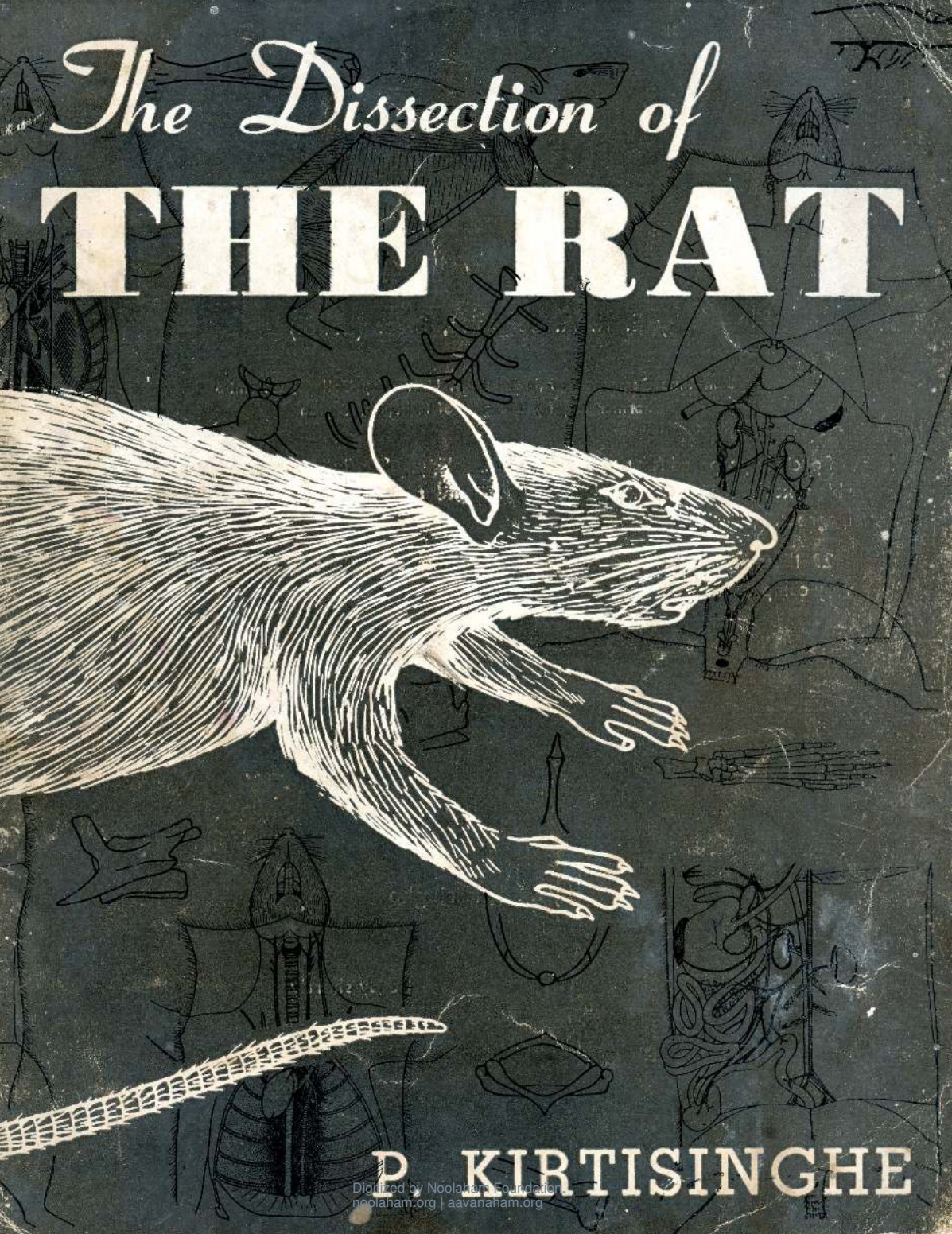
The Dissection of THE RAT



P. KIRTISINGHE

THE TOAD

by E. R. A. de Zylva, B.Sc. (Lond.)

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Former Deputy Director of Fisheries, Ceylon

Specially prepared for the beginner in Zoology. Highly recommended as a suitable text for the G. C. E. (Advanced Level) and the First Examination for Medical Degrees.

29 illustrations, being drawings of actual dissections by the Author. Includes a very comprehensive Index.

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THE SHARK

by P. Kirtisinghe

Ready shortly

G. BALASING...
10TH MAY 1963

The dissection of

THE RAT

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INTRODUCTION

The rat is the mammalian type used for dissection in the first year course in Zoology for science as well as for medical studies in Ceylon. There are already a few books that deal with the dissection of this animal. Among these is the "Anatomy of the Rat" by Greene, a voluminous work containing numerous illustrations, with brief notes, of the detailed anatomy of the animal. Excellent though it is as a reference book for teachers and advanced students, it is very much beyond the scope of the first year student. Then there is "The Rat as a small Mammal" by Rowett. This work brings together much data concerning the rat, but the author himself admits that there is more detail in it than is needed by students of this level. "Dissection Guides —III, The Rat" by the same author is much nearer the required standard. Unfortunately, this book contains too many diagrams, each illustrating a fragment of a dissection, so that the student using it may be unable to see the wood for the trees. There is also "The Rat", published locally by Rajan and Vythianathan.

The aim of the present book is to provide the student with a practical guide to those dissections of the rat which he may be expected to carry out during his first year course in science or medicine and to present to him those features of the anatomy of the rat as can be seen in dissections. No attempt is made to give theoretical information for which he can refer to standard textbooks.

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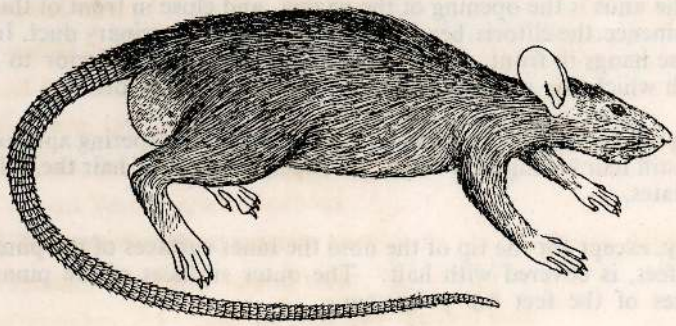

Fig. 1. THE RAT

The common house rat in Ceylon is *Rattus rattus kandiyanus* (Kelaart). This sub-species (Fig. 1) is fairly widely distributed within the Island and consequently shows some degree of variation in colour and size. The colour is lead grey on the upper surface becoming lighter on the lower; some specimens are brown on the upper surface and whitish or even yellowish on the lower. A full grown male has a body length (from tip of snout to base of tail) of six to seven inches, exceptionally a little longer. The female is smaller on the average.

The head is produced in front into a pointed snout, with the nose at its tip. The apertures of the nostrils are directed downwards. Below these is the transverse opening of the mouth. The upper jaw is longer than the lower and the upper lip is divided by a median vertical cleft. The eyes are placed slightly to the dorsal side of the head, about half way along its length. They are small, provided with upper and lower eyelids and a minute nictitating membrane, and set so as to look forwards and sideways. At the postero-lateral points of the head are the ears with their large, rounded ear-lobes or pinnae. Specially large sensory hairs, called vibrissae, are present on the head. There are groups of these vibrissae over the upper eyelids, on the cheeks, on the sides of the snout, below the chin, and a little further back below the lower jaw.

A short neck connects the head with the trunk. The trunk bears the two pairs of limbs arising from its sides anteriorly and posteriorly. The fore limbs are shorter than the hind limbs; each forefoot has five digits of which the first digit is short and bears a flat nail while the four remaining digits end in claws. The longer hind limbs are more powerfully built and all five digits of each hind foot carry terminal claws. The under surfaces of the fore and hind feet have thickened sub-digital pads.

In the female, on the ventral side of the trunk are five or six pairs of nipples arranged along two longitudinal rows. Two or three of these pairs are pectoral in position and, somewhat separated from these, are a pair of nipples on the lower belly and two pairs in the inguinal regions. The anus lies below the base of the tail. In front of the anus is the opening of the vagina and close in front of this is a small conical prominence, the clitoris, bearing the aperture of the urinary duct. In the male, the scrotal sac hangs in front of the anus and immediately anterior to this is the penis through which the urinogenital duct runs to the exterior.

The long tail, as long as the body or a little longer, is a tapering appendage which is beset with stiff hair arranged in rings. Between the rings of hair the tail is covered with scaly plates.

The body, except for the tip of the nose the inner surfaces of the pinnae and the soles of the feet, is covered with hair. The outer surfaces of the pinnae and the upper surfaces of the feet are pubescent.

THE SKELETAL SYSTEM

The skeleton can be prepared from a freshly killed rat* by boiling the carcase in water, and then, with forceps, picking off the soft parts from the bones. Care should be taken not to over-boil as over boiling would make the parts of the skeleton become detached too readily. It is very desirable to have the vertebral column and the skeleton of the thorax intact. The limbs may become separated from the body, but an effort should be made to keep the skeleton of each limb with its parts undetached. A good point at which to stop boiling is when the skin comes away easily on being pinched with forceps. This should be tested for from time to time while the rat is being boiled.

The flesh should be thoroughly and carefully picked from the bones. In order to complete the cleaning it may be necessary to soften any tough pieces of muscle or tendon still remaining on the bone by dipping in hot water for short periods. The skull cavity must be cleaned out by removing the brain.

The skeleton of a mammal is usually considered in two parts, the axial skeleton and the appendicular skeleton. The axial skeleton consists of the skull, vertebral column, ribs, and sternum; the appendicular skeleton consists of the skeleton of the limbs and the limb girdles.

*Rats can be killed in the laboratory by several different methods. The method generally employed however, is chloroforming. Whatever method is used, after the rats have been killed, they should be kept completely immersed in a four per cent. solution of formalin for ten minutes or so. This is a precautionary measure necessary to ensure that any plague fleas (*Xenopsylla cheopis*) harboured by the rats are killed. After the treatment with formalin, the rats are washed in water and taken up for study.

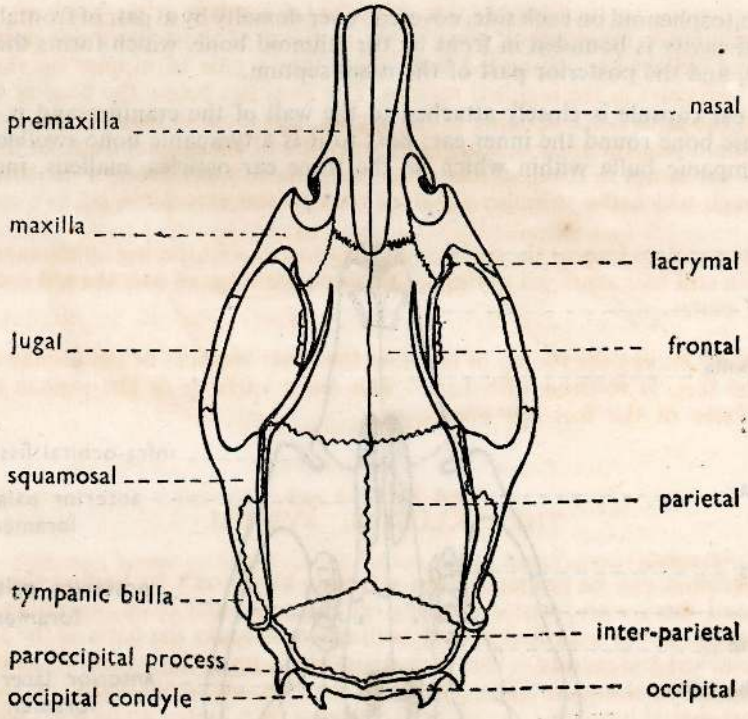

Fig. 2. SKULL, dorsal view

The skull (Figs. 2, 3, and 4) is taken to include all those bones developed in and around the original neurocranium or brain-box, the bones developed round the sense capsules (nose, eye and ear capsules), the jaw bones and the bones of the hyoid arch. The bones developed in relation to the neurocranium are, for convenience, treated as forming three rings. Starting from the posterior end of the skull, the ring of bones round the foramen magnum is the occipital ring formed by the fusion of four bones, the basi-occipital, two exoccipitals and the supra-occipital. Two short downward projecting processes from the lower sides of this ring of bone are the par-occipital processes. Also developed from it on the lower margin of the foramen magnum are the two occipital condyles by which the skull articulates with the vertebral column. The ring of bone anterior to this is formed of the basisphenoid fused with an alisphenoid on each side, completed dorsally by a pair of parietal bones. A broad inter-parietal bone occupies the space between the two parietals and the occipital region. The ring of bone next in front is formed of the presphenoid fused

with an orbitosphenoid on each side, covered over dorsally by a pair of frontal bones. The cranial cavity is bounded in front by the ethmoid bone, which forms the cribriform plate, and the posterior part of the nasal septum.

