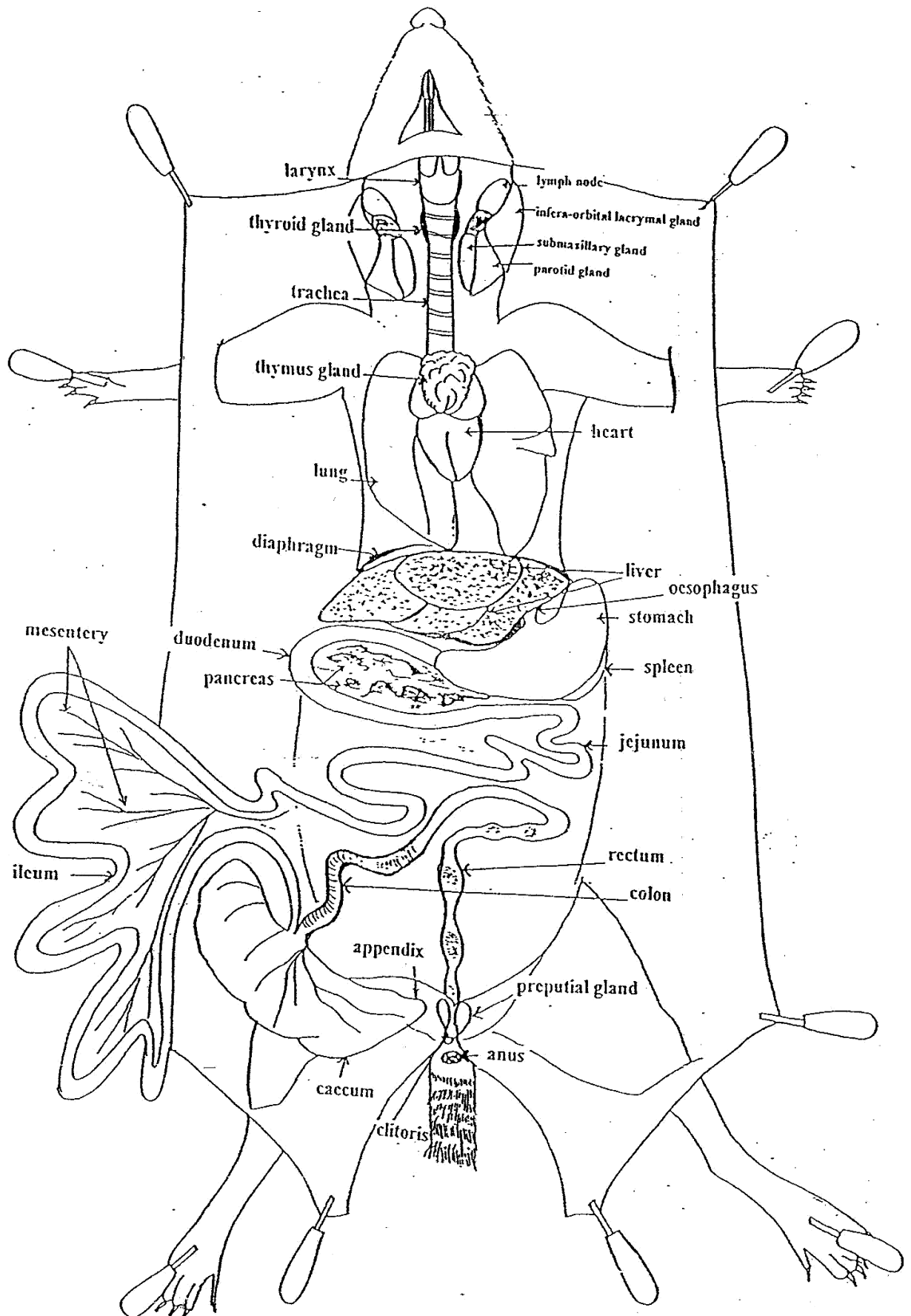


THE FEMALE



THE MALE

THE GENERAL VISCERA OF THE RAT



THE GENERAL VISCERA OF THE RAT

The Digestive System :

The digestive system consists of **the buccal cavity, pharynx, oesophagus, stomach, small intestine and large intestine**. The associated glands are the salivary glands, the pancreas and the liver.

Dissection I:

Open the buccal cavity by cutting through the muscles on each side. Turn the lower jaw through about 180 degrees and examine the structures of the buccal cavity, which is the region between the mouth and the pharynx.

Observations:

***The jaws** are long and narrow. The upper jaw is fixed but the lower jaw is movable by articulation to the skull, just anterior to the ears.

*In each jaw there are one pair of incisors, no canines, no premolars and 3 pairs of molars. Thus the dental formula is: I 1/1, c0/0, pm 0/0, m 3/3=16.

*The tongue is very muscular and has a ridged and roughened surface. On the surface of the tongue are taste buds.

*At the posterior end of the buccal cavity appears the pharynx which joins the buccal cavity with the oesophagus. It also forms the passage between the nasal cavities and the windpipe. The opening to the windpipe lies on the ventral side of the pharynx and is called the glottis, this opening can be closed and covered by the epiglottis so that food cannot pass through it during swallowing.

Dissection II:

*Remove the lower jaw, taking with it the oesophagus, the larynx and the trachea.

*Displace the above structures together with stomach and the small and large intestines to one side. Unravel the coils of the intestine leaving the duodenal loop and the rectum with their mesenteries untouched. Spread the intestine on the dissecting board so as to show the proportions of its several parts.

Observations:

***The oesophagus** appears as straight tube extending from the pharynx to the stomach. It lies partly in the neck, dorsal to the trachea and partly in the thorax diaphragm before reaching the stomach.

***The stomach** is large and saccular. It shows extremely its division into a cardiac part, which is translucent with white lining, and a pyloric part which has an opaque thicker wall.

***The small intestine** is about 6 times the length of the body from snout to anus. It is approximately uniform in diameter and is supported in the abdominal cavity (before unraveling) by an extensive mesentery.

*The first part of the small intestine forms a U-shaped loop known as the **duodenum**. The bile duct from the **liver** opens into this region. This duct is joined

by numerous pancreatic ducts from **the pancreas**. The remainder of the small intestine is known as the ileum.

***The large intestine** is about one-sixth the length of the small intestine. It is also supported by mesentery (before unraveling). It is divided into a short colon and a longer rectum which opens by the anus. The lining of the colon has the colon and the ileum there is a diverticulum called the caecum, the blind end of the presence of a mass of lymphoid tissue in its lateral wall.

***The liver** is suspended from the posterior surface of the diaphragm by the falciform ligament, it has 4 lobes. The right lobe is large and partially divided the left lobe is also large but undivided, the median or cystic lobe has a deep fissure for the hepatic ligament, and the caudal lobe is a small portion of the liver tissue wrapped around the oesophagus. The bile duct receives tributes from each of the lobes and has a muscular sphincter at its duodenal end, but the rat has no gall bladder.

***The pancreas** is very diffuse with small lobules scattered in the mesentery of the duodenal loop and in the fold called the gastro-splenic omentum. It has many ducts opening into the bile duct.

***The spleen**, which is not a part of the digestive system, is a bright red body lying close to the greater curvature of the stomach.

THE RAT

Rattus norvegicus

THE UROGENITAL AND NERVOUS SYSTEMS

The Urogenital System:

*The excretory system of mammals consists of **2 kidneys, 2 ureters, a bladder and a urethra.**

*In the female rat the excretory system is separate, while in the male it is joined with the genital system.

Dissection:

1. Dissect and open an anaesthetized rat as you did in the last laboratory session.
2. Remove the alimentary tract leaving only the stump of the rectum.
3. Cut the bones of the sides of the public symphysis and remove the cut pieces away.

So as to expose the posterior part of the urogenital system.

4. Examine carefully all parts of the urogenital system, then with a sharp scalpel slit

One kidney opens from its outer edge, and turns the ventral half inwards, so as to

Expose the cut surface.

Observations:

The Excretory System:

***The two kidneys** are dark red in color, bean-shaped and are enveloped within a fibrous capsule. The right kidney lies more interiorly than the left. Anterior to each kidney, a small yellowish rounded body, the adrenal gland is present. Each kidney has a notch called the hilum where the renal artery enters and the renal vein and ureter emerge.

***The two ureters** extend from the concavity of the kidney to open into the posterior wall of the urinary bladder.

*The urinary bladder is an ovoid sac which narrows posteriorly. In the female it receives only the ureters at this narrow end, the neck which extends as a tubular urethra bladder.

***The urinary bladder** is an ovoid sac which narrows posteriorly. In the female it receives only the ureters at this narrow end, the neck, which extends as a tubular urethra in the pelvis to open by the urethral opening at the tip of the clitoris in the pelvis as a urogenital passage before opening by a common urogenital opening at the tip of the penis.

*In the cut kidney, the substance of the kidney can be differentiated into an outer cortex with a dotted appearance due to the presence of the Malpighian bodies which are confined to this part. The inner part is the medulla. It appears radially striated and consists mainly of the renal and collecting tubules. The inner surface of the medulla projects into the renal pelvis of the kidney forming the pyramids on which the collecting tubules open.

The Male Genital System:

*This consists of **two testes**, each with an **epididymis** and a **vas deferens**, **2 seminal vesicles** and a number of associated glands.

*The testes lie in the **scrotal sacs** and each remains connected with its original position in the abdominal cavity by a spermatic cord. The spermatic cord consists of a spermatic artery, a spermatic vein and a spermatic nerve, all bound in connective tissue.

*Along the side of each testis lies the **epididymis** which is enlarged anteriorly forming the caput epididymis and posteriorly forming the cauda epididymis.

The spermatic cord is connected to the caput epididymis.

*The 2 vasa deferentia are connected to the cauda epididymis and each passes forwards out of the scrotal sac to open into the dorsal wall of the narrow neck of the bladder.

*Associated with each vas deferens is a vesicular seminalis which is relatively enormous in size, curved and sacculated and is closely connected with a large coagulating gland.

*There is a pair of prostate glands, each of which is subdivided so that they appear as 2 pair of prostate glands, each pair being attached by a stalk to the neck of the bladder.

*The pair of Cowper or bulbo-urethral glands open into the urethra at the flexure where it emerges from the pelvis.

*Around the neck of the bladder lies another gland called the gland of vas deferens.

*The urogenital canal, the urethra, opens at the tip of the protrusible

penis which has a fold of skin called the prepuce.

*Two preputial glands lie under the skin of the prepuce and open at the base of this fold into the area between the prepuce and the penis. The secretions of these glands identify the individuals within the rat community. These glands are not part of the reproductive system.

The Female Genital System:

*This consists of **the paired ovaries** and **oviducts** and the unpaired **vagina**.