Each ear capsule is closely attached to the wall of the cranium and is ossified as a periotic bone round the inner ear; next to it is a tympanic bone swollen out to form a tympanic bulla within which lie the three ear ossicles, malleus, incus and stapes.

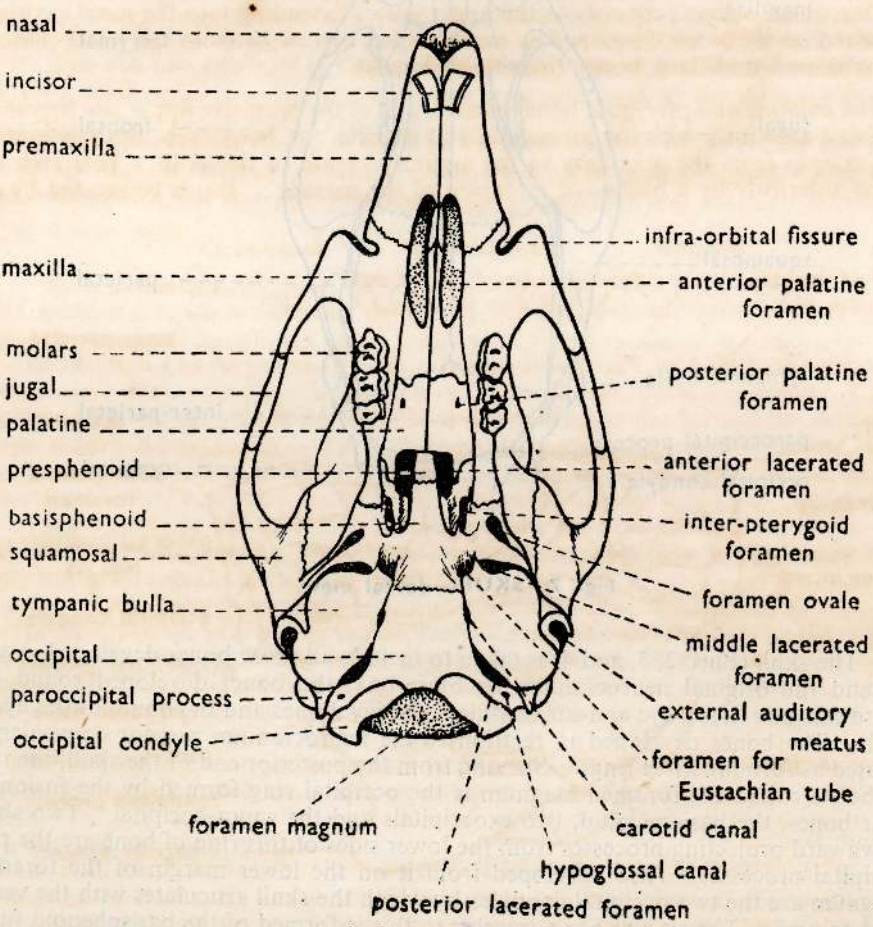

Fig. 3. SKULL, ventral view

No bones are developed in relation to the capsules of the eyes. Mention should however, be made here of a pair of small bones, the lacrymals, at the inner anterior borders of the orbits.

The two nasal capsules are separated from each other by a bony septum formed from the ethmoid and, more anteriorly, by a cartilaginous nasal septum. This nasal septum stands on a base formed of an unpaired bone, the vomer. Paired nasal bones form the roof of the nasal capsules, their sides being formed by the premaxillae and maxillae which belong primarily to the upper jaw. Extending into the nasal cavities are paired scroll bones developed as much-folded ingrowths from the nasal (naso-turbinals) and maxillary bones (maxillo-turbinals).

The palatine and pterygoid bones of each side of the primitive upper jaw become associated anteriorly with the premaxilla and maxilla. A bony arch, the zygomatic arch, extends from the maxillary to the auditory region of the skull. This arch is formed anteriorly by a backward extension of the maxilla ; this is connected by a

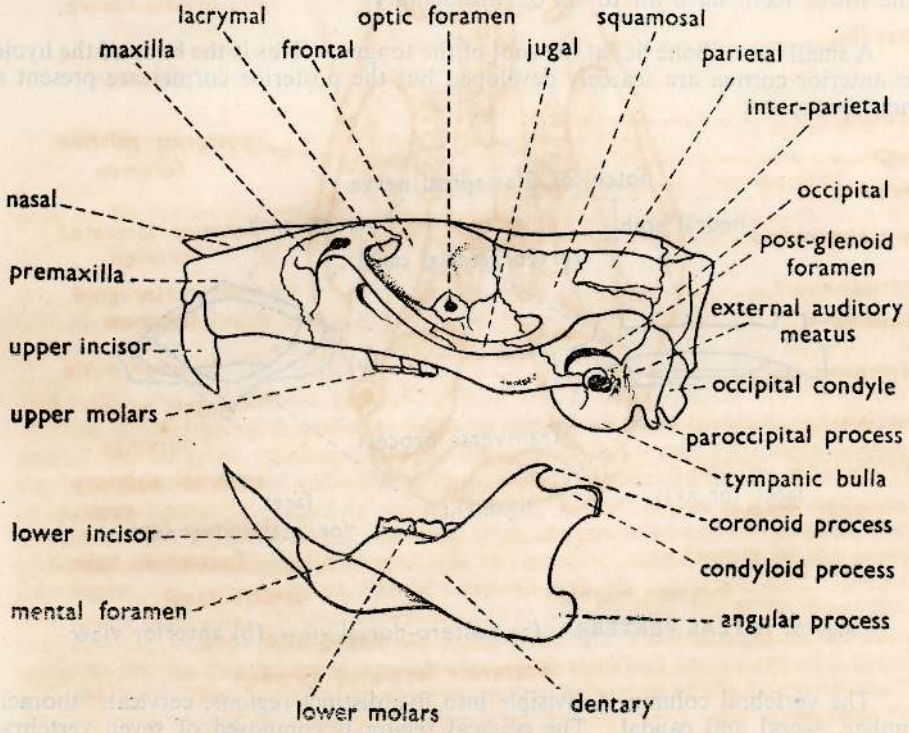

Fig. 4. SKULL AND LOWER JAW, lateral view

jugal bone with an anteriorly directed process from a squamosal bone lying at the side of the skull below the parietal bone. The air which enters the nostrils passes through the nasal cavities into a respiratory passage formed by the vomer above and the premaxillae, maxillae and palatines below. Behind the palatines the passage is continued above the soft palate, the roof and sides of the passage now formed by the presphenoid and the pterygoids respectively.

The lower jaw (Fig. 4) is made up of two symmetrical halves or mandibular rami, each ramus consisting of a single bone, the dentary. The two rami are fused together in front. Posteriorly, each ramus is produced into three processes, the coronoid, the articular and the angular processes. The top of the articular process bears an articulating surface which fits into a glenoid fossa on the ventral side of the squamosal and so effects the articulation of the lower jaw to the skull.

The teeth are implanted in sockets in the jaws, a condition termed "thecodont". The upper incisors and molars occur in the premaxillae and maxillae respectively. The lower teeth have all to be on the dentary.

A small bar of bone lies at the root of the tongue. This is the body of the hyoid. Its anterior cornua are scarcely developed but the posterior cornua are present as short processes.

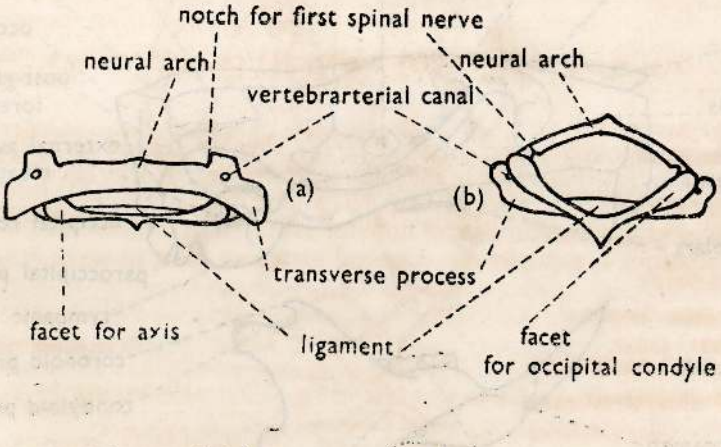

Fig. 5. **ATLAS VERTEBRA.** (a) postero-dorsal view, (b) anterior view

The vertebral column is divisible into five distinct regions, cervical, thoracic, lumbar, sacral and caudal. The cervical region is composed of seven vertebrae. The first of these is the atlas (Fig. 5). It is in the shape of a bony ring, with short transverse processes, a minute neural spine and a posteriorly directed ventral spine.

It is without centrum or zygapophyses but has a pair of anterior articular surfaces for the occipital condyles of the skull and a pair of posterior articular surfaces for the second cervical vertebra. This vertebra, named the axis (Fig. 6), has a short

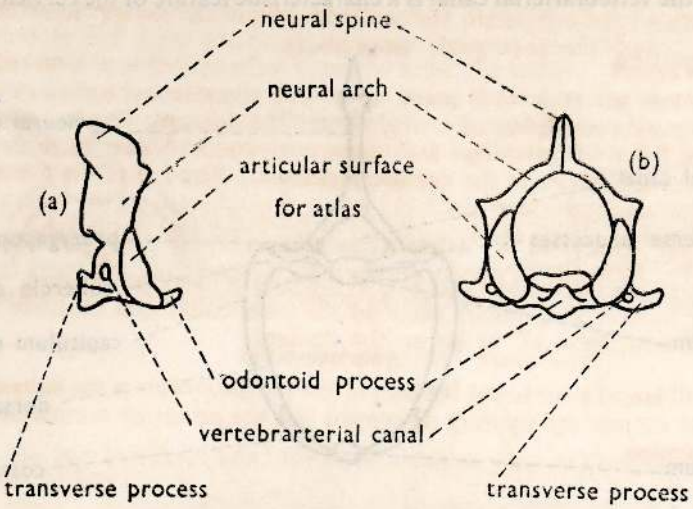

Fig. 6. AXIS VERTEBRA, (a) lateral view, (b) anterior view

process, the odontoid process, attached to the anterior face of its centrum. The odontoid process is the centrum of the atlas which has secondarily become fused with the centrum of the axis. Also, the axis has a long, laterally flattened neural spine, small transverse processes, a pair of anterior articulating surfaces for the atlas and a pair of posterior zygapophyses. Cervical vertebrae three to seven are all nearly

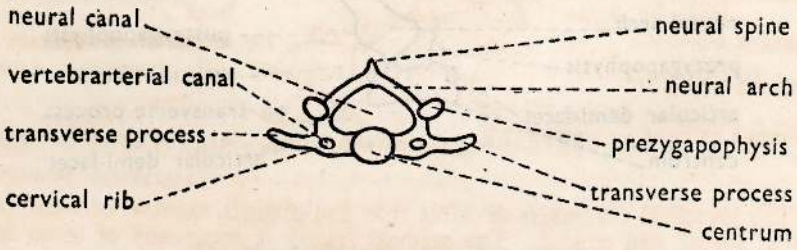

Fig. 7. FIFTH CERVICAL VERTEBRA, anterior view

alike. Each (Fig. 7) consists of centrum, neural arch with short neural spine, paired pre-and post-zygapophyses and transverse processes to which short cervical ribs are fused, enclosing between them a canal for the vertebral artery. This artery perforates the transverse processes of the atlas and axis vertebrae as well. Thus the presence of the vertebrarterial canal is a characteristic feature of the cervical vertebrae.