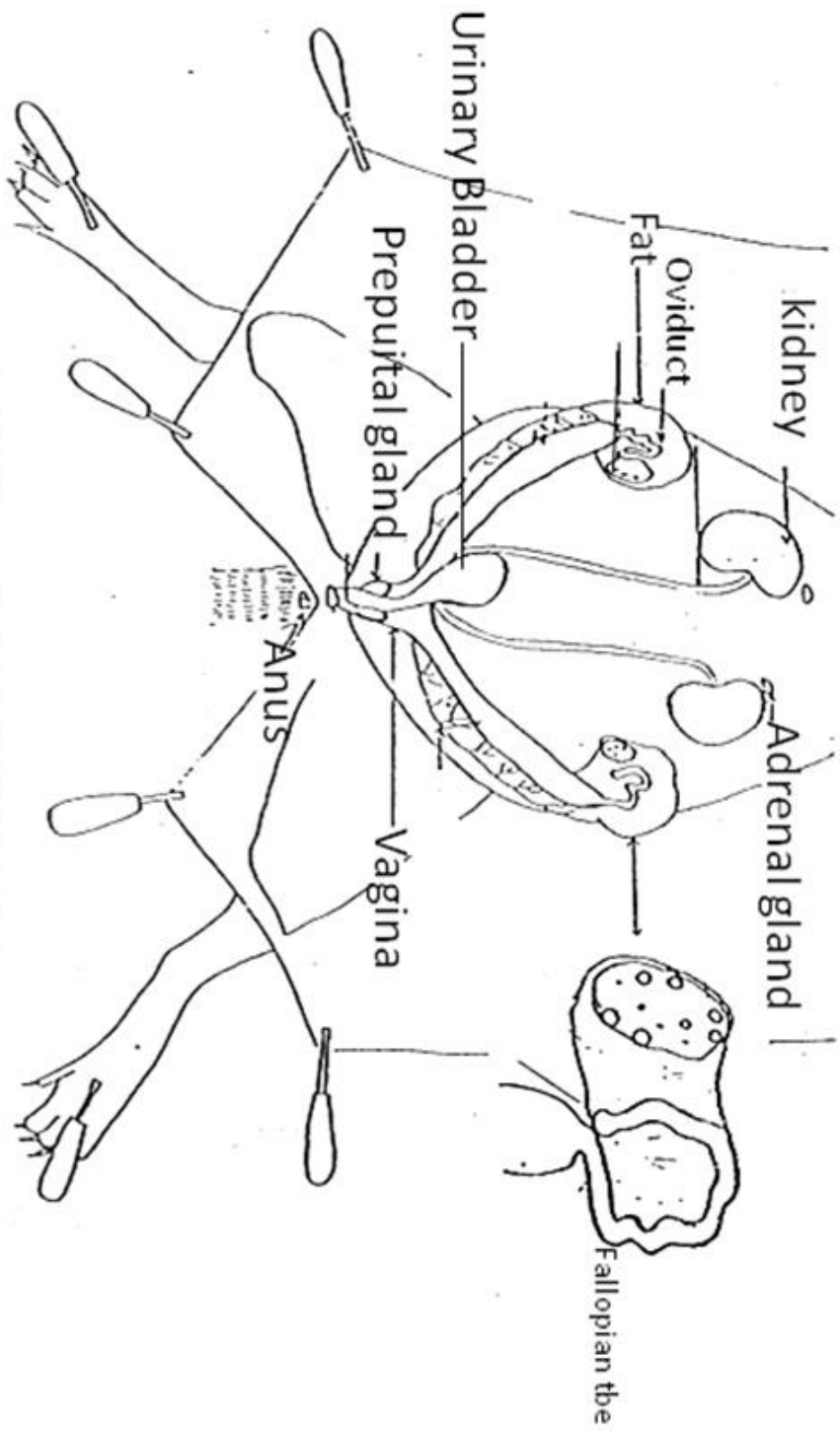
*The ovaries are much smaller than the testes and lie in the abdominal cavity ventro-lateral to the kidneys, enclosed within a very walled periovarial sac.

***The oviducts** are tubular and each has a minute opening close to the corresponding ovary. The oviducts are suspended from the wall of the abdomen by peritoneal folds called the mesovaria. Each oviduct is divided into 2 regions. The first region is narrow and coiled and is called the Fallopian tube, while the other region is wide and usually called the uterine horns or uterine cornua.

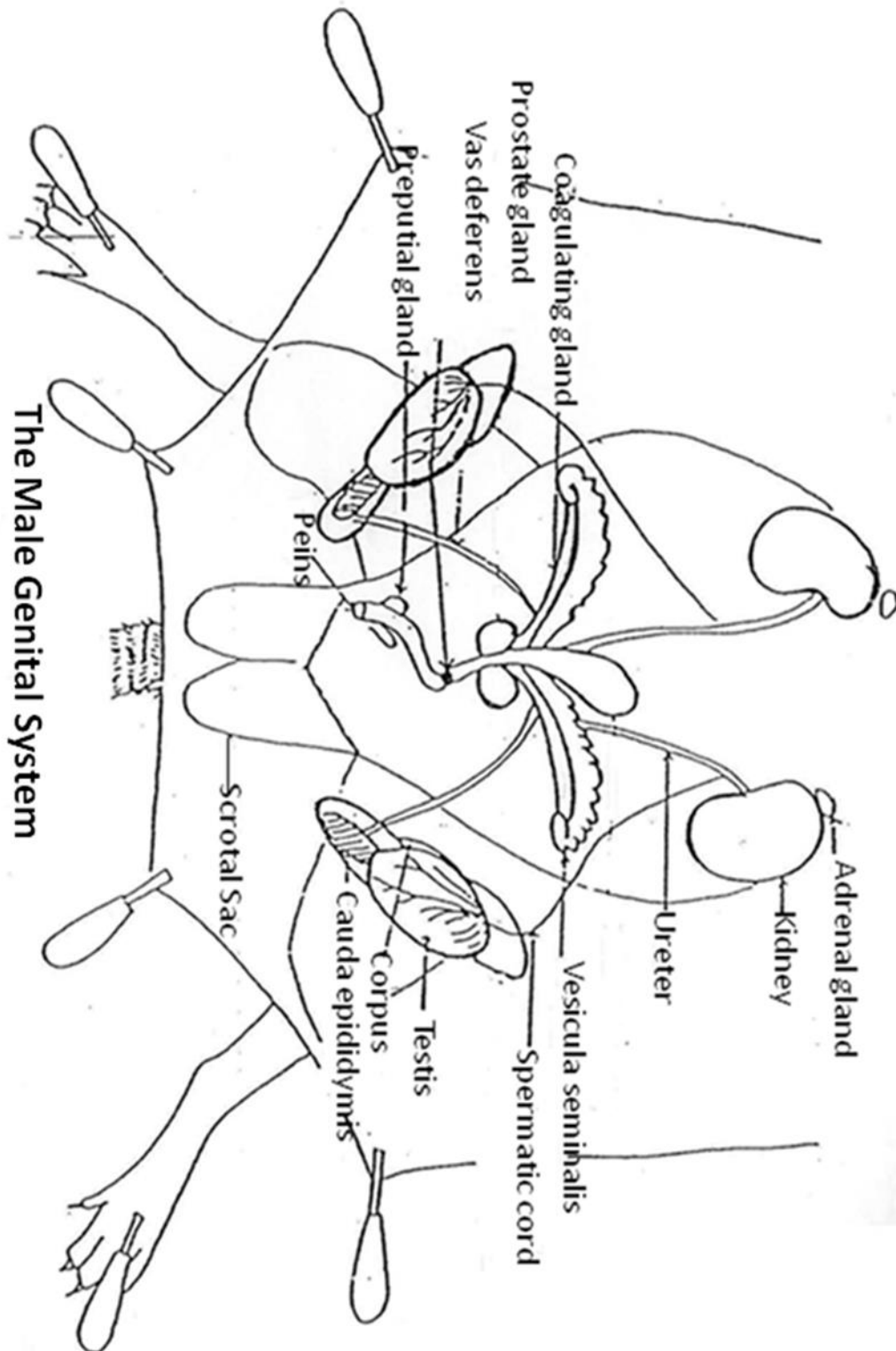
***The two uterine** horns open separately into the vagina which extends backwards lying dorsal to the urethra but ventral to the rectum and anal passage. The external opening of the vagina is immediately posterior to the opening of the urethra.

*Two prepuccial glands lie under the skin on the sides of the urethra but open into the vagina. They are not part of the reproductive system.

*In young rats the opening of the vagina is partially covered by a membrane called the hymen.



The Female Genital System



The Male Genital System

The Nervous System :

*This consists of the **central nervous** system and **the peripheral nervous** system.

*The central nervous system consists of **the brain**, which is enclosed by the skull, and the **spinal cord** which extends within the spinal column.

*The peripheral nervous system consists of the cranial nerves, which originate from the brain, and **the spinal nerves**, which originate from the spinal cord and innervate all parts of the body.

To study the brain and the cranial nerves, the skull has to be dissected open. The spinal nerves can be studied in the dissected rat after removing all the viscera.

Dissection of The Head :

1 .Remove the skin of the head with the help of the scalpel. Separate with a bone-

Cutter the two halves of the lower jaw.

2 .Remove the upper and side walls of the cranium. Cut the roots of the cranial nerves

On both sides, and very gently take the brain out, put it in the dissecting dish

Examine it.

3 .Examine also the roots of the cranial nerves.

Observations :

*The brain is ensheathed by the Dura (outer) and Pia (inner) mater.

*In the dorsal side, the following parts are, clearly seen:

1 .**Two large cerebral hemispheres**, separated by the median fissure, which form the major part of the brain.

2 .**The olfactory lobes** which are found in front the cerebral hemispheres.

3 .**The cerebellum** which consists of a median lobe or vermis and two lobes lateral to the vermis, each is called the flocculus and carries laterally a small lobe called the paraflocculus.

4 .The cerebral hemispheres are separated from the cerebellum by the

venous sinus, in which projects the pineal body (at the tip of a pineal stalk) which lies at the end of the median fissure.

*The medulla oblongata merges backwards from the brain and connects it with the spinal cord.

*In the ventral surface, the olfactory lobes, the cerebral hemispheres, the flocculus, the paraflocculus and medulla oblongata are clearly seen. In addition, the pituitary body, just anterior to the medulla oblongata, and the optic chiasma are observed.

*The roots of the cranial nerves consists of 12 pairs, which are, on each side:

- I. The olfactory nerve.
- II. The optic nerve.
- III. The oculomotor nerve.
- IV. The trochlear nerve.
- V. The trigeminal nerve.
- VI. The abducens nerve.
- VII. The facial nerve.
- VIII. The auditory nerve.
- IX. The glosso-pharyngeal nerve.
- X. The vagus nerve.
- XI. The spinal accessory nerve.
- XII. The hypoglossal nerve.

The Spinal Nerves :

1 .the rat has 34 pairs of spinal nerves: 8 cervical, 13 thoracic, 6 lumbar, 4 sacral and 3 caudal.

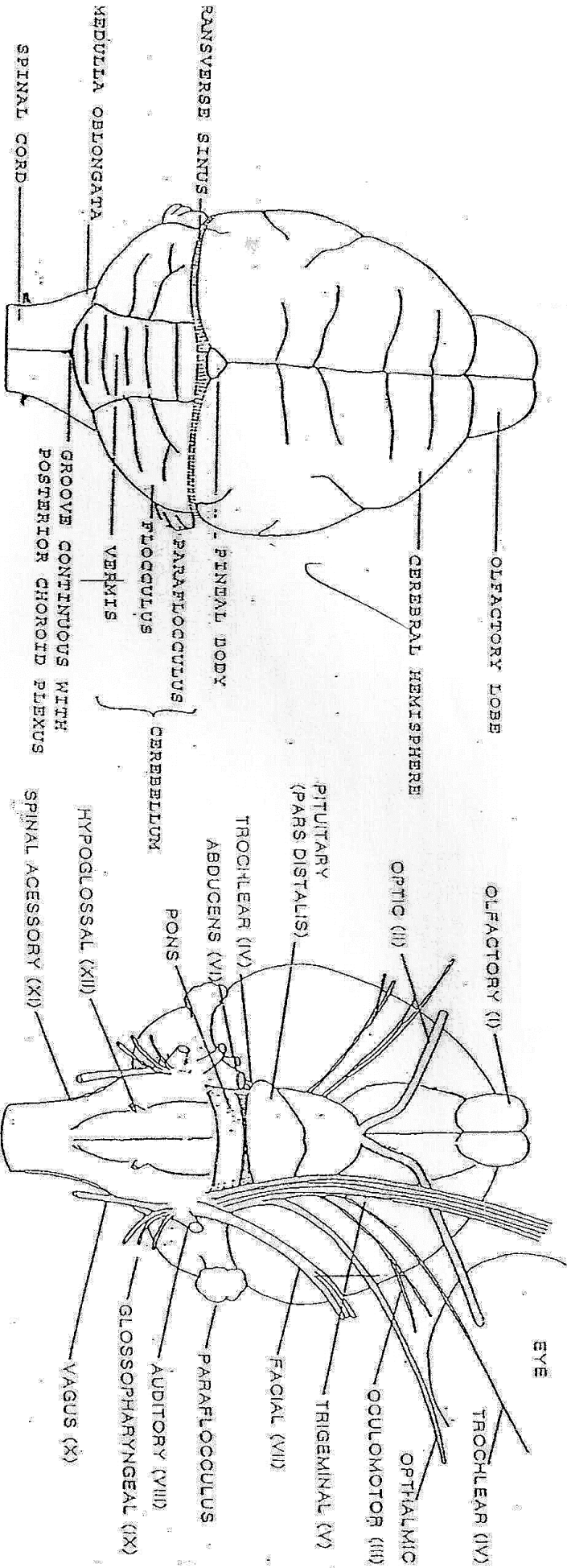
2 .In the regions of the limbs, the spinal nerves form networks or plexuses interiorly,

The brachial plexus is composed of 6 nerves beginning with the fourth cervical and

Ending with first thoracic nerve. Posteriorly, the lumbo-sacral plexus is composed

Of 7 nerves beginning with the first lumbar and ending with first sacral nerves.

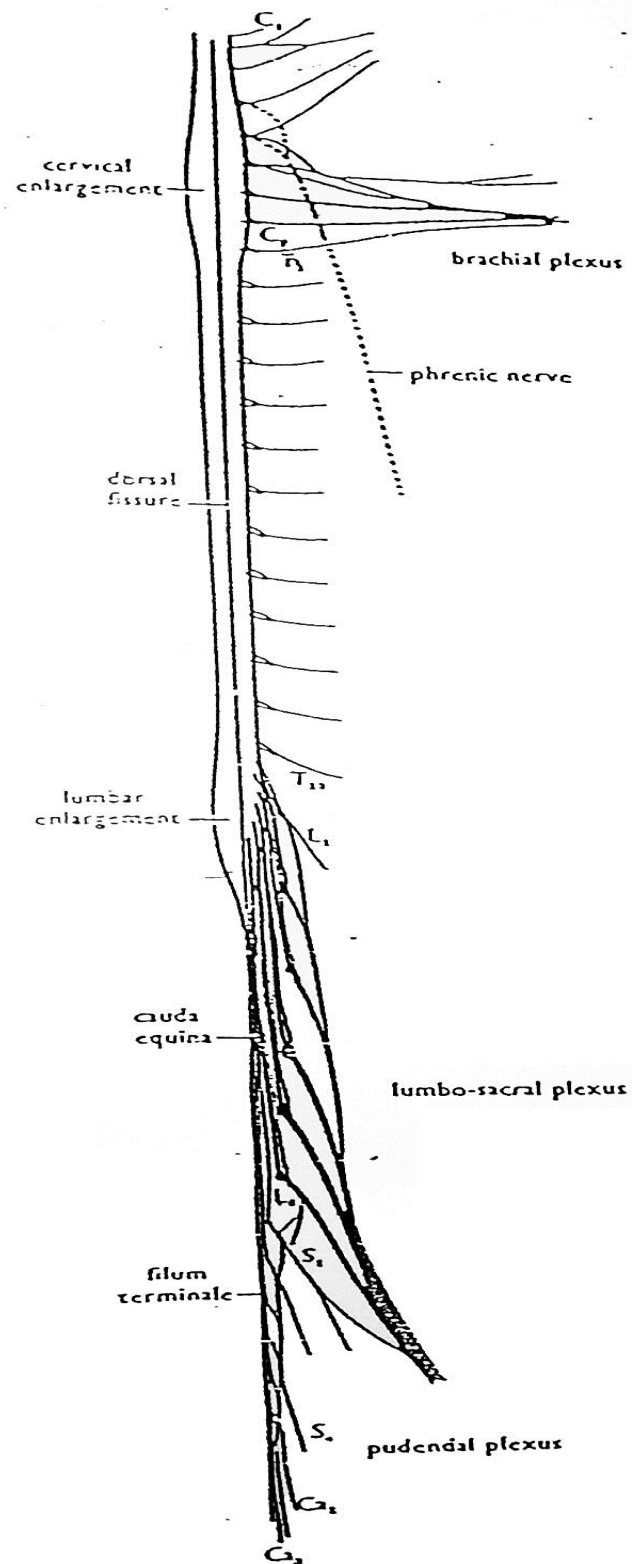
THE BRAIN OF THE RAT



DORSAL VIEW

VENTRAL VIEW

THE SPINAL NERVES OF THE RAT



THE RAT

THE CIRCULATORY SYSTEM

The Circulatory System.

* Remove the thymus gland away, and cut through the pericardium as you did with the other vertebrate animals, to expose the heart and roots of the large blood vessels. Note that the heart, together with the thoracic part of the oesophagus, aorta,.. etc. lie in a special cavity, — *the mediastinal cavity*.

Identify the chief vessels connected to the heart :

Into the right auricle open three venae cavae, two anterior, right and left, and one posterior. Into the left auricle open two pulmonary veins which unite just in the auricular wall. The pulmonary arch comes out from the right ventricle, while the systemic aorta comes out from the left ventricle. Note the ligamentum arteriosus (ductus in the embryo), a thin fibrous cord connecting the pulmonary arch with the aorta.

—In the Venous System, note :

i) The right anterior vena cava, formed of the following tributaries :

—The internal jugular vein from the brain, and runs in the neck.

—The external jugular vein is large and runs along the side of the neck. It is

formed of the **anterior (internal)** and the **posterior (external)** facial veins collecting blood from the face.

—The **subclavian vein**, from the fore-limb and the shoulder.

— The **internal mammary vein** is small and drains the upper side of the sternum.

— The **anterior intercostal vein** is small and drains the anterior 4 or 5 intercostal spaces.

— The **azygos vein** is single and median, and runs close to the vertebral column

along the right side of the aorta. It receives tributaries from the posterior 7-8

intercostal spaces of both sides.

ii) The **left anterior vena cava** is formed of similar veins like those of the right

iii) one, except that *it lacks an azygos vein*.

iv) The **posterior vena cava** receives the following veins :

—The **phrenic veins** are a pair of small veins draining the diaphragm.

— The **hepatic veins** are 3-4 large veins from the liver.

—The **renal veins** are one pair from the kidneys.

— The **spermatic or ovarian veins** are one pair from the testes or ovaries respectively.

— The **iliolumbar veins** are one pair from the hinder abdominal region.

— The **external iliac veins** are one large pair from the hind-limbs. Each receives a small **vesical vein** from the urinary bladder. The external iliac vein is a direct continuation of a **femoral vein** which extends along the inner border of the thigh.

— The **internal iliac veins** are one pair from the back of the thighs .

iv) The **hepatic portal vein** (or **portal vein** since it is single in mammals; the renal portal veins being absent) receives several factors: the **duodenal vein**; the **anterior** and **posterior mesenteric veins**, from the intestine and rectum; the **lienogastric vein** from the stomach and spleen; and runs into the liver where it breaks into several branches in its lobes.

v)The **pulmonary veins**, from the two lungs and open into the left auricle.

—In The Arterial System, note :

—The **pulmonary arch**

comes out from the right ventricle, curves over on to the dorsal side of the heart and branches into two **pulmonary arteries** to the lungs.

— The **systemic aorta**

arises from the left ventricle, passes dorsal to the pulmonary arch and curves around the dorsal side of the heart to lie ventral to the vertebral column, where it extends backwards as the **dorsal aorta**. It gives off an **innominate artery**, from which arise the **left and right common carotid arteries** to the head. Each of them divides at the base of the head into the **external and internal carotid arteries**. From the right common carotid, and close to its origin from the innominate artery, there arises the **right subclavian artery** to the right fore-limb. The **left subclavian artery** arises from the aorta directly*. Each subclavian artery gives off a **vertebral artery** to the cervical vertebrae and an **internal mammary artery** to the ventral thoracic wall.

The dorsal aorta gives off **intercostal arteries** (usually 9) to the thoracic wall; **coeliac artery**, to the liver (**hepatic a.**) and to the stomach and spleen (**lienogastric a.**) ;**anterior mesenteric artery**, to the intestine; two **renal arteries**, to the kidneys; two **spermatic arteries**, to the testes, or two **ovarian arteries** to the ovaries; **posterior mesenteric**

artery to the rectum; and two **common iliac arteries**, which result from the bifurcation of the dorsal aorta, each gives off an **iliolumbar artery** to the body wall, an **internal iliac artery** to the pelvic region, and a **vesical artery** to the urinary bladder. The common iliac artery then runs into the hind-limb along which it is continued as the **femoral artery**.

The Heart.

* Cut through the great vessels slightly off the base of the heart, and study this organ. You may

use the heart of sheep or ox to help you in your study.

* Open the right ventricle by cutting through its wall longitudinally, then continue the incision forward along the pulmonary arch. Remove any blood clot that you may find.

The right auriculo-ventricular opening is guarded by a tricuspid valve formed of 3 flaps or cusps, and connected to the free edges of which are delicate but strong threads or cords, the chordae tendineae, which extend to the tips of prominent projections, the papillary muscles, in the ventricle wall. This is produced into longitudinal muscle ridges, the columnae carnaeae.

Note that the opening of the pulmonary arch is guarded by 3 pocket-like semilunar valves.

* Open the left ventricle and the systemic aorta as you did with the right side.