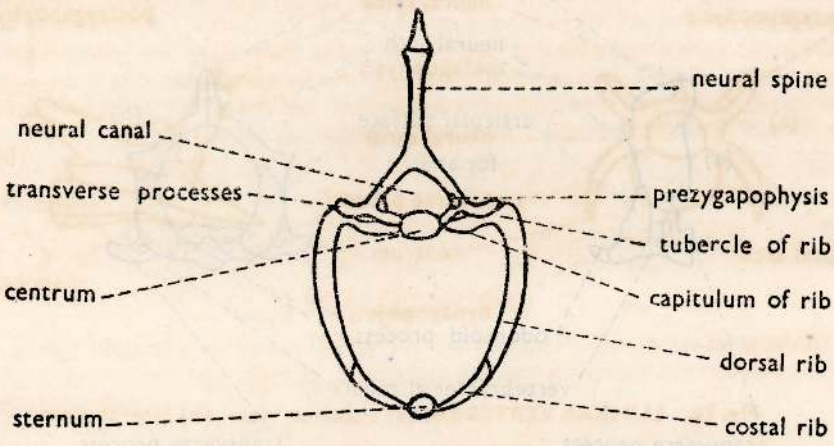

Fig. 8. SECOND THORACIC VERTEBRA, anterior view

The thoracic region contains thirteen vertebrae. They are the rib-bearing vertebrae and typically possess articular facets for the capitula and tubercula of the ribs. A facet (Fig. 9) at the end of the transverse process provides articulation with the tuberculum of a rib and a facet, formed partly by the centrum of the vertebra

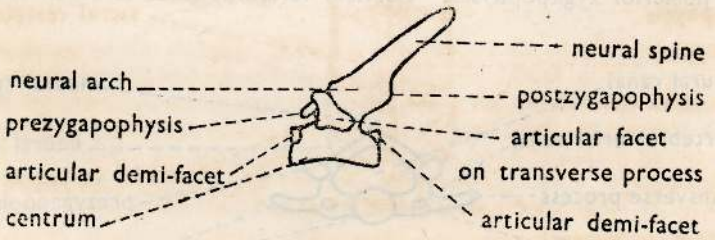

Fig. 9. EIGHTH THORACIC VERTEBRA, lateral view

corresponding to the rib and partly by the centrum of the next following vertebra, provides articulation for the capitulum of a rib. The neural spines of the thoracic vertebrae are long, the spine of the second thoracic vertebra (Fig.8) is very long and bears another small piece of bone at its tip. The neural arches carry pre-and post-zygapophyses.

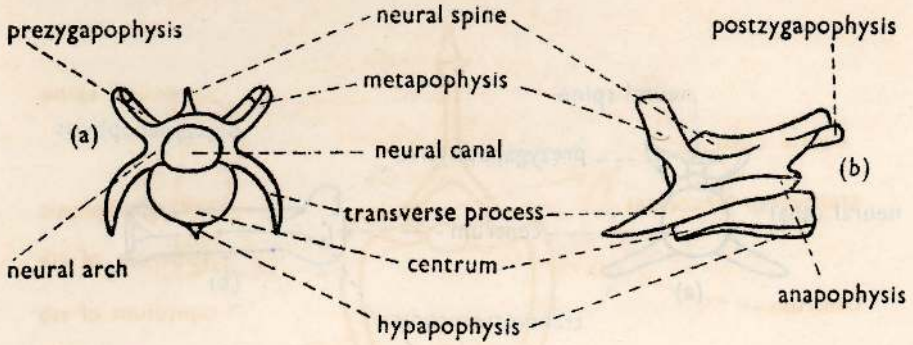

Fig. 10. LUMBAR VERTEBRA, (a) anterior view, (b) lateral view

There are six vertebrae included in the lumbar region. These lumbar vertebrae (Fig. 10) are stout, their transverse processes forwardly projecting and the sides of the pre-zygapophyses are produced forwards as metapophyses. From the sides of the neural arch are developed backwardly projecting processes, the anapophyses. In some of the lumbar vertebrae a ventral flattened spine termed the hypapophysis is developed from the centrum.

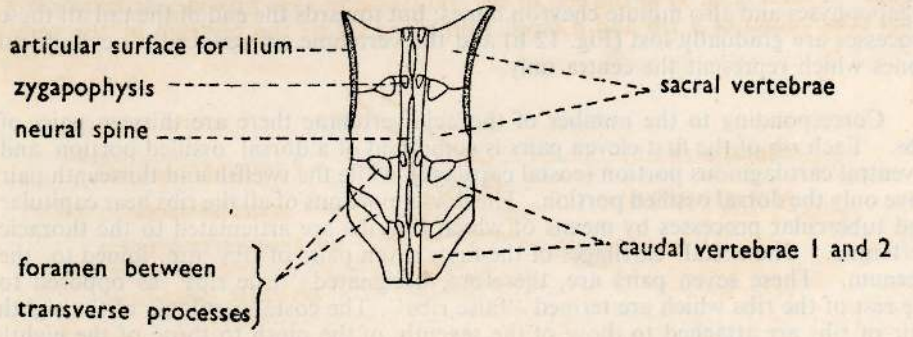

Fig. 11. SACRUM, dorsal view

The sacral vertebrae (Fig. 11) are those vertebrae which are joined to the ilia of the pelvic girdle. There are only two such vertebrae, united by their transverse processes to the ilia. In addition, the first two vertebrae from the tail region become fused with each other and with the sacral vertebrae proper to form the sacrum of the adult rat.

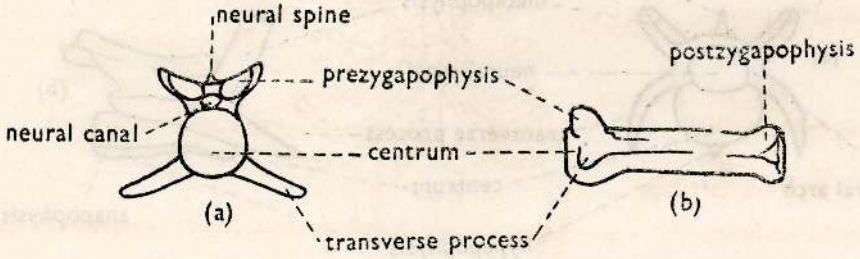

Fig. 12. CAUDAL VERTEBRAE,

(a) an anterior caudal vertebra, anterior view

(b) a middle caudal vertebra, lateral view

The remaining vertebrae of the caudal region vary in number from twenty-seven to thirty-five. The anterior tail vertebrae (Fig. 12a) retain all the characters of a typical vertebra, possessing well developed neural spine, transverse processes and zygapophyses and also minute chevron bones; but towards the end of the tail all these processes are gradually lost (Fig. 12 b) and the vertebrae are reduced to cylindrical bones which represent the centra only.

Corresponding to the number of thoracic vertebrae there are thirteen pairs of ribs. Each rib of the first eleven pairs is composed of a dorsal ossified portion and a ventral cartilaginous portion (costal cartilage), while the twelfth and thirteenth pair have only the dorsal ossified portion. The dorsal portions of all the ribs bear capitular and tubercular processes by means of which the ribs are articulated to the thoracic vertebrae. The costal cartilages of the first seven pairs of ribs are joined to the sternum. These seven pairs are, therefore, designated "true ribs" as opposed to the rest of the ribs which are termed "false ribs". The costal cartilages of the eighth pair of ribs are attached to those of the seventh, of the ninth to those of the eighth and of the tenth to those of the ninth. The costal cartilages of the eleventh ribs end freely as do the twelfth and thirteenth pairs of ribs. These last three pairs of false ribs are also termed "floating ribs".

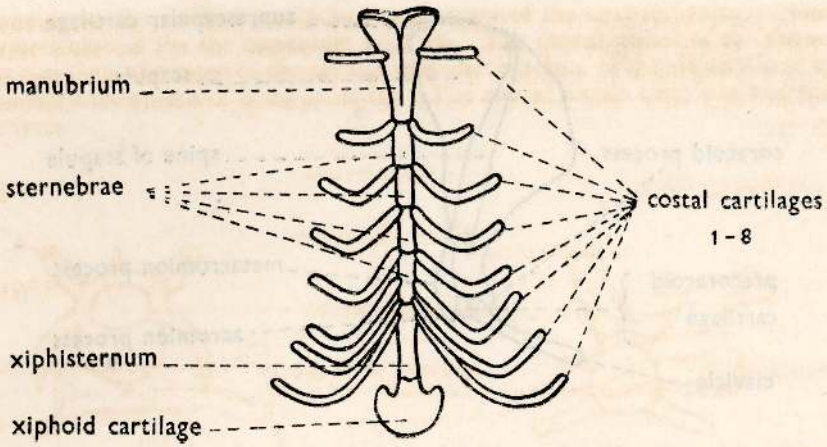

Fig. 13. STERNUM, ventral view

The sternum (Fig. 13) lies along the mid-ventral line of the thorax and is made up of a few pieces of bone jointed together. The first of these is the manubrium. It is broader anteriorly and bears a pair of articular facets laterally for the small omosternal bones; behind these are a pair of articular facets for the ends of the costal cartilages of the first pair of ribs. The manubrium is followed by four rectangular pieces of bone, the sternebrae, which bear articular facets for the costal cartilages of the six remaining pairs of true ribs. The sternebrae are followed by a more slender piece of bone, the xiphisternum, to the posterior end of which is attached a flat cartilaginus plate, the xiphoid cartilage.

The pectoral girdle is made up of similar halves connected, not very rigidly, with the sternum and having no connection with vertebral column. Each half of the girdle consists of a flat, triangular bone the scapula (Fig. 14), a narrow rod-shaped bone the clavicle, and vestiges of a coracoid and a precoracoid. The dorsal border of the scapula remains unossified as the supra-scapular cartilage. The blade of the scapula, which narrows ventrally, is enlarged terminally and bears a slight concavity, the glenoid cavity, overhung in front by the small coracoid process. The outer surface of the scapula is raised into a prominent ridge called the spine. The presence of this spine divides the outer surface of the scapular blade into pre-scapular and post-scapular fossae. At its lower end the spine projects as the acromion process which is produced slightly backwards to form the metacromion process. The acromion

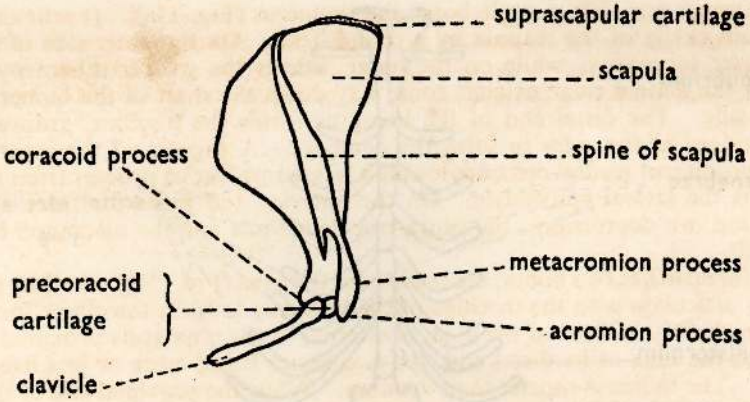

Fig. 14. PECTORAL GIRDLE, ventro-lateral view

process connects with the clavicle by means of a vestige of the precoracoid bone over which the clavicle is laid down. At its other end, the clavicle is connected by more precoracoid cartilage which ossifies as a small omosternum attached to the antero-lateral end of the manubrium of the sternum.

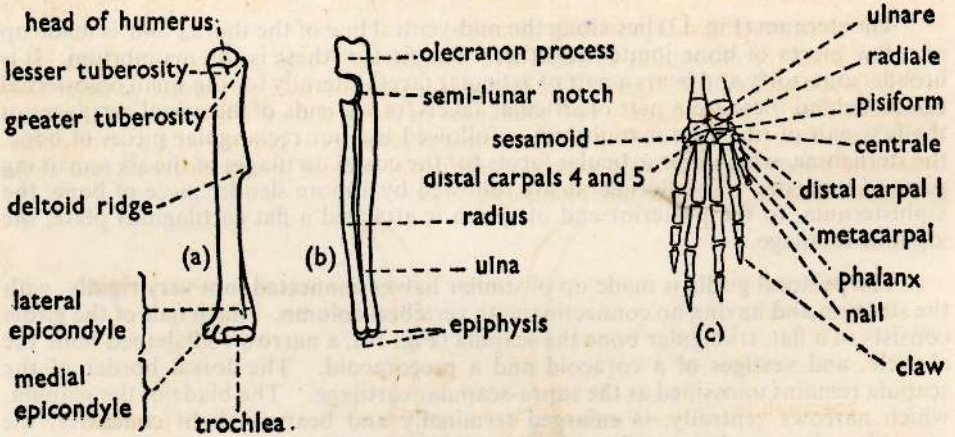

Fig. 15. BONES OF THE FORE LIMB

(a) Humerus (b) Radius and Ulna (c) Foot

The upper arm has a single bone, the humerus (Fig. 15a). It articulates with the glenoid cavity of the scapula by a round head. On the inner side of the head is the lesser tuberosity, while on the outer side is the greater tuberosity. From the latter the deltoid ridge extends some way down the shaft of the humerus on its anterior side. The distal end of the humerus forms the trochlea, grooved in the middle, ridged at the sides to form the condyles. A process of the inner condyle forms a prominent medial epicondyle and a less conspicuous process from the outer condyle is the lateral epicondyle. On the anterior and posterior sides above the trochlea are two depressions, the supra-trochlear fossa and the olecranon fossa respectively.