_ Note that the left ventricle is much thicker walled than the right, and the left auriculo-ventricular opening is guarded by a mitral or bicuspid valve, formed of two flaps only, with the same features as in the right ventricle. The opening of the systemic aorta is also guarded by 3 semilunar

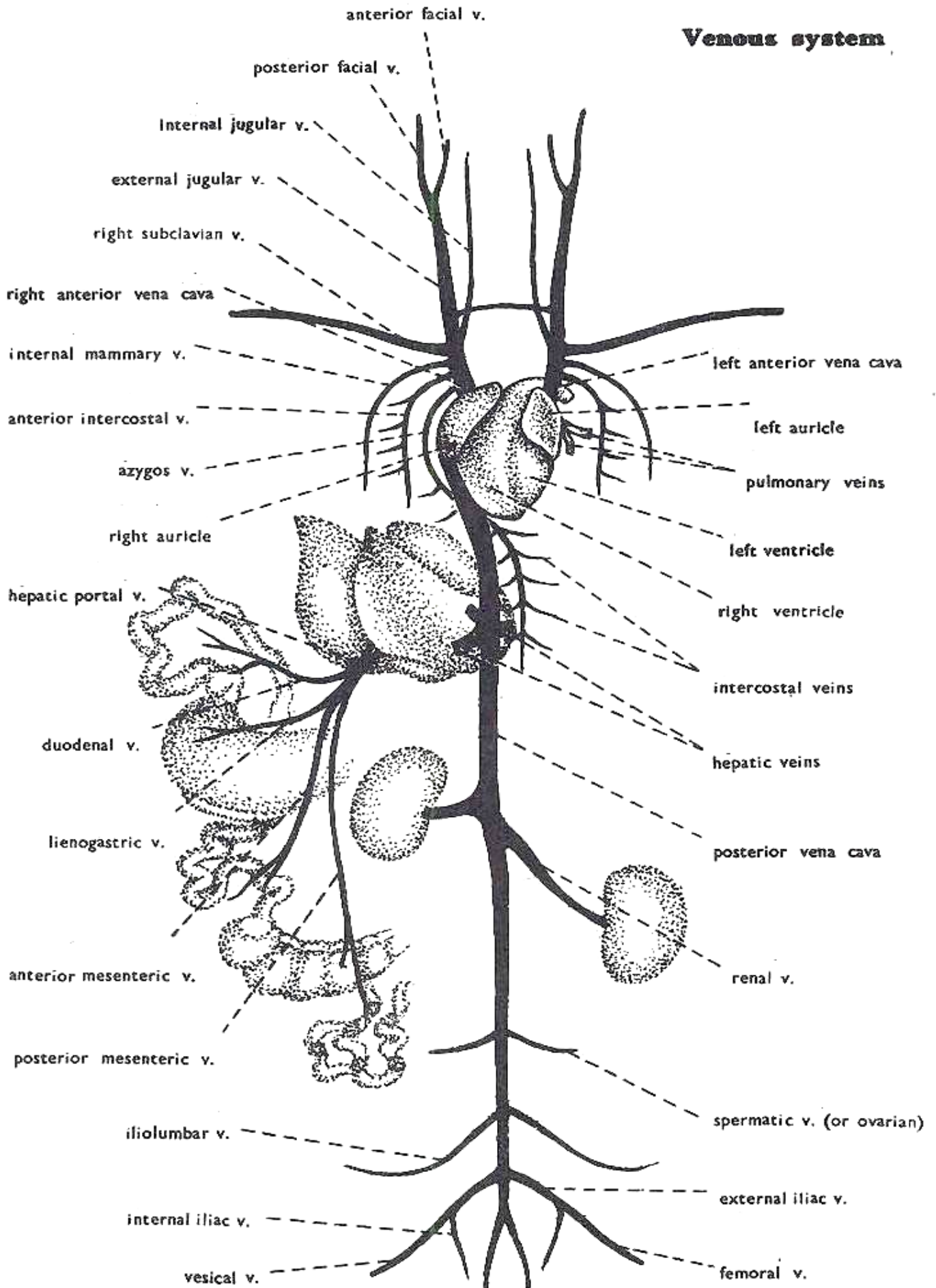
valves. The aorta gives off, just beyond the valves, the coronary arteries which supply with blood the muscular wall of the heart; the coronary veins collect blood from it to be poured into an anterior vena cava.

* Open the right and left auricles.

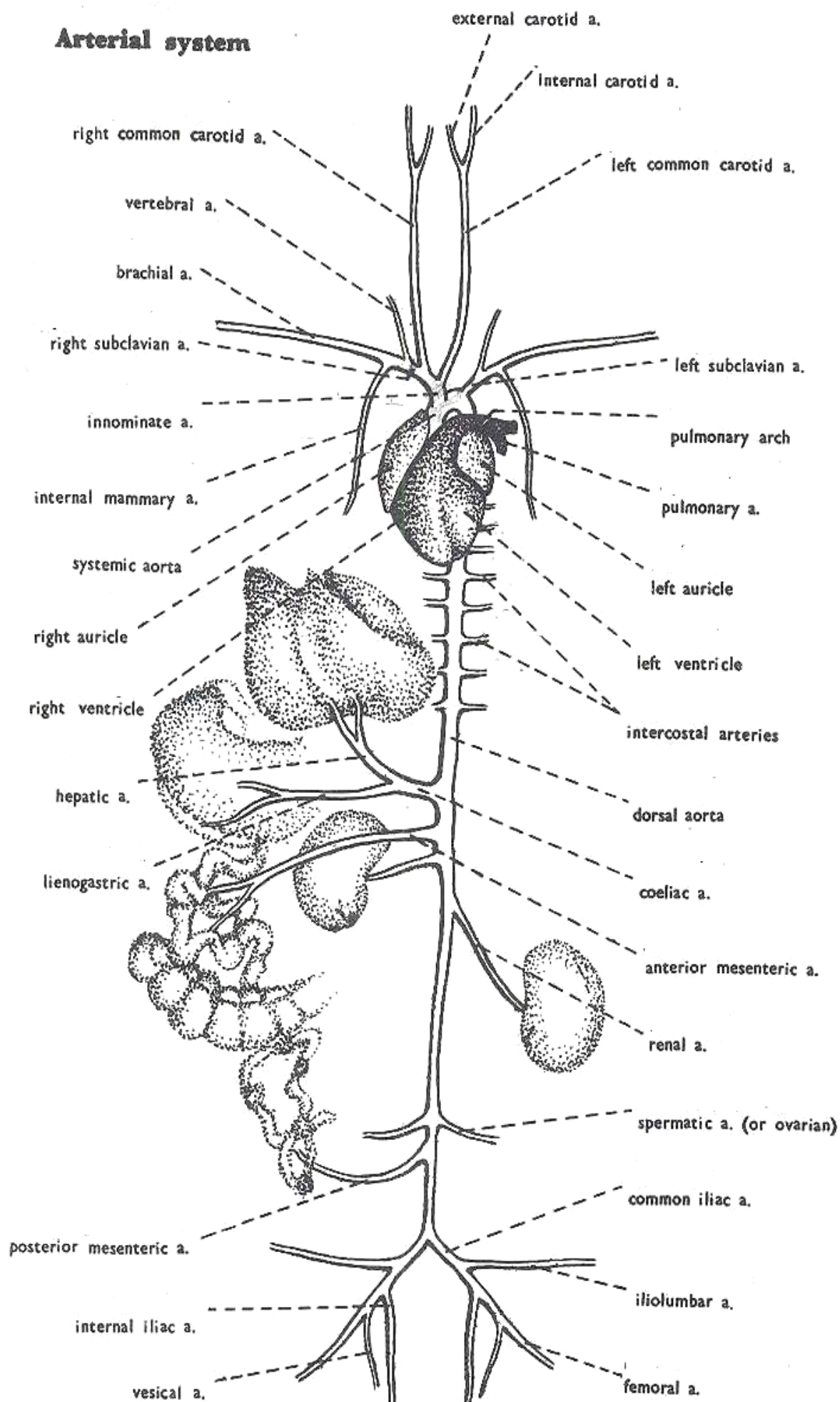
Note the interauricular septum in which is found a depression, the fossa ovalis, which in the embryo was an opening, the fenestra ovalis.

* Prepare a film of blood of the rat. Examine it and point out the difference between it and the blood of the other vertebrates you studied.

Venous system



Arterial system



THE RAT

THE SKELETON

The skeleton of vertebrates is composed primarily of bone. Cartilage covers articular surfaces between bones and connects the ribs to the sternum. The skeleton is divided into two major parts:

- The **Axial skeleton** includes the skull, mandible, hyoid, ribs, sternum, and vertebrae
- The **Appendicular skeleton** includes the girdle, limb and feet bones

The Axial skeleton

Skull:

The skull which is part of the axial skeleton has two major regions. The facial region houses the nose, eyes, and provides support for the jaw. It is elongate in mammals that depend on their sense of smell. The more posterior cranial region of the skull houses the brain and ear. The size of this region depends on brain volume. At the back of the skull is the **foramen magnum** through which the spinal cord passes into the vertebral column. On either side of the foramen magnum are the **occipital condyles**, which articulate with the first cervical vertebra.

Premaxillary and maxillary: These bones are associated with the teeth. The large incisors are located in the premaxillary bones and the molars are in the maxillary bones.

Nasal: These bones form the dorsal wall of the nasal cavity.

Frontal: These bones form the roof of the anterior portion of the skull and the lateral wall of the eye socket.

Zygomatic arch: The arch encloses the ventrolateral side of the orbit. It is composed of three bones: the **maxillary** at the anterior end, the **zygomatic bone** in the middle and the **temporal bone** forming the posterior margin. An expanded **tympanic bulla** with an opening to the inner ear lies at the base of the temporal bone.

Parietal & Interparietal: These bones and the temporals form the dorsal and lateral wall of the cranium.

Occipital: This bone has the occipital condyles and foramen magnum on its caudal surface.

Palatine: These bones form the roof of the mouth and the ventral surface of the facial portion of the skull.

Sphenoid: These bones form the ventral wall of the cranial cavity, that houses the brain.

Mandible: Two **dentary** bones fuse anteriorly to form the lower jaw or mandible which provides support for two types of teeth: **incisors** for gnawing and **molars** for grinding.

The many openings in the skull bones provide for the passage of nerves and blood vessels. Flat spaces and ridges provide surfaces for attaching muscles that support the **skull and jaw**:

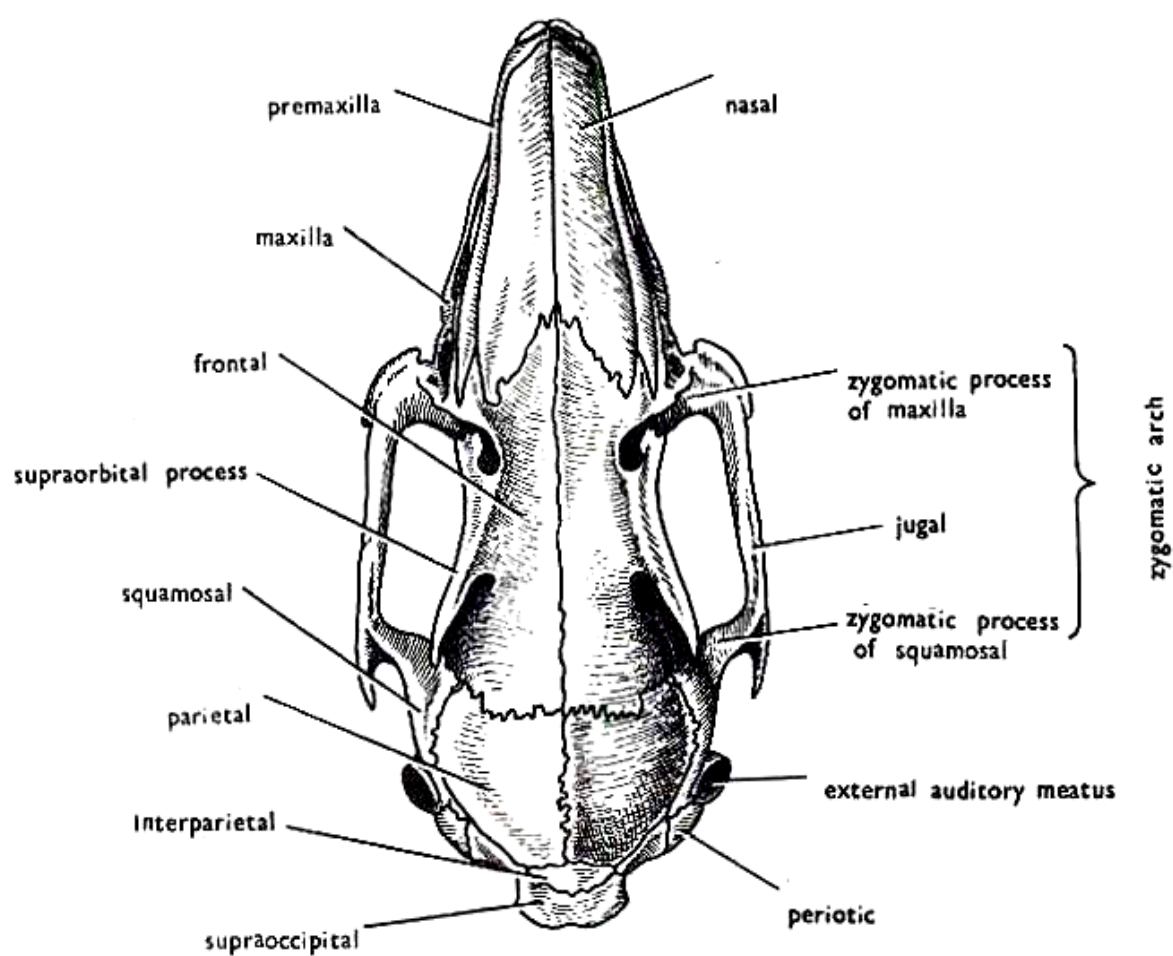
The lower jaw is formed of a single dentary in each half or ramus, the two rami being connected at the **symphysis mentis**. Note that each ramus is formed of a horizontal body, carrying teeth, and a vertical ascending portion, showing a dorsal **coronoid process**, a **condyle** for the articulation, and a **ventral angular process**.

Vertebral Column, Ribs and Sternum: are part of the axial skeleton. The vertebrae provide support for the head and body. All vertebrae have a similar basic design. Typical vertebra. Vertebrae all have a body or **centrum** located on the ventral surface of the bone. The size of the centrum varies along the length of the vertebral column. Vertebrae also have an arch that creates a large opening through which the spinal cord passes. Vertebrae have three types of processes: a dorsal **spinous process**, lateral **transverse processes**, and anterior and posterior **articular processes**. The articular processes orient dorsally on the anterior surface of a vertebra and ventrally on the posterior surface. Muscles that control the movement of the vertebral column attach to these processes. Pay special attention to how the processes change along the length of the vertebral column. Also note the manner in which the vertebrae overlap.

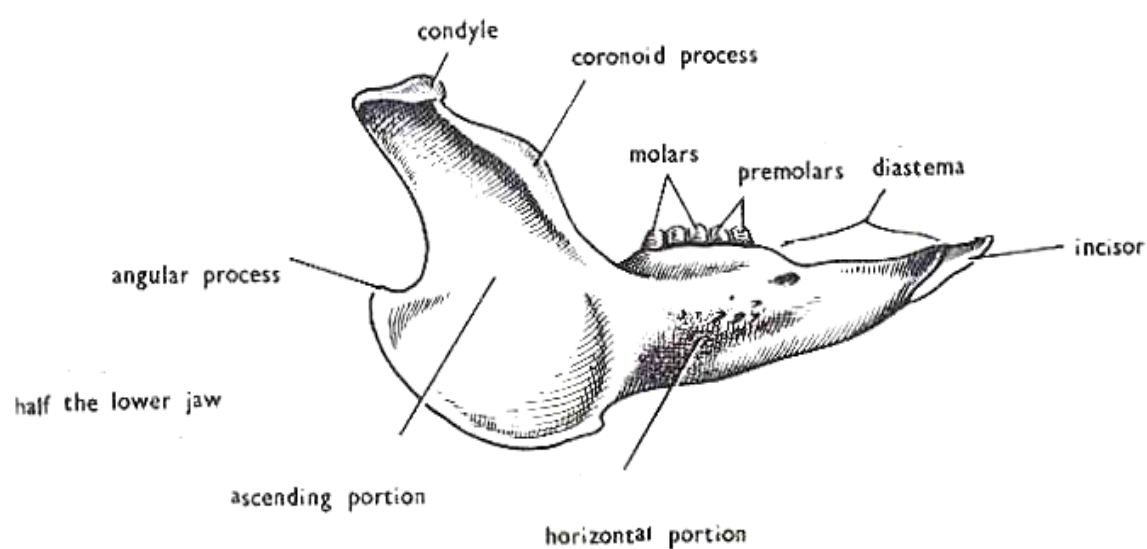
The different types of vertebrae that compose the vertebral column: **Cervical vertebrae**, **Thoracic vertebrae**, **Lumbar vertebrae**, **Sacral vertebrae**, **Caudal vertebrae**.

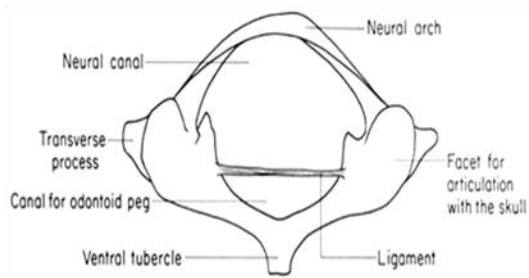
The Appendicular Skeleton

The appendicular skeleton consists of the **pectoral** (shoulder) **girdle**, the **pelvic** (hip) **girdle** and the **limbs**. In rats the pectoral girdle consists of the **scapula** and **clavicle**. The pelvic girdle is composed of 3 bones that have fused together — the **ilium**, **ischium** and **pubis**. The forelimb consists of the long bones — the **humerus**, **radius**, and **ulna** — and the bones of the wrist and hand. The hindlimb is divided the same way, except that the long bones are called the **femur**, **tibia**, and **fibula**.

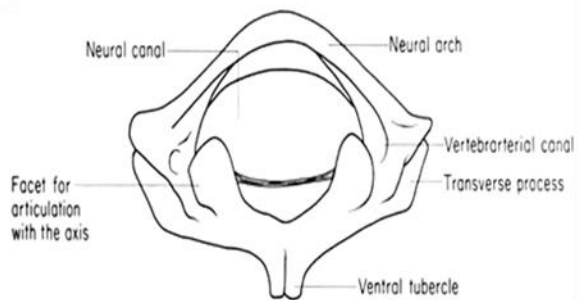


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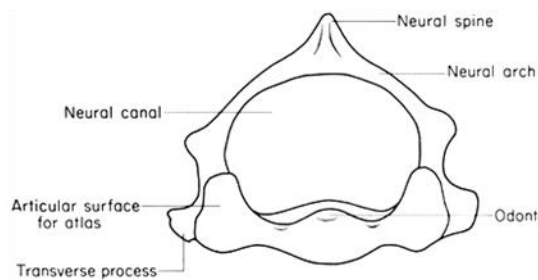


Anterior view



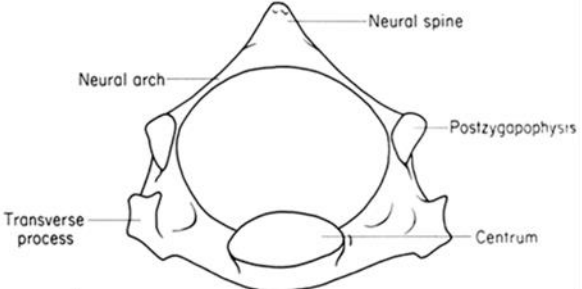
Atlas

Posterior view

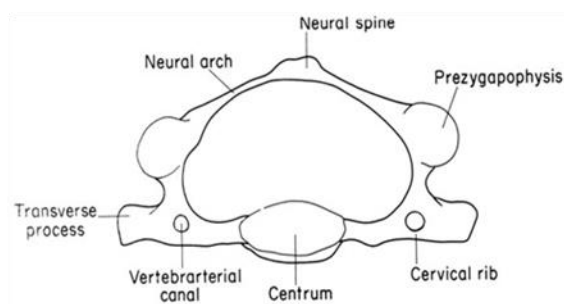


Anterior view

Axis

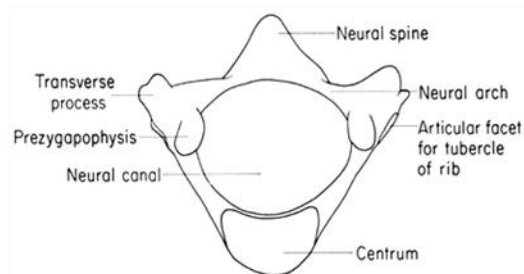
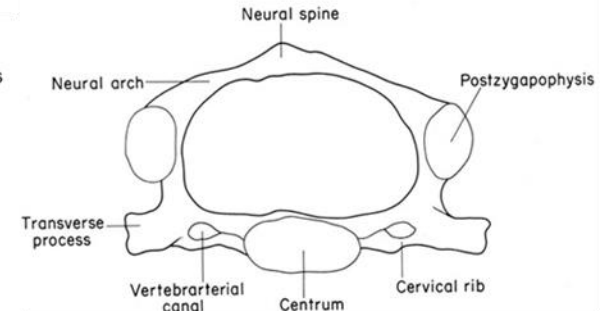