The forearm has two bones, the radius and the ulna (Fig. 15b). At their proximal ends they articulate with the trochlea of the humerus to form the elbow joint. The radius lies slightly in front of the ulna, is external to the ulna at its proximal end and internal to the ulna at its distal end, the two bones being more or less fixed in this position. The radius is shorter than the ulna. While the proximal end of the radius stops at the trochlea of the humerus, the ulna forms a deep sigmoid notch into which the trochlea of the humerus fits, forming the hinge-joint of the elbow, and is then continued as the olecranon process which fits into the olecranon fossa at the posterior end of the humerus when the fore limb is extended. The distal end of the ulna, however, is smaller than the distal end of the radius.

The bones of the wrist (Fig. 15c) are the carpal bones. They are arranged in two rows, a proximal row of two bones consisting of the fused radiale and intermedium, and the ulnare, and a distal row of five bones consisting of the distal carpals 1 (trapezium) and 2 (trapezoid), the centrale, the distal carpal 3 (magnum) and the fused distal carpals 4 and 5 (unciform). In addition, two small sesamoid bones, the pisiform and the ulnar sesamoid, are usually present.

The hand (forefoot) has a row of five metacarpal bones and beyond these there are the phalanges of the digits. The first metacarpal bone is very much smaller than the other four. There are only two phalanges in the first digit while each of the other digits has three phalanges of which the terminal phalanx is capped with a strong claw. Sesamoid bones are usually developed at the distal ends of the metacarpals and at the proximal ends of the terminal phalanges.

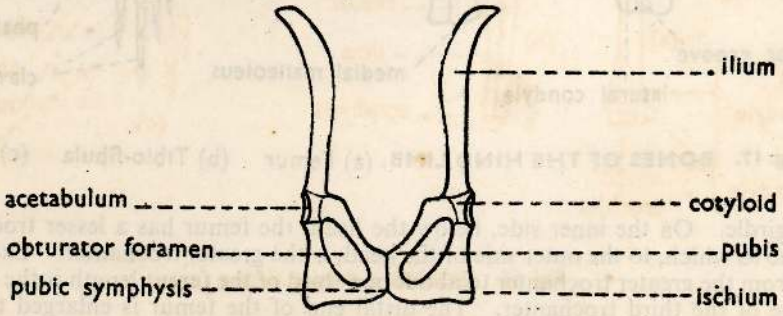

Fig. 16. PELVIC GIRDLE, ventral view

Like the pectoral girdle, the pelvic girdle (Fig. 16) is formed of two halves united together. Each half is called an innominate bone (os innominatum) and is composed of three bones, the ilium, the ischium and the pubis together with a small cotyloid bone. The ilium, ischium and pubis meet laterally. On the outer side of this junction is a cup-shaped depression, the acetabulum, bounded anteriorly by the ilium, posteriorly by the ischium, and ventrally by the cotyloid bone. The ilium extends forwards and articulates with the transverse processes of the sacral vertebrae. The ischium is directed backwards and turns down a little ventrally to meet the ventral and backwardly directed pubis, leaving a large space, the obturator foramen, between them. The union of the two innominate bones is brought about by the meeting of the pubic bones of the two sides in a mid-ventral symphysis.

The thigh has a single long bone, the femur (Fig. 17a). At its proximal end the femur is produced into a rounded head with a long neck. The head fits into the socket of the acetabulum and brings about the articulation of the hind limb with the

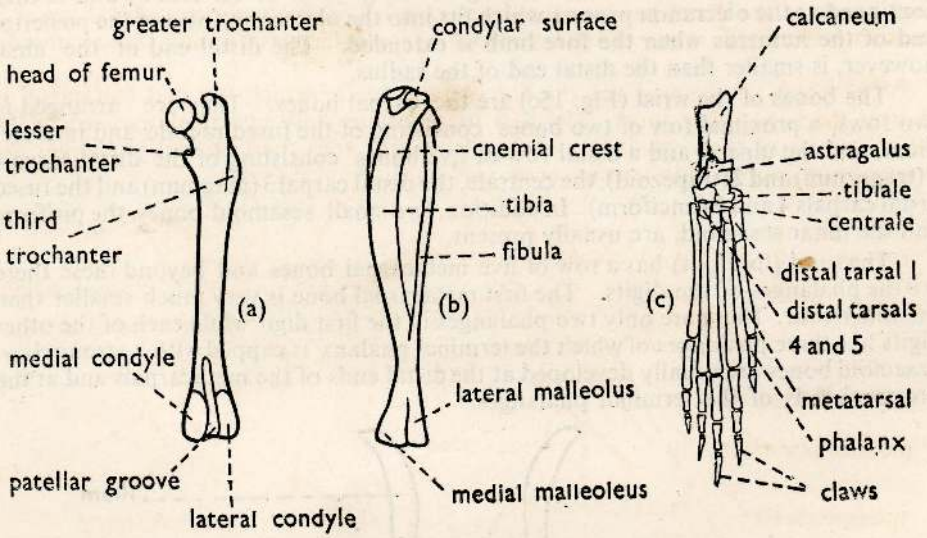

Fig. 17. BONES OF THE HIND LIMB, (a) Femur (b) Tibio-fibula (c) Foot

pelvic girdle. On the inner side, below the head, the femur has a lesser trochanter opposite to which, to the outer side of the head, is the greater trochanter. Extending down from the greater trochanter to about one-third of the femur length is the flattened ridge of the third trochanter. The distal end of the femur is enlarged to form two condyles, the lateral and medial condyles, between which is a groove. On the anterior surface, this groove receives the tendon in which lies the knee-cap bone or

patella. On the posterior surface, the groove is deeper between the two condyles and forms the inter-condylar notch. Two sesamoid bones lie immediately above the condyles on the posterior side.

The bones of the shank are the tibia and fibula (Fig. 17b). At the proximal end the two bones are separate, but they are fused at the distal end and so form a tibio-fibula. The free part of the fibula is slender and takes no share in forming the knee-joint; that of the tibia is much stouter, raised on its anterior surface to form the cnemial crest and carries two facets at its broad proximal end for articulation with the condyles of the femur. Distally, the tibio-fibula carries two knobs, called malleoli, for articulation with the ankle joint.

The ankle joint (Fig. 17c) has a proximal row of two bones and a distal row of four bones, with a bone between them in the centre. The two proximal bones are the pulley-shaped astragalus and the elongated calcaneum. The malleoli of the tibio-fibula articulate with the astragalus. The central bone is the navicular. The four bones of the distal row are the distal tarsal 1 (endocuneiform), distal tarsal 2 (mesocuneiform), distal tarsal 3 (ectocuneiform) and distal tarsal 4 and 5 fused (cuboid).

The bones of the foot are the five metatarsals of which the first metatarsal is shorter than the other four. The first toe contains only two phalanges while the other toes carry three phalanges each. In all the toes the terminal phalanges are pointed and capped with strong claws.

THE SUPERFICIAL MUSCLES

For the study of the muscles a freshly killed male rat is preferable to a female rat as the separate muscles are more readily distinguishable in the male. Cut through the skin along the mid-ventral line, then make transverse cuts through the skin along the ventral side of each limb and, using the handle-end of the scalpel, separate away the skin from the underlying muscles of the body. In doing so, it will be necessary to sever the dermal or integumentary muscles at their insertions. These muscles arise from the skin and are inserted on the body. When this has been done the skin can be peeled away dorsally. Now cut the skin around the snout, wrists and ankles and peel the skin away backwards along the length of the tail. Dissect away the salivary and lymph glands in the region of the neck and remove any fatty tissue or other sub-cutaneous tissue to expose the superficial muscles.

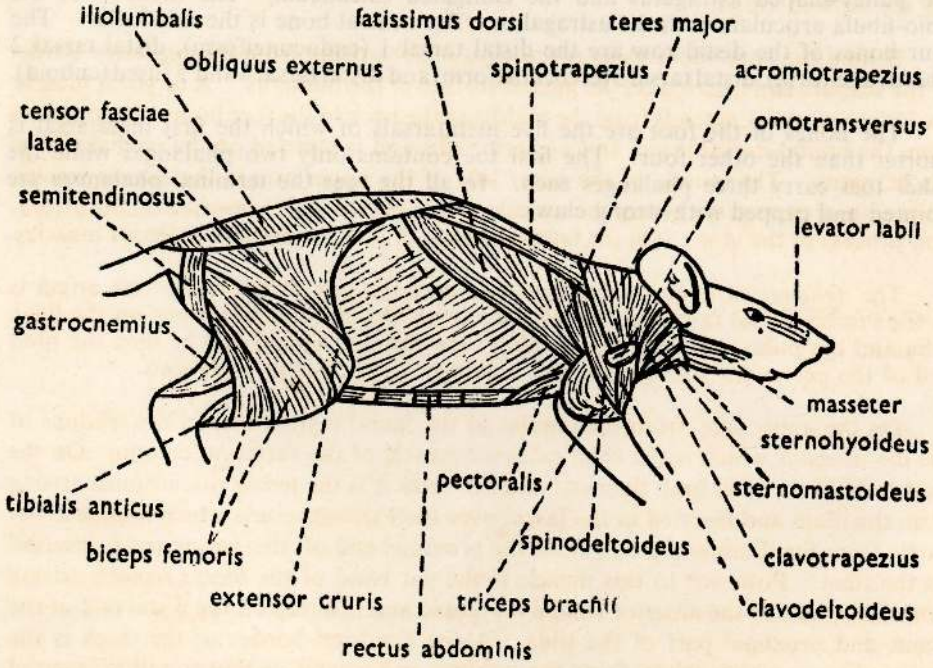

Fig. 18. SUPERFICIAL MUSCLES, lateral view

Place the rat on its side and observe the muscles seen in this lateral view (Fig. 18). Over the cheek lies the broad band of the *masseter* which arises from the zygomatic arch of the skull and is inserted on the lower jaw. On the lower side of the neck

is the *sternohyoideus* which arises from the manubrium of the sternum and is inserted at the anterior end of the hyoid. Above this is the *sternomastoideus* which also arises from the manubrium and is inserted on the mastoid process of the skull. More dorsally there is the *clavo-trapezius* arising from the skull and inserted on the clavicle. This muscle is the anterior part of a broad sheet of muscle termed the *trapezius*. Its middle part is the *acromio-trapezius* arising from spines of the cervical vertebrae and inserted partly on the acromion process and partly on the spine of the scapula. The hindermost part of the trapezius is the *spino-trapezius* arising from the spines of the posterior thoracic and the lumbar vertebrae and inserted on the spine of the scapula. Below the acromio-trapezius a portion of the *omo-transversus* can be seen. It arises from the skull and is inserted on the acromion process of the scapula. In the front part of the chest is the *deltoideus*. Two components of it are visible; the lower is the *clavo-deltoideus* arising from the clavicle and inserted on the humerus; the upper component is the *spino-deltoideus* arising from the spine of the scapula and inserted on the deltoid ridge.

Behind the spino-deltoideus is the *teres major* arising from the posterior border of the scapula and inserted on the medial surface of the humerus. A large fat muscle, the *latissimus dorsi*, extends from the middle of the back to the fore limb. It originates from the lumbo-dorsal fascia and posterior ribs and is inserted on the medial side of the humerus. The muscle of the outer side of the upper arm is the *triceps brachii*; it has several parts arising from the scapula and humerus and is inserted on the olecranon process of the ulna. On the lateral surface of the forearm are extensor muscles.

The *obliquus externus* covers the area over the side of the belly. Its origin is in the lumbo-dorsal fascia and on the posterior ribs and has insertions on the linea alba and the pubis. On the lower side of the thoracic region can be seen the hind end of the *pectoralis*, followed on the abdomen by the *rectus abdominis*.

On the upper side, from the lumbar to the sacral region, extend the tendons of the *ilio-lumbalis* which is the chief extensor muscle of the vertebral column. On the outer side of the hind limb the most anterior muscle is the *tensor fasciae latae* arising from the ilium and inserted in the fascia over the *extensor cruris* which muscle arises partly from the ilium and partly from the proximal end of the femur and is inserted on the tibia. Posterior to this muscle is the flat band of the *biceps femoris* arising from the spines of the anterior caudal vertebrae and inserted on the distal end of the femur and proximal part of the tibia. Along the hind border of the thigh is the *semitendinosus* which arises from the ischium and caudal vertebrae and is inserted on the tibia.

On the posterior surface of the shank is the *gastrocnemius* arising from the condyles of the femur and tibia and inserted by the tendo-Achilles on the calcaneum; The anterior surface of the shank is occupied by the *tibialis anterior* arising from the tibia and inserted on the second metatarsal.

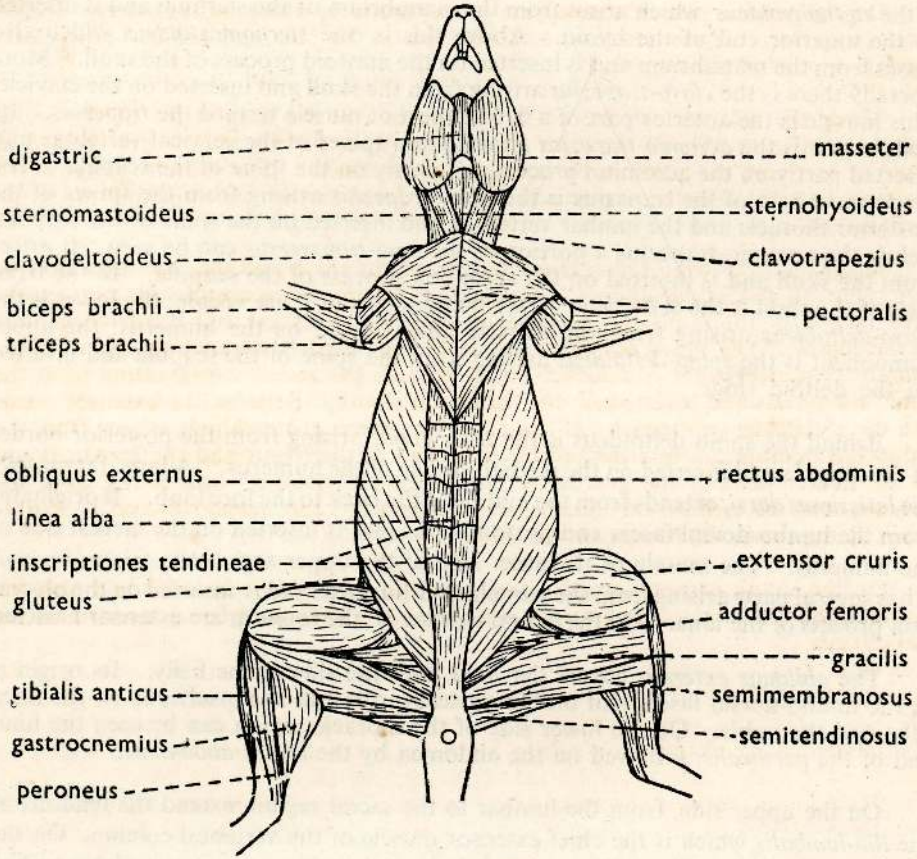

Fig. 19. SUPERFICIAL MUSCLES, ventral view

Now place the rat on its back and pin the legs out sideways. Observe the muscles of the ventral side (Fig. 19). Below the head, between the masseters already mentioned, the *digastrics* are visible. They have their origins on the occipitals and are inserted on the ventral surfaces of the mandibles. On the lower side of the neck, to the sides of the midline, lie the *sternohyoids*, flanked by the *sternomastoids* and, still more laterally, by the *clavo-trapezius* muscles. The origins and insertions of these muscles have already been mentioned. The chest is covered by the *pectoralis* arising from the sternum along its length and inserted on the deltoid ridge and lesser tuberosity of the humerus and a part of the muscle inserted on the coracoid process. In front of this muscle can be seen, on either side, the *clavo-deltoideus* muscle already referred to.

On the ventral side of the upper arm, anteriorly there is the *biceps brachii* originating from the glenoid fossa and inserted on the ulna and radius; posteriorly there is a part of the *triceps*.

Along the mid-ventral line of the abdomen run the long strips of the *rectus abdominis* on each side of the *linea alba*. The fibres of this muscle are crossed at more or less regular intervals by *inscriptiones tendineae*. The muscle arises at the anterior end of the pubic symphysis and is inserted on the sternum and the costal cartilages.

In the angle between the anterior border of the thigh and the abdomen may be seen the front end of the *gluteus*. The mass of fibres of this muscle arises from the anterior end of the ilium and becomes inserted on the great and third trochanters of the femur. The inner anterior surface of the thigh is covered by the *extensor cruris*. Posterior to this is another broad muscle, the *gracilis*, originating from the pubic symphysis and inserted on the thigh and shank. Between the extensor cruris and the gracilis lie two muscles of the *adductor femoris* group which, arising from the pubis and ischium, are inserted on the distal end of the femur and the proximal end of the tibia. Behind the gracilis is the *semimembranosus* originating from the ischium and inserted on the shank, and behind this the *semitendinosus* is visible again at the posterior border of the thigh.

On the shank can be seen the *gastrocnemius*, the *tibialis anterior* and also the *peroneus* the last of these originating from the tibio-fibula and being inserted on the metatarsals.

Pin the rat on its back by a pin through each limb, and also a pin through the skin of the snout to keep the neck well stretched. Cut through the skin along the mid-ventral line from the hind end of the belly to the chin; connect this cut with short, transverse cuts along the ventral side of each limb. Separate the skin from the ventral muscles by tearing away, with the handle-end of a scalpel, the intervening sub-cutaneous tissue; pin the skin down on either side.

Observe the glands on the anterior, ventral region of the neck. Distinguish between the salivary glands and the lymph nodes situated close to them.

Cut through the abdominal wall from the hind end along the midventral line up to the thorax, then cut outwards behind the thorax and make similar transverse cuts at the hind end of the belly. Pin down the two flaps of the abdominal wall thus obtained, on each side. Cut away and remove the pectoralis muscles* to lay bare the sternum and costal ribs. Cut through the thorax, keeping as close as possible to the middle line of the sternum and taking special care not to penetrate the heart with the point of the scissors. Observe the diaphragm separating the thoracic and abdominal cavities. Cut the attachment of the diaphragm to the ventral wall of the thorax and cut away and remove part of the side walls of the thorax, sufficient to give a good view of the thoracic cavity. Cut away and remove the sternohyoid and sterno-mastoid muscles. Cut through the pubic symphysis and spread out the halves of the pelvic girdle. Insert one blade of a strong pair of scissors into the mouth and cut through the left† angle of the jaws. Turn the lower jaw over to the right side, thus exposing the cavity of the mouth. The trachea should be displaced slightly to the right to bring into view the part of the oesophagus in the neck-region. Also the anterior blood vessels of the left side should be cut and the left phrenic nerve cut away. Then the left lobe of the lung should be turned over to the right side to display the oesophagus within the thoracic cavity. The lobes of the liver should be turned forwards and to the right.

The mouth leads into the buccal cavity which is the first region of the alimentary canal (Fig. 20). The buccal cavity is bounded in front and at the sides by the lips and cheeks and immediately internal to these are the upper and lower teeth-bearing jaws. The space between the gums and the lips and cheeks is the vestibule. Correlated with the gnawing habit of the rat, its teeth are specialized; of the four kinds of teeth—incisors, canines, premolars and molars—present on the jaws of a typical mammal, only two kinds—incisors and molars—are represented in the dentition of the rat. There is a pair of incisors on each jaw in the middle, and much further back on the hinder margins of each jaw there are two groups of teeth, each group consisting of three molars. Thus there are eight teeth on each jaw, giving a total of sixteen

*The removal of the pectoral muscles makes it easier to pin down the walls of the thorax.

†Throughout this book "left" and "right" refer to the left hand side and the right hand side of the rat.

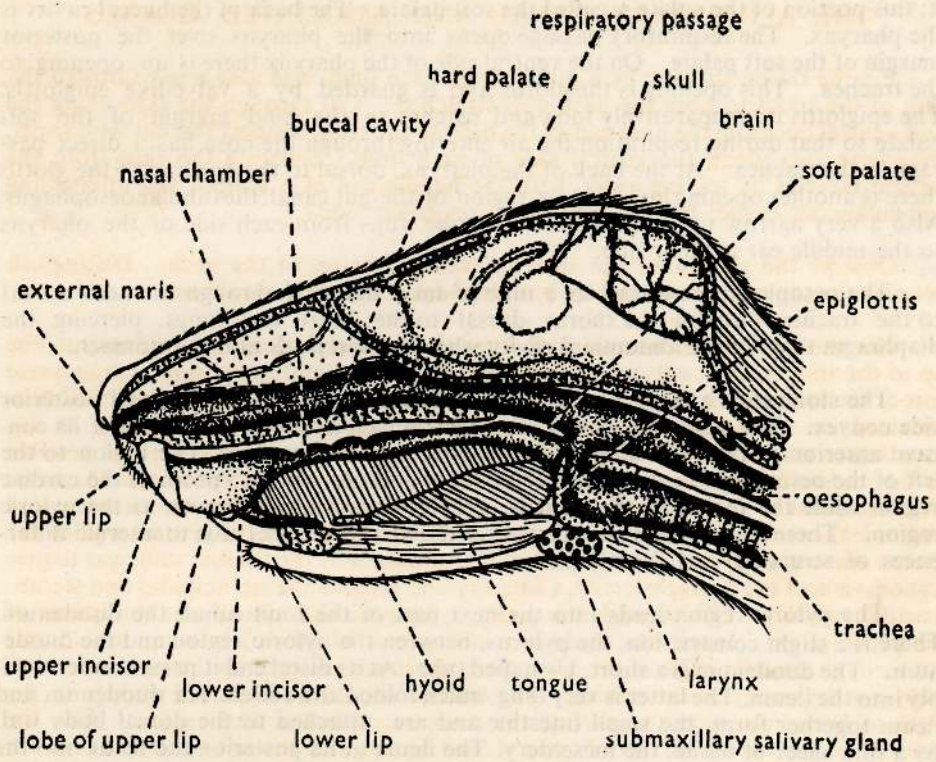

Fig. 20. SAGITTAL HALF OF THE HEAD

teeth in the mouth. The dental formula which shows the arrangement of teeth in each half of a jaw is :— $\frac{1.0.0.3.}{1.0.0.3.}$ The upper pair of incisors are anterior to the lower pair and because these teeth have enamel on their anterior surfaces only, with use they are worn off on their posterior surfaces so that they become chisel-edged. The molar teeth have broad crowns with flat grinding surfaces. The non-development of canines and premolars leaves a long gap or diastema between the incisors and molars of each side. A lobe of the upper lip projects into the mouth cavity through each diastema. On the floor of the buccal cavity lies the muscular tongue. It has a rough upper surface. The roof of the buccal cavity is formed by the palate. Its anterior portion is transversely ridged and as this part lies close against the bones of the skull it is called the hard palate. The posterior portion of the palate is smooth and separates the buccal cavity from the hind part of the respiratory passage which runs above

it; this portion of the palate is called the soft palate. The back of the buccal cavity is the pharynx. The respiratory passage opens into the pharynx over the posterior margin of the soft palate. On the ventral side of the pharynx there is an opening to the trachea. This opening is the glottis and is guarded by a valve-like epiglottis. The epiglottis is comparatively long and reaches to the hind margin of the soft palate so that during respiration the air entering through the nose has a direct passage to the trachea. At the back of the pharynx, dorsal to the opening of the glottis there is another opening into the next region of the gut canal, the tubular oesophagus. Also a very narrow tube, the Eustachian tube, runs from each side of the pharynx to the middle ear of that side.

The oesophagus continues as a tube of small diameter through the neck dorsal to the trachea, through the thorax dorsal to the heart and lungs, piercing the diaphragm to enter the abdominal cavity where it soon leads into the stomach.

The stomach is a large, curved sac whose anterior side is concave and posterior side convex. The oesophagus runs into the stomach at about the middle of its concave anterior surface. The stomach is divisible into two regions. The region to the left of the oesophageal connection is the more anterior and is known as the cardiac region while the region to the right is more posterior and is known as the pyloric region. These two regions have distinct external appearances due to internal differences of structure and function.