Posterior view



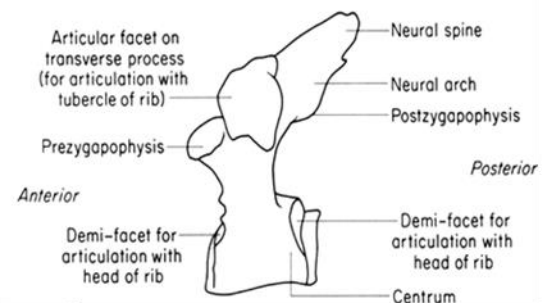
Anterior view

Cervical vertebra

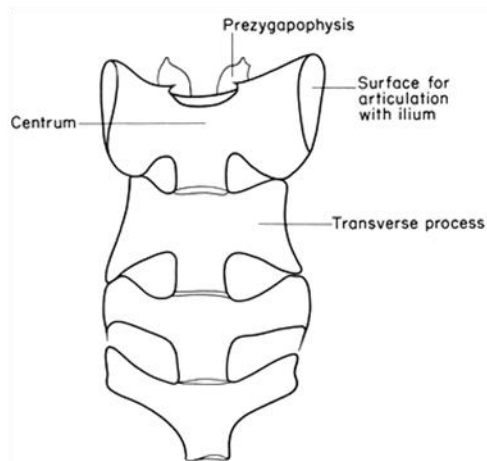
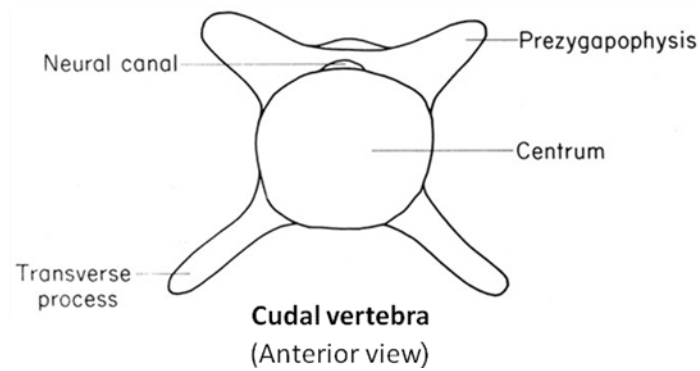
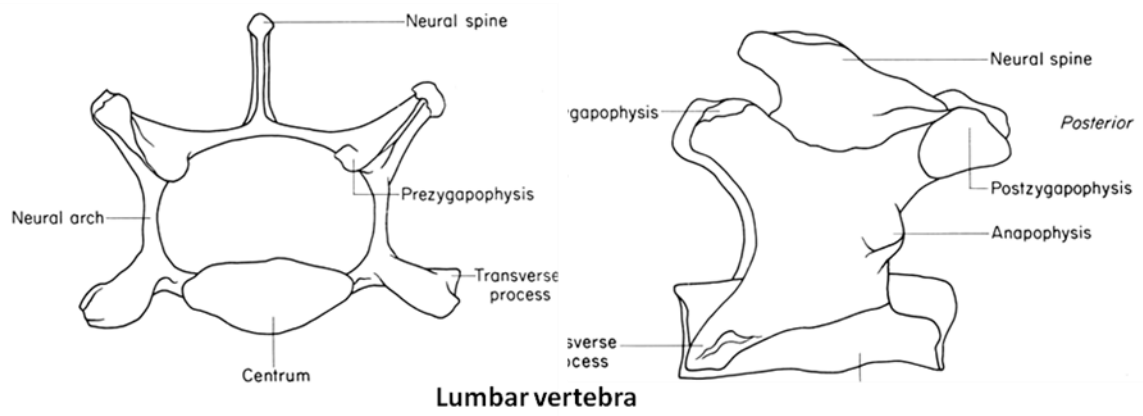


Anterior view

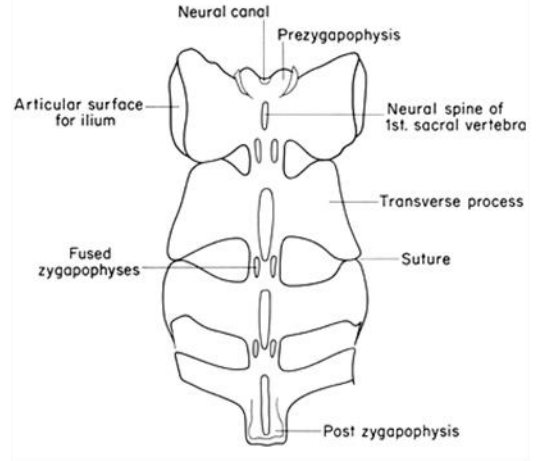
Thoracic vertebra



Lateral view

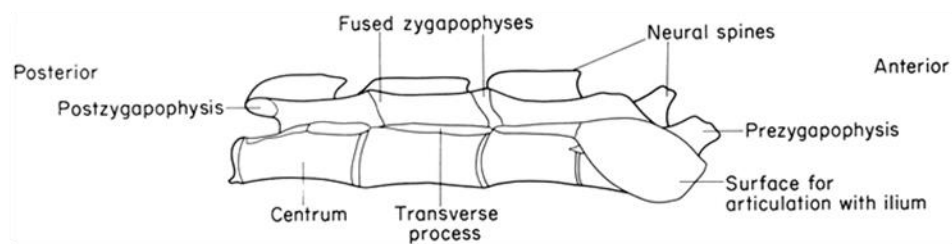


Ventral view

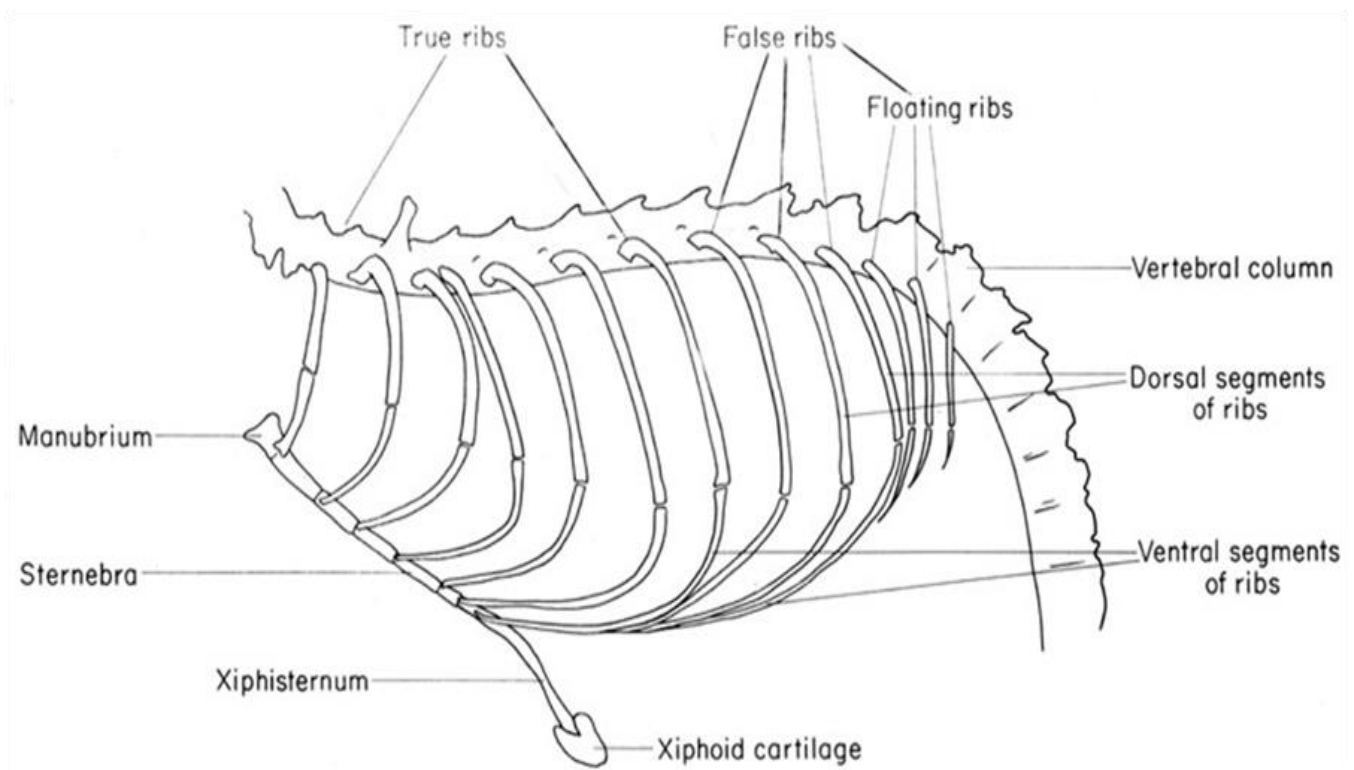


Dorsal view

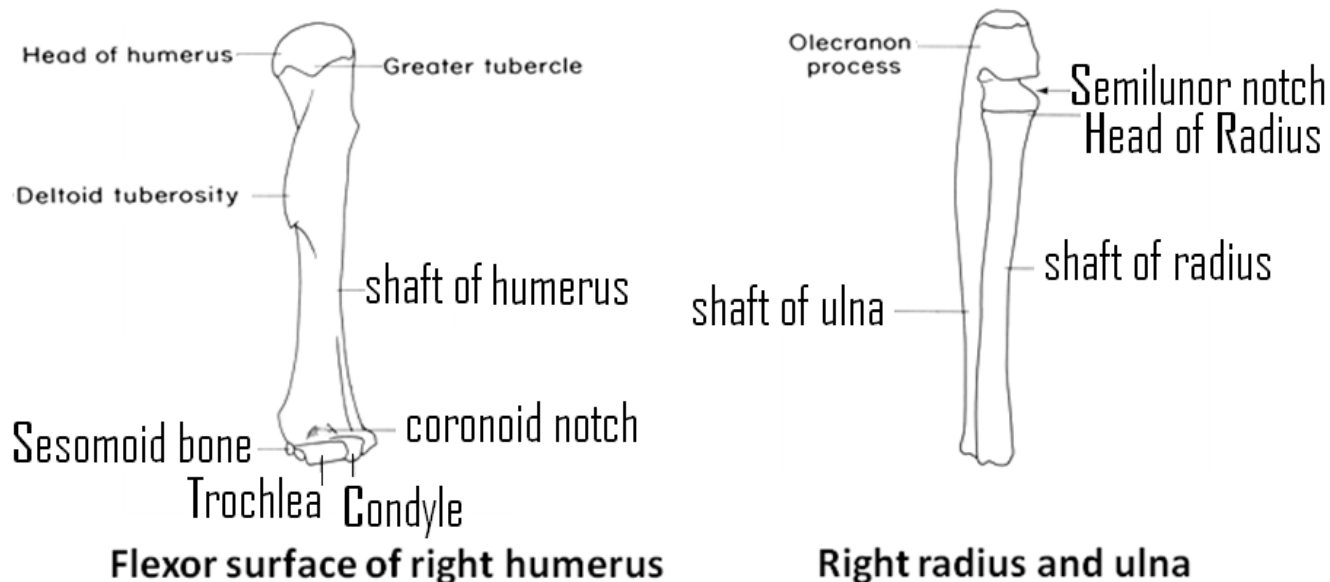
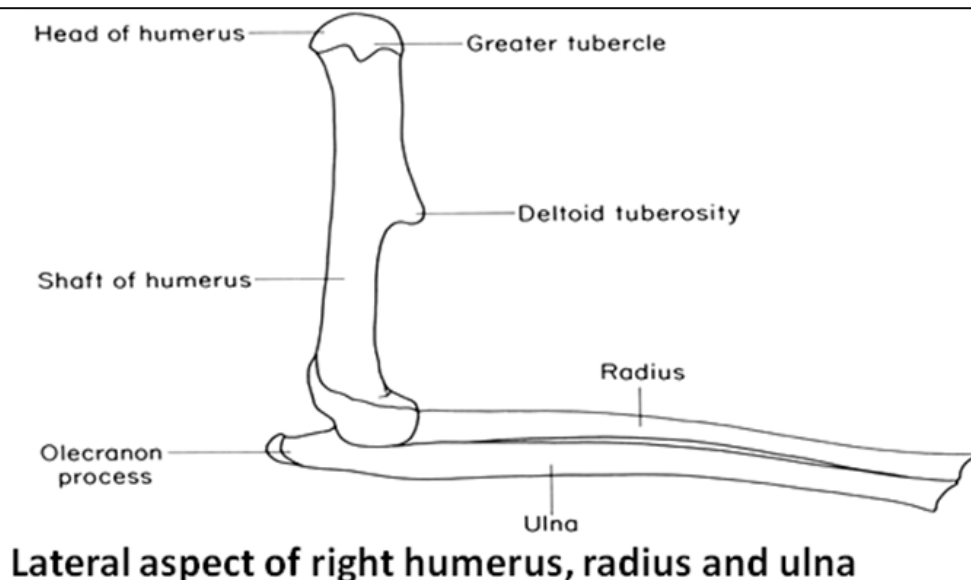
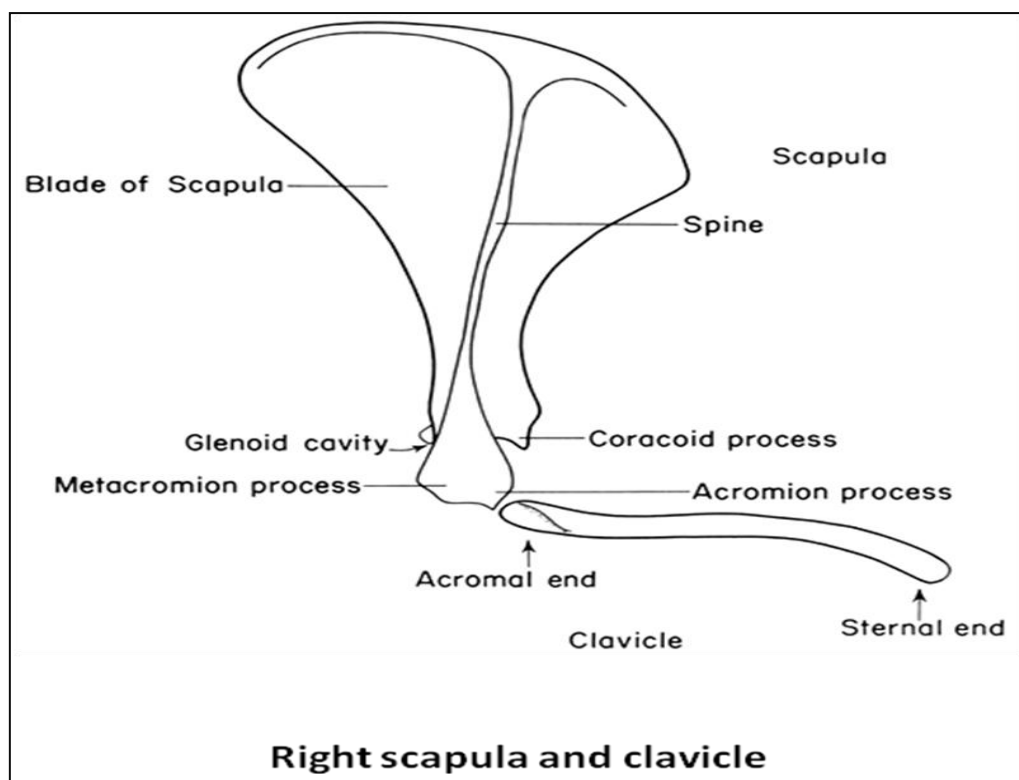
Sacral vertebra

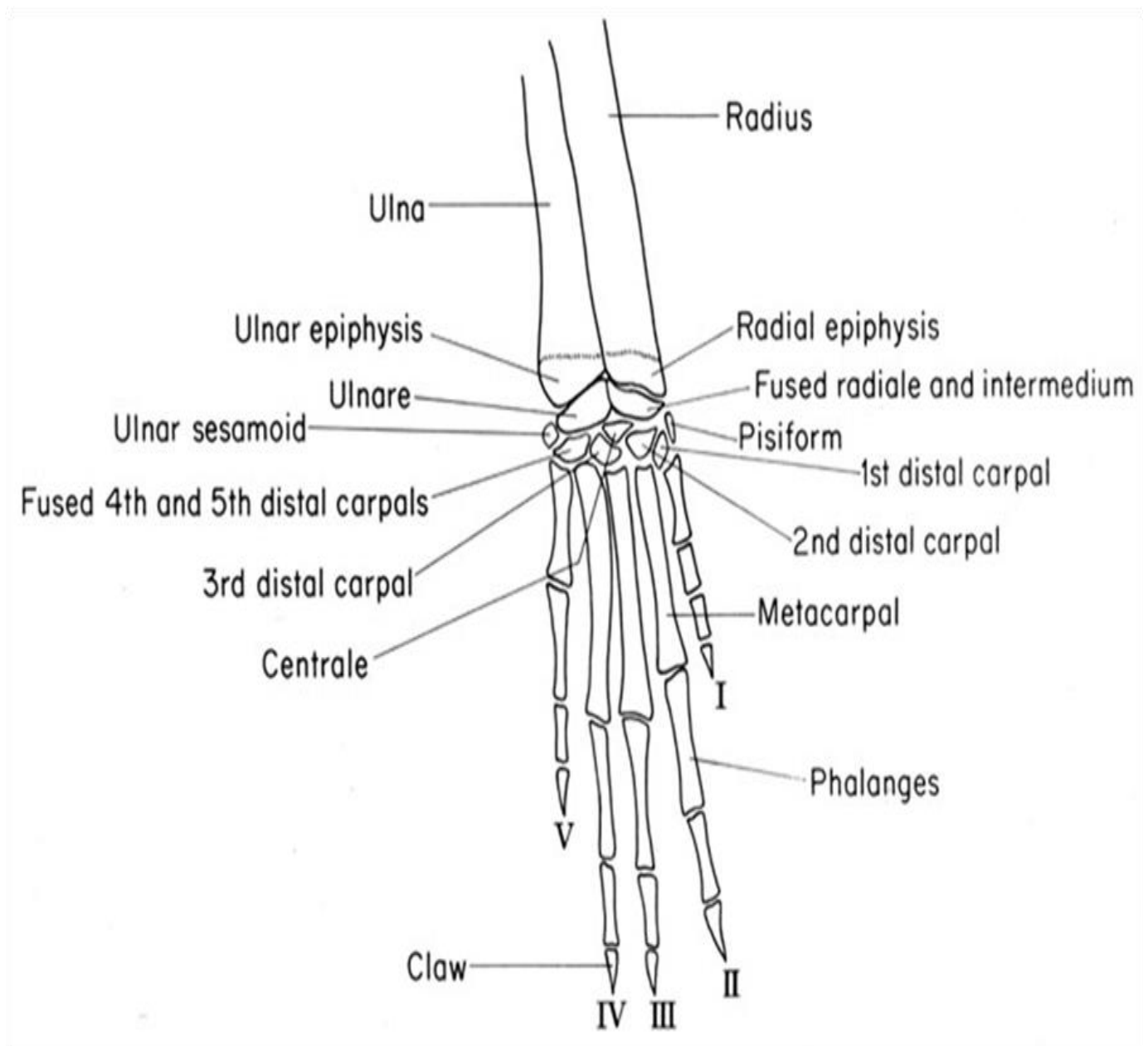


Lateral view

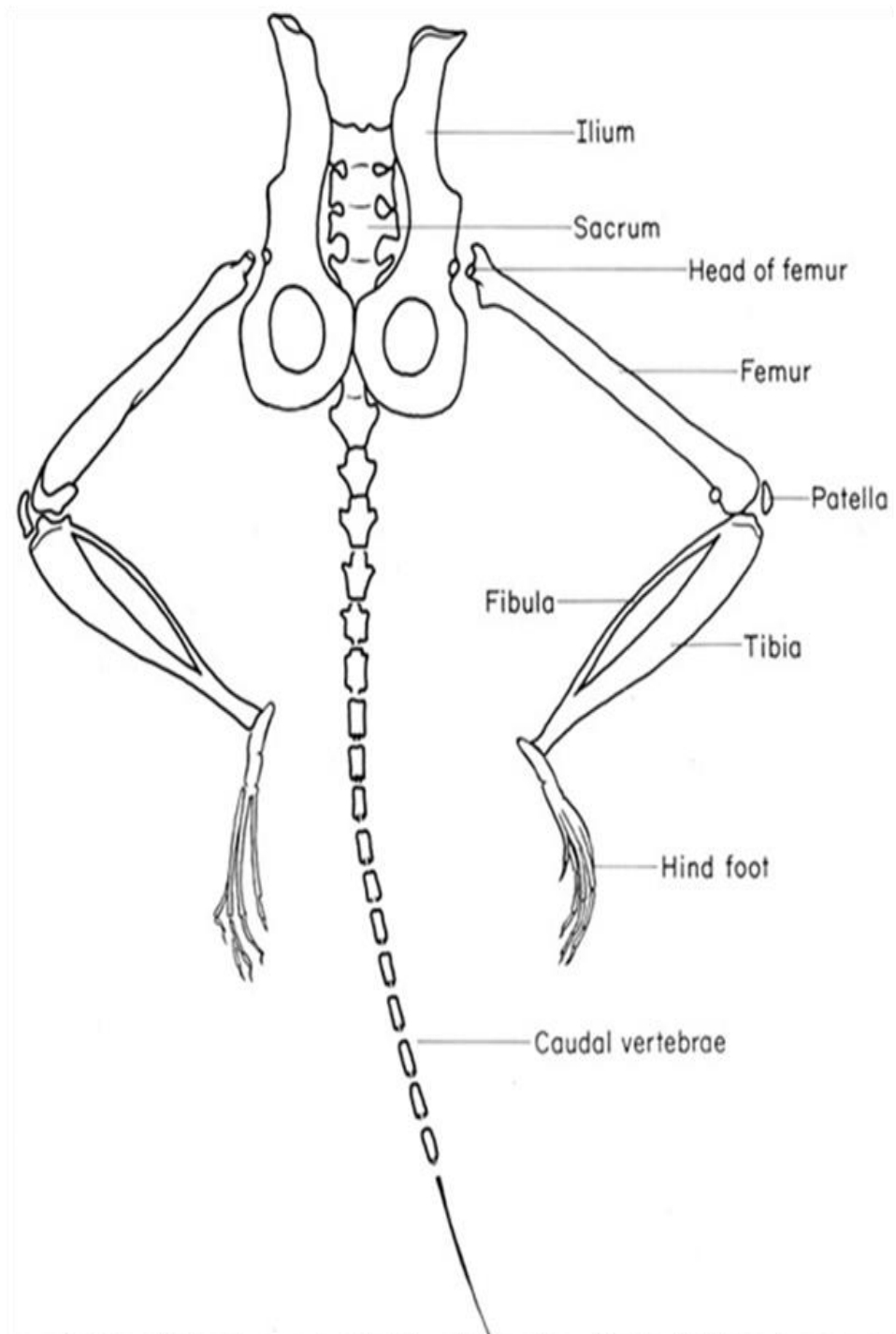


Thoracic cage, formed by 13 thoracic vertebrae, 13 pairs of ribs and the sternum

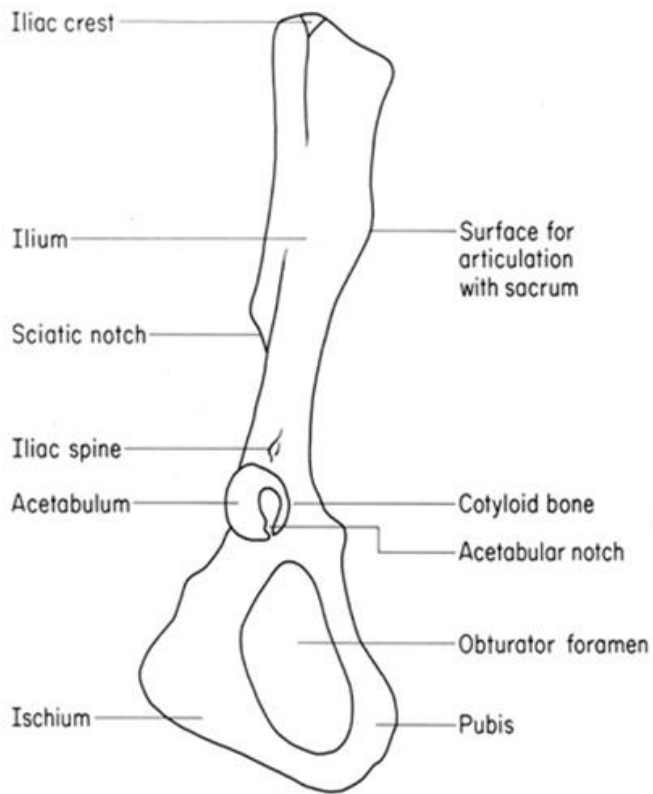




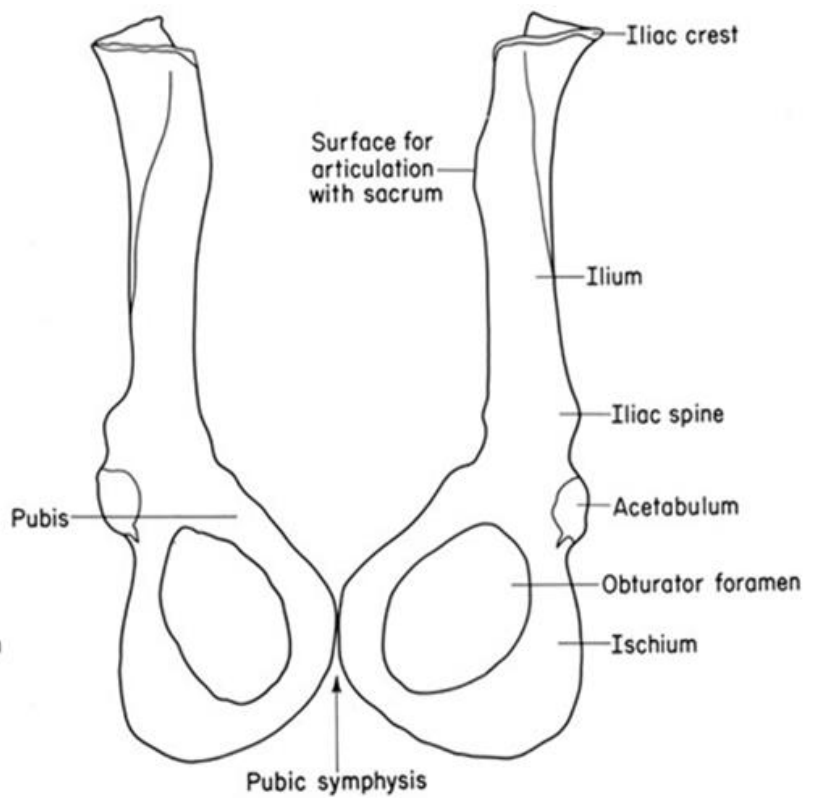
Skeleton of hind-limb



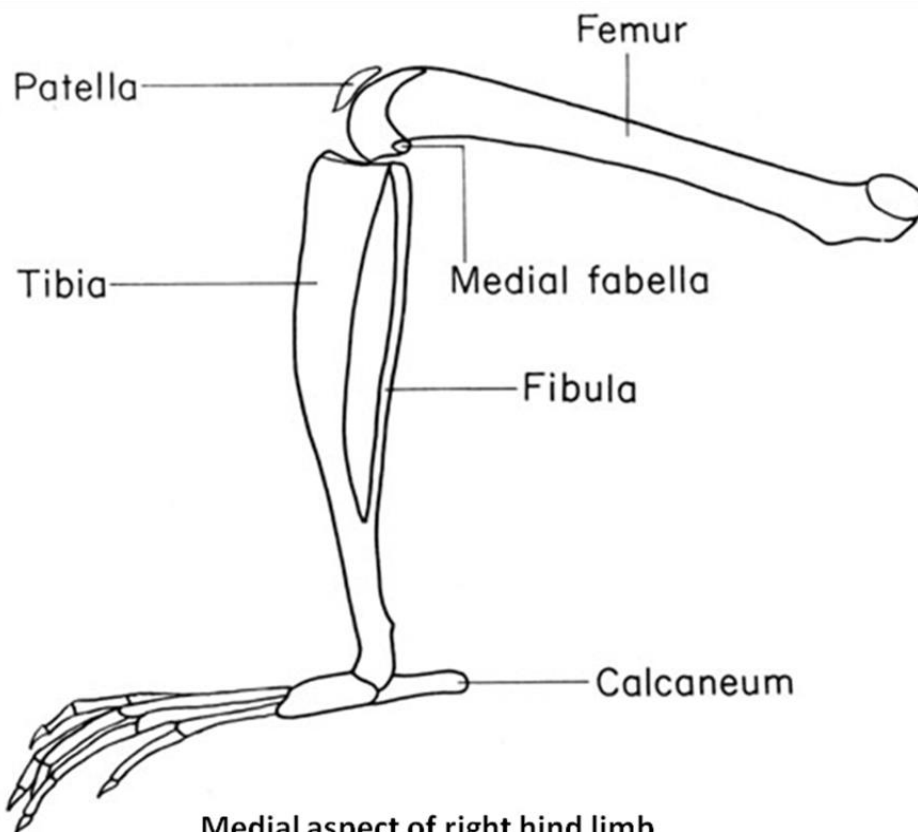