The pyloric region leads into the next part of the food canal, the duodenum. There is a slight constriction, the pylorus, between the pyloric region and the duodenum. The duodenum is a short, U-shaped tube. At its distal end it passes imperceptibly into the ileum. The latter is very long, much folded and coiled. The duodenum and ileum together form the small intestine and are attached to the dorsal body wall by a thin sheet of tissue, the mesentery. The ileum at its posterior end leads into the large intestine consisting of two regions termed the colon and rectum respectively. Where the ileum meets the colon there is a sac-like, blindly ending diverticulum called the caecum. It is longer and narrower on one side; this narrower portion is regarded as the appendix. The proximal part of the colon is, like the caecum, sacculated. Its distal part, however, passes imperceptibly into the rectum which runs back through the pelvis to open to the exterior by the anus placed below the base of the tail.

The glands associated with the alimentary canal are the salivary glands, the liver, and the pancreas.

There are four pairs of salivary glands. The largest of these are the parotid salivary glands which lie underneath the skin below the ears and are of irregular shape. Each parotid salivary gland has several ducts which soon unite to a single duct running forward along the cheek, at first external to the masseter muscle and later penetrating through this muscle to pour its secretion into the buccal cavity by the side of the upper molar teeth. Next to the parotid salivary glands in size are the submaxillary salivary glands situated on the ventral side of the neck just behind the head. They are ovoid in shape and their ducts run forward to open on the floor of

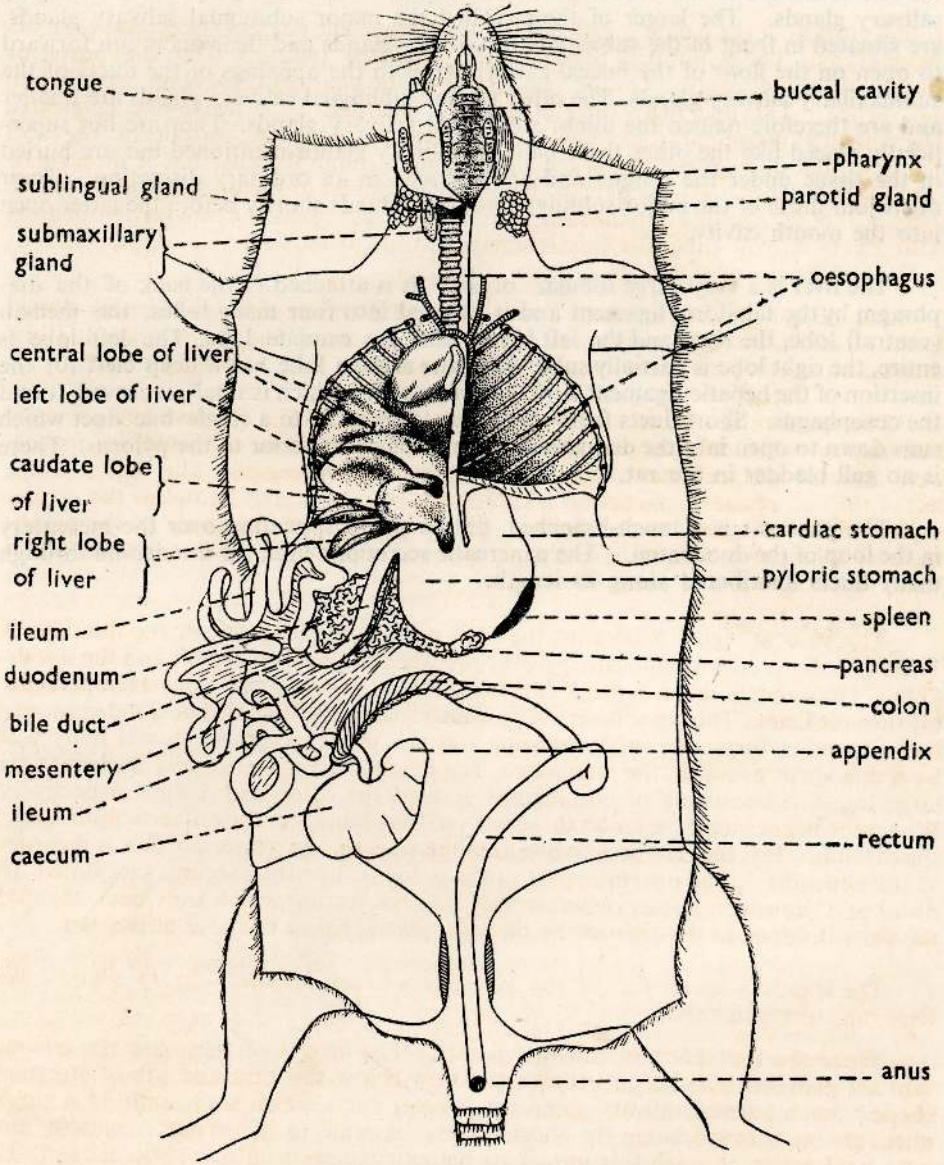

Fig. 21. ALIMENTARY CANAL

the buccal cavity anterior to the base of the tongue. There are two pairs of sublingual salivary glands. The larger of these, called the major sublingual salivary glands, are situated in front of the submaxillary salivary glands and their ducts run forward to open on the floor of the buccal cavity lateral to the openings of the ducts of the submaxillary salivary glands. The other pair of sublingual salivary glands are smaller and are therefore named the minor sublingual salivary glands. They are not superficially placed like the other three pairs of salivary glands mentioned but are buried in the tissue under the tongue and are not seen in an ordinary dissection. Their ducts join those of the major sublingual salivary glands shortly before the latter open into the mouth cavity.

The liver is a very large lobular organ. It is attached to the back of the diaphragm by the falciform ligament and is divided into four main lobes, the median (central) lobe, the right and the left lobes, and the caudate lobe. The left lobe is entire, the right lobe is partially subdivided, the median lobe has a deep cleft for the insertion of the hepatic ligament, and the caudate lobe which is small, is curved round the oesophagus. Short ducts from these four lobes unite to a single bile duct which runs down to open into the duodenum some distance posterior to the pylorus. There is no gall bladder in the rat.

The pancreas is a much-branched, diffuse gland spreading over the mesentery in the loop of the duodenum. The pancreatic secretions enter the duodenum through many ducts distributed along its length.

Pin the rat down and cut through the skin, pinning out the two flaps as before. On either side of the neck the external jugulars will be seen even at this stage. These two vessels should be further cleared by removing the connective tissue over them. Open out the abdominal cavity as before. Now remove the pectoralis muscles and cut through the mid-ventral line of the thorax, keeping as close as possible to the middle line of the sternum. Sever the attachment of the diaphragm to the ventral wall of the thorax and open out and pin down the flaps of the thoracic wall. This can be facilitated by gently pressing down with the fore-finger with just enough pressure to break the ribs, and bending the flaps down so as to open out the thoracic cavity. The thoracic walls should not be cut away and removed in this dissection as the internal mammary arteries and veins have to be shown.

Carefully free the heart from the pericardium. In some specimens a large thymus gland may be present below the anterior region of the heart. This also should be removed carefully.

Observe the four chambers of the heart. The two auricles are smaller and of a darker red colour than the two ventricles. The right ventricle is slightly the larger and is partly wrapped round the left ventricle.

Venous System (Figs. 22 and 23). As the veins generally have a more superficial course than the arteries, it is convenient to observe the venous system first. After that the arteries can be traced. Blood from the various parts of the body is brought to the heart by veins. Veins bringing oxygenated blood from the right and left lungs unite together into a single pulmonary vein before opening into the left auricle on its dorsal side.

From the head, neck and fore-limbs blood is brought to the heart by two main vessels, the right and left anterior venae cavae (precaval veins; superior venae cavae). On each side, internal and external facial veins from the head join together at the anterior end of the neck forming the external jugular vein which runs back along the neck, joined on its way by a cephalic vein from the hinder region of the neck. As soon as this external jugular vein enters the thoracic cavity it is joined by an internal jugular vein bringing blood from the brain, and a subclavian vein bringing blood from the fore-limb. The combined vein so formed flows back as the anterior vena cava which, after receiving a small vertebral vein from the neck vertebrae and an internal mammary vein from the side of the sternum, opens into the right auricle on its dorsal surface. An azygos vein bringing blood from the wall of the thorax and the diaphragm also joins the left anterior vena cava before it discharges into the heart.

Blood from the hind limbs and the trunk region is returned to the heart through the posterior vena cava (postcaval vein; inferior vena cava). It runs forward from the hind end of the body cavity to open into the heart, like the anterior venae cavae, through the dorsal side of the right auricle. It is formed posteriorly by the union of right and left common iliac veins which bring bood mainly from the hind limbs but also collect blood from the rectum, bladder, the pubic region, the hinder region

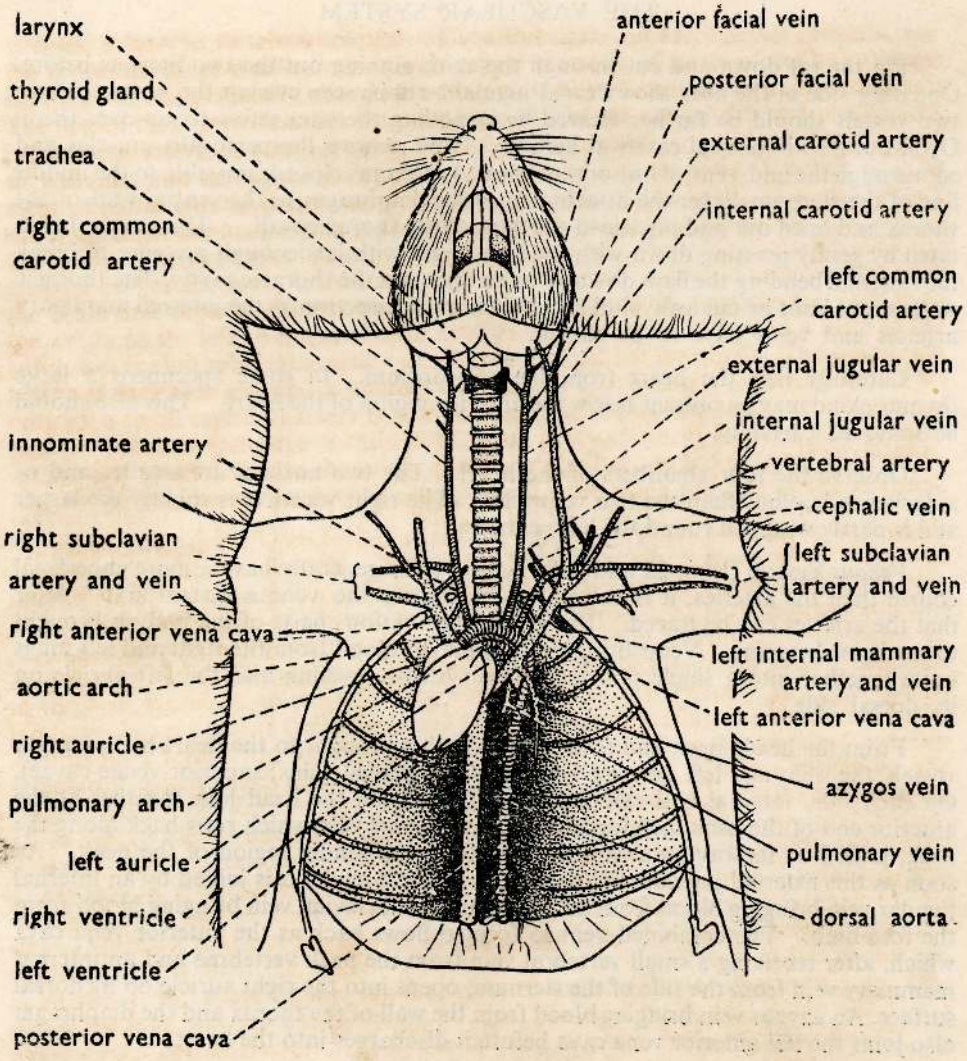

Fig. 22. ANTERIOR BLOOD VESSELS

of the abdominal wall, and the uterus (in the female) or scrotal sac (in the male). A small caudal vein from the tail also joins the hind end of the posterior vena cava. As this large vessel runs forward in the abdominal cavity it receives the right and left ilio-lumbar veins and, a little more anteriorly, the right and left genital veins. Very

commonly the left genital vein, instead of opening into the posterior vena cava directly, may join the left renal vein. Blood from the kidneys and adrenal bodies is sent to the posterior vena cava by renal veins, the right renal vein joining the posterior vena cava a little anterior to the left renal vein.