Pelvic girdle and hind limbs, partially disarticulated. Ventral aspect



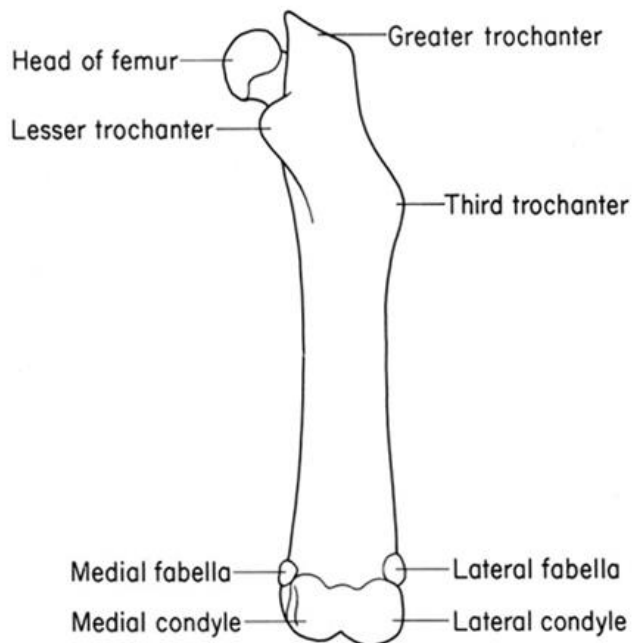
Half Pelvic Girdle



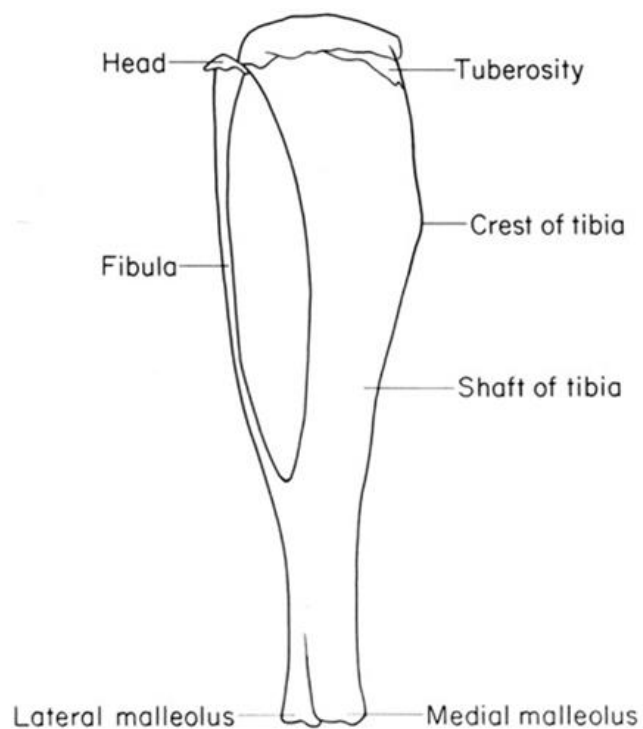
Pelvic Girdle



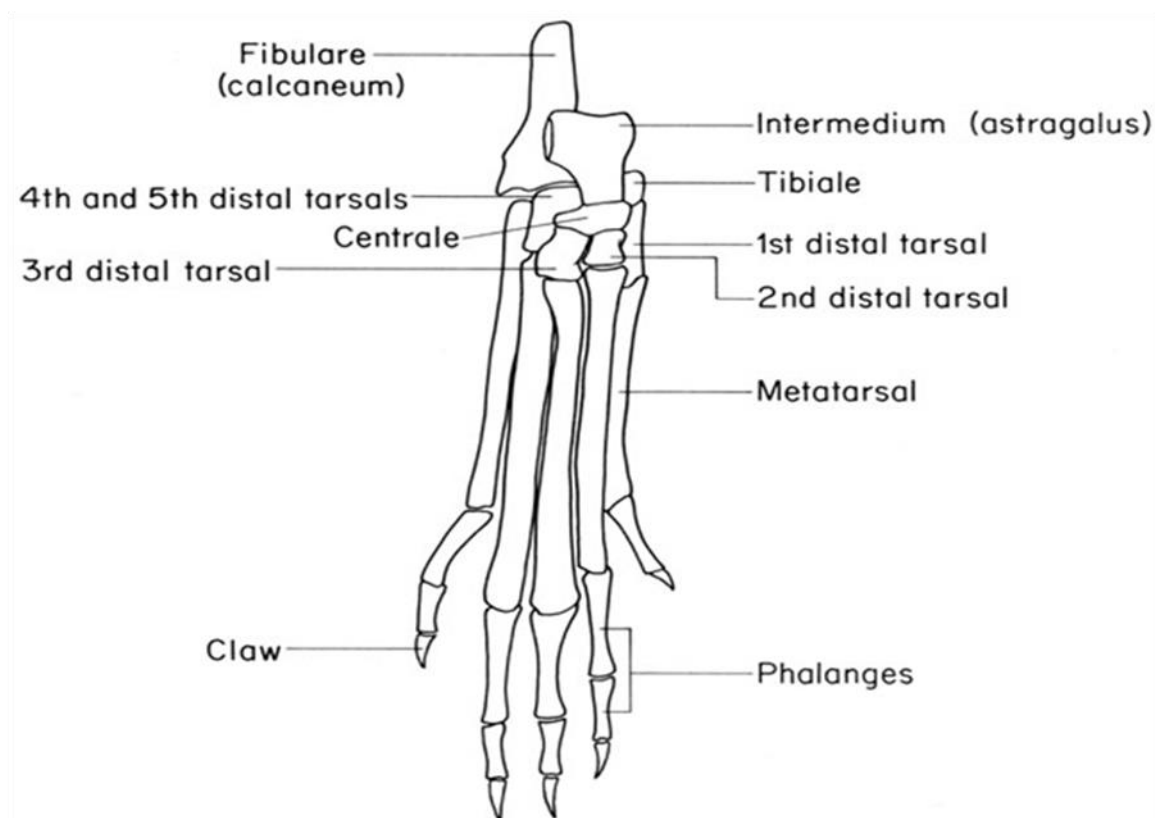
Medial aspect of right hind limb



Right femur.



Right tibia and fibula



Skeleton of fore-limb