Blood from the stomach, spleen, pancreas, and the intestines collects in a number of small veins which finally unite to form a single (hepatic) portal vein entering the liver, in which organ it breaks up in capillaries. From the liver this blood is again passed into two or three short, hepatic veins which join the posterior vena cava just before the latter runs through the diaphragm on its way to the heart.

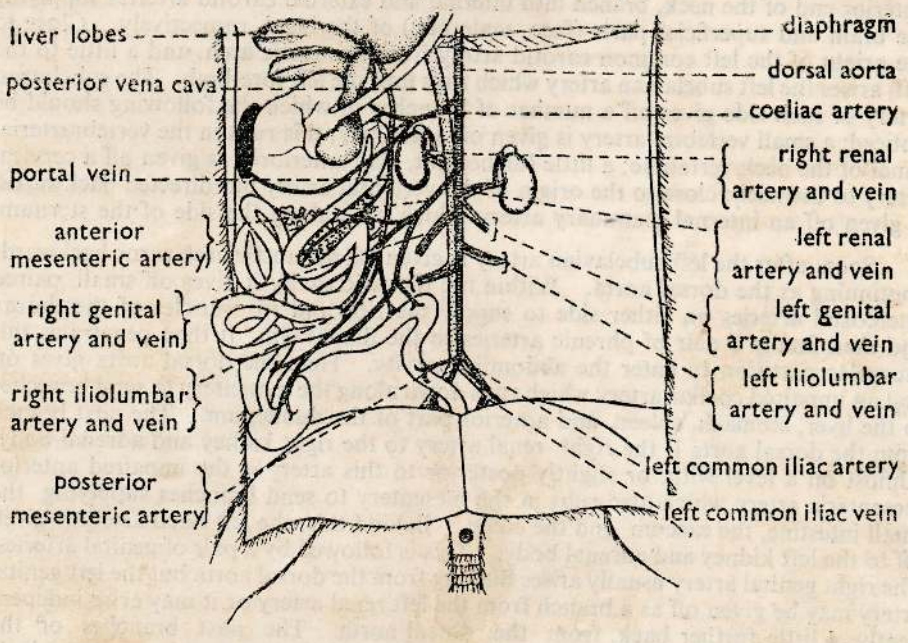

Fig. 23. POSTERIOR BLOOD VESSELS

Arterial System (Figs. 22 and 23). The external jugular veins can be cut away and removed to trace the arteries. From the anterior end of the right ventricle issues the pulmonary arch which runs forwards and slightly to the left, ventral to the heart between the two auricles turns dorsalwards at the anterior margin of the heart and then runs for a very short distance backwards, dorsal to the heart, before dividing into the right and left pulmonary arteries to the lungs.

The left ventricle at its anterior end gives origin to the aortic arch which runs forwards and slightly to the right above the pulmonary arch. At the anterior border of the heart, the aortic arch curves strongly to the left and then gradually comes in to run as the dorsal aorta along the mid-dorsal line of the thoracic and abdominal

cavities, below the vertebral column. The aortic arch and its posterior continuation, the dorsal aorta, give off arteries which supply blood to all parts of the body except the lungs which, as already observed, are supplied by branches of the pulmonary arch. The first of these arteries arises from the right side of the aortic arch and is called the innominate artery; it runs forwards and slightly outwards for a short distance and then divides into the right subclavian artery running into the right fore-limb and the right common carotid artery supplying the right side of the head. The next artery given off from the aortic arch is the left common carotid supplying the left side of the head. The right and left common carotid arteries, when they have reached the anterior end of the neck, branch into internal and external carotid arteries supplying the brain and superficial parts (face, scalp etc.) of the head, respectively. Close to the origin of the left common carotid artery from the aortic arch, and a little to the left, arises the left subclavian artery which runs into the left fore-limb. The subclavian artery of each side gives off a number of branches of which the following should be noticed: a small vertebral artery is given off anteriorly; this runs in the vertebrarterial canal of the neck vertebrae; a little further out, also anteriorly, is given off a cervical artery to the neck; close to the origin of the vertebral artery but directed backwards, is given off an internal mammary artery which runs along the side of the sternum.

Soon after the left subclavian artery is given off the aortic arch turns backwards continuing as the dorsal aorta. Within the thoracic cavity it gives off small, paired intercostal arteries on either side to supply the ribs and rib muscles of the thorax and then finally a pair of phrenic arteries to the diaphragm. It then penetrates this muscular partition to enter the abdominal cavity. Here the dorsal aorta gives off first an unpaired coeliac artery which runs down along the mesentery to send branches to the liver, stomach, spleen, and anterior part of the duodenum. The next branch from the dorsal aorta is the right renal artery to the right kidney and adrenal body. Almost on a level with, or slightly posterior to this artery is the unpaired anterior mesenteric artery which also runs in the mesentery to send branches supplying the small intestine, the caecum and the colon. Behind this, the left renal artery is given off to the left kidney and adrenal body. This is followed by a pair of genital arteries. The right genital artery usually arises directly from the dorsal aorta but the left genital artery may be given off as a branch from the left renal artery or it may arise independently, a little further back, from the dorsal aorta. The next branches of the dorsal aorta are a pair of ilio-lumbar arteries. The left ilio-lumbar artery arises a little more anteriorly than the right. On reaching the posterior end of the abdominal cavity the dorsal aorta divides into the right and the left common iliac arteries running along the hind limbs. At the point of this division, the caudal artery which is a small dorsal branch, is given off to the tail and also the posterior mesenteric artery which is a small ventral branch, to the rectum. Each common iliac artery gives off a branch which divides again to send a vesicular artery to the urinary bladder and a uterine artery (in the female) or a testicular artery (in the male). After this the common iliac artery divides into internal and external iliac arteries in the proximal region of the hind limb.

In well fed rats the blood vessels in the abdomen may be swathed in fat. This has to be carefully removed to display the blood vessels clearly.

Pin down and cut open the rat as before but it is not necessary, in the anterior region, to proceed beyond making the mid-ventral cut through the sternum. The pubic symphysis must be cut through and the halves of the pelvic girdle forced apart.

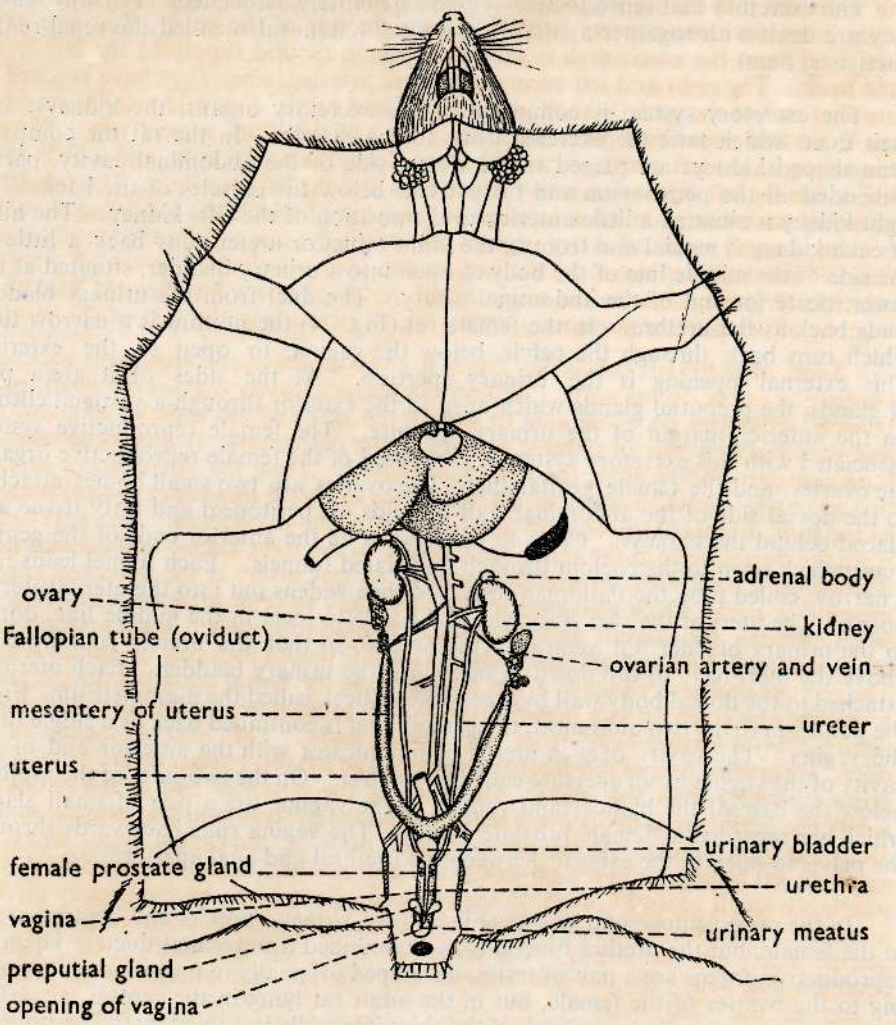

Fig. 24. FEMALE URINOGENITAL SYSTEM

Cut across the rectum just anterior to the urinary bladder and, separating the intestines from their mesenterial attachment, pin them forwards to the side of the animal below the right fore-limb. The stomach and liver have to be displaced forwards to expose the anteriorly placed right kidney.

The excretory and reproductive systems are closely associated. For this reason they are dealt with together as the urinogenital system (also called the renal-reproductive system).

The excretory system is composed of the excretory organs, the kidneys, and their ducts which take the excreted urine to the exterior. In the rat the compact, bean-shaped kidneys are placed to the dorsal side of the abdominal cavity, partly embedded in the peritoneum and fatty tissue below the muscles of the back. The right kidney is situated a little anterior to the position of the left kidney. The hilus of each kidney is medial and from it, the kidney duct or ureter runs back a little to the side of the middle line of the body to open into a urinary bladder, situated at the lower, posterior end of the abdominal cavity. The duct from the urinary bladder leads back as the urethra. In the female rat (Fig. 24) the urethra is a narrow tube which runs back through the pelvis, below the vagina, to open to the exterior. This external opening is the urinary aperture. At the sides of it are a pair of glands, the preputial glands which open to the exterior through a vestigial clitoris on the anterior margin of the urinary aperture. The female reproductive system associated with this excretory system is composed of the female reproductive organs, the ovaries, and the female genital ducts. The ovaries are two small bodies attached to the dorsal side of the abdominal wall by folds of peritoneal and fatty tissue and placed behind the kidneys. Close to the ovaries lie the anterior ends of the genital ducts which open to the coelom through fimbriated funnels. Each funnel leads into a narrow, coiled tube, the Fallopian tube, and then widens out into the uterus (uterine horn). The uteri of the two sides run backwards to meet in the middle line, dorsal to the urinary bladder but ventral to the ureters, so that the ureters running back above the uteri have to dip down to open into the urinary bladder. Each uterus is attached to the dorsal body wall by a peritoneal sheet, called the mesometrium. From the point where the two uteri meet, the genital duct is continued back as a single tube, the vagina. The cavity of each uterus communicates with the anterior end of the cavity of the vagina by an aperture called an *os uteri*. On the two sides of the urethra, below the base of the bladder and ventral to the vagina, are a pair of small glands which are regarded as female prostate glands. The vagina runs backwards through the pelvis to open to the exterior between the urethral and anal apertures.

In the male urinogenital system (Fig. 25) the kidneys, ureters and bladder are as in the female, but the urethra functions as a combined urinogenital duct. The male reproductive organs are a pair of testes, developed originally in positions corresponding to the ovaries of the female, but in the adult rat lying in the scrotal sac. This sac is formed externally by a pouch of the skin; internally it is lined by the peritoneum derived from the lining of the body cavity. When the skin and the internal lining, the tunica vaginalis, of the scrotal sac are cut open each testis can be observed

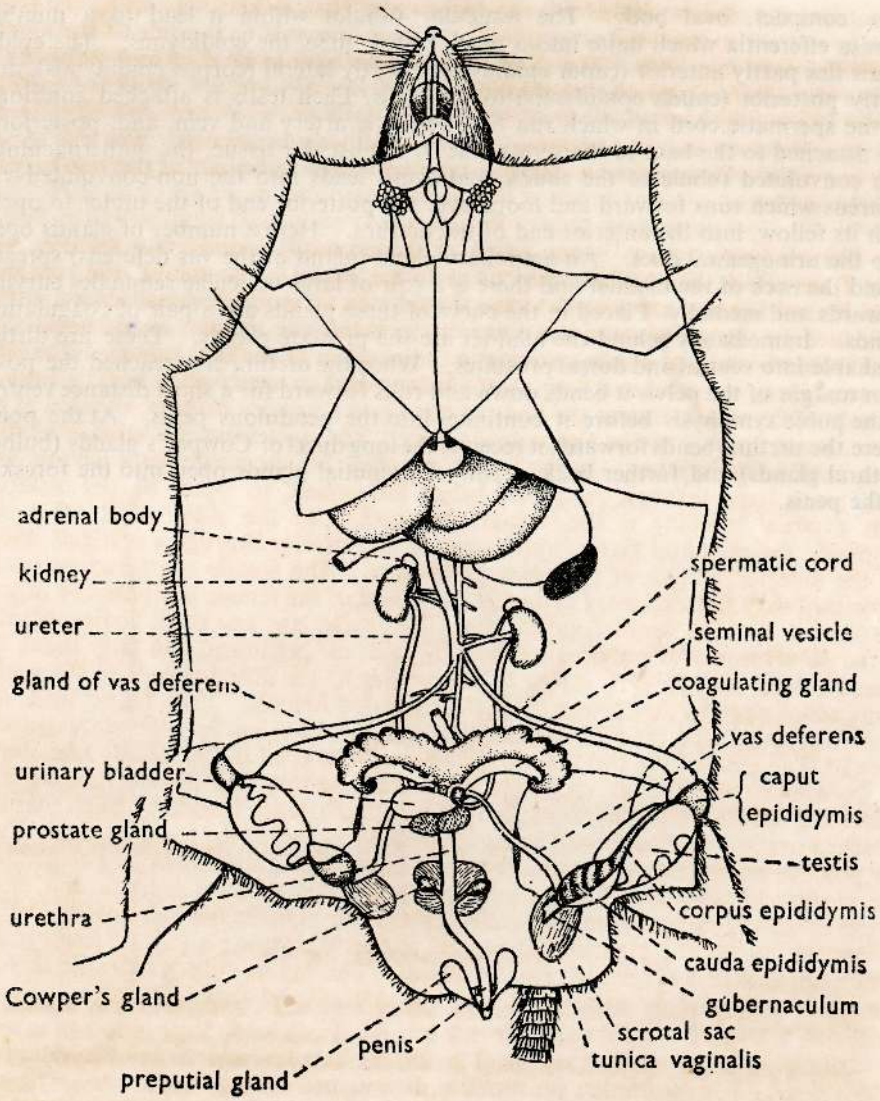

Fig. 25. MALE URINOGENITAL SYSTEM

as a compact, oval body. The testicular tubules within it lead to a number of vasa efferentia which unite into a much coiled tube, the epididymis. The epididymis lies partly anterior (caput epididymis), partly lateral (corpus epididymis), and partly posterior (cauda epididymis) to the testis. Each testis is attached anteriorly by the spermatic cord in which run the spermatic artery and vein, and, posteriorly it is attached to the base of the scrotal sac by a muscular tissue, the gubernaculum. The convoluted tubule of the cauda epididymis leads into the non-convoluted vas deferens which runs forward and loops over the posterior end of the ureter to open, with its fellow, into the anterior end of the urethra. Here a number of glands open into the urinogenital duct. An ampullary gland (gland of the vas deferens) spreads round the neck of the bladder and there is a pair of large vesiculae seminales curving forwards and medially. Placed in the curve of these glands are a pair of coagulating glands. Immediately behind the bladder are the prostate glands. These are distinguishable into ventral and dorsal prostates. When the urethra has reached the posterior margin of the pelvis it bends down and runs forward for a short distance ventral to the pubic symphysis before it continues into the pendulous penis. At the point where the urethra bends forwards it receives the long ducts of Cowper's glands (bulbo-urethral glands) and, further back, a pair of preputial glands open into the foreskin of the penis.

The brain has to be hardened before it can be dissected out. For this purpose a rat that has been preserved in alcohol or formalin can be used. It is, however, better to cut off the head of a freshly killed rat and preserve the head in four per cent. formalin or ninety per cent. alcohol for a week or ten days. Cut away the skin from the top of the head. Grip the nasal bones transversely with forceps and crush these bones. Pick away the pieces of crushed bone and in this way make an opening into the skull cavity without damaging the brain. Working backwards from the nasal bones, pick away the bones of the roof of the skull, piece by piece, until the dorsal side of the brain is exposed. Then pick away the side walls of the skull and work round and underneath the brain, cutting the cranial nerves and gradually freeing the brain from its base. When this has been done and the brain removed, some of the coverings (meninges) of the brain—the outer *dura mater* and the inner *pia mater*—may still remain. Carefully remove these as well.

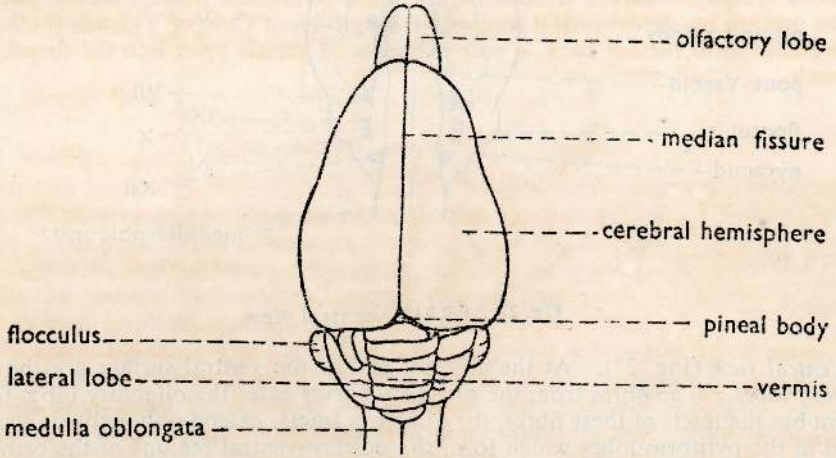

Fig. 26. BRAIN, dorsal view

Dorsal view (Fig. 26). The two small, nearly triangular masses lying close together at the anterior end of the brain are the olfactory lobes. Posterior to them are the large cerebral hemispheres separated from each other by a deep median sagittal fissure. Their surfaces are smooth, without the convolutions usually present on this region of the mammalian brain. Posteriorly, the cerebral hemispheres cover over the diencephalon (thalamencephalon) and the mid-brain and reach the cerebellum leaving only the tip of the pineal stalk visible in the centre between the cerebral hemispheres and the cerebellum. If the posterior ends of the cerebral hemispheres are lifted apart and away from the cerebellum, the four round optic lobes (corpora

quadrigemina) of the mid-brain will become visible. The cerebellum is a large mass with its surface marked by several grooves. It has a median lobe, the vermis, and a pair of lateral lobes. Each of these lateral lobes is connected by a narrow stalk to another small lobe, the flocculus, enveloped by bone and usually left behind when the brain is removed from the skull. The cavity of the fourth ventricle, covered by a choroid plexus, lies beneath the vermis. The cerebellum is followed by a short medulla oblongata which passes into the spinal cord behind the foramen magnum.

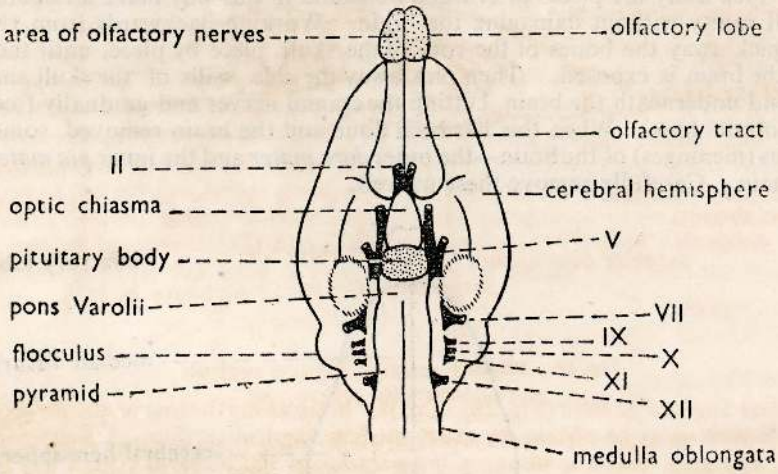

Fig. 27. BRAIN, ventral view

Ventral view (Fig. 27). At the anterior end of the ventral surface are the two olfactory lobes. The fibres from the olfactory nerves enter the olfactory lobes from in front but the tracts of these fibres, the olfactory tracts, extend obliquely hindwards to end in the pyriform lobes which form the postero-ventral regions of the cerebral hemispheres. Between the two pyriform lobes is seen the ventral surface of the diencephalon. This is bounded in front by the optic chiasma which is formed by the fibres of the optic nerves crossing to the opposite sides of the brain. Behind the optic chiasma is a small swelling—the *tuber cinereum*—to which the pituitary body is attached by a short stalk. If the pituitary body has not come off with the brain but has remained behind in its position on the base of the skull, a small aperture will mark the place of its attachment to the brain. The ventral surface of the mid-brain is occupied by nearly longitudinal bands of nerve fibres, the *crura cerebri*, which connect the cerebral hemispheres with the medulla oblongata. The rest of the ventral surface belongs to the hind brain. Its anterior part is crossed by transverse nerve fibres which are called the *pons Varolii*. Behind the pons the medulla oblongata has a median longitudinal fissure on either side of which are arranged longitudinal fibre tracts, the pyramids.

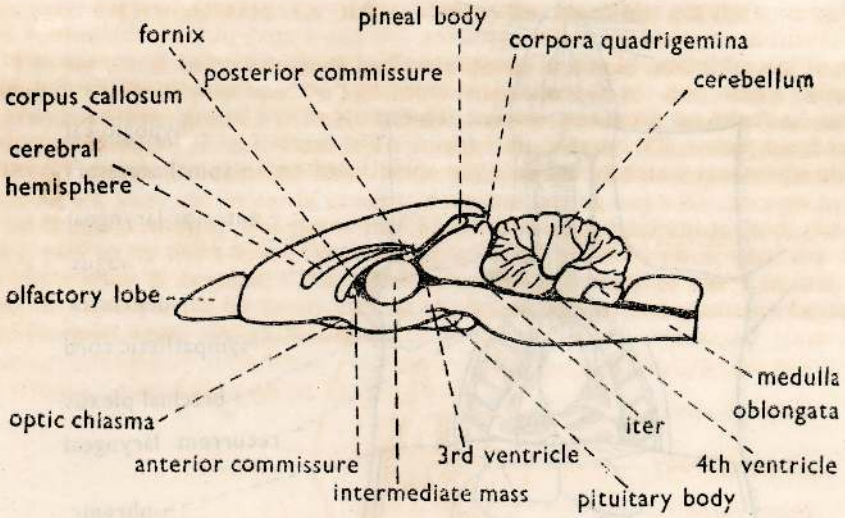

Fig. 28. BRAIN, median sagittal section

Median Sagittal Section (Fig. 28). Cut the brain along the line of the longitudinal cerebral fissure so as to obtain an exact median sagittal section. Observe the cut surface. The grey matter containing the neurons of the cerebral cortex lies outside the white matter formed by the nerve fibres. The fibres of the *corpus callosum* which connect the cerebral hemispheres form an obliquely placed band of white matter which is bent on itself ventrally. This ventral portion is the *fornix*. Immediately in front of the anterior end of the fornix is a round section of a small bundle of fibres which is the anterior commissure. More dorsally, behind the base of the pineal stalk, is a section through the posterior commissure. The anterior and posterior commissures provide connections between the two sides of the brain. The cavity of the diencephalon is the third ventricle. It extends into the *tuber cinereum* and the pituitary body. A large round section in the middle of this ventricle represents the cut surface of the intermediate mass of tissue which extends through the cavity of the third ventricle, uniting the lateral parts of the thalamus. In the roof of the mid-brain can be seen an anterior and a posterior optic lobe. In this part the cavity of the brain is narrowed to form the *iter* connecting the third ventricle of the diencephalon with the fourth ventricle of the hind brain. The cortex of the cerebellum shows the tree-like branching of the white matter within the grey matter to form the *arbor vitae* or tree of life.

The Nerves of the Neck (Fig. 29). The dissection to display the neck nerves should be carried out on a freshly killed rat. It is only necessary to open up the thoracic cavity and to clear the ventral surface of the neck by removing the salivary glands, lymph glands, and the sternohyoid and sternomastoid muscles.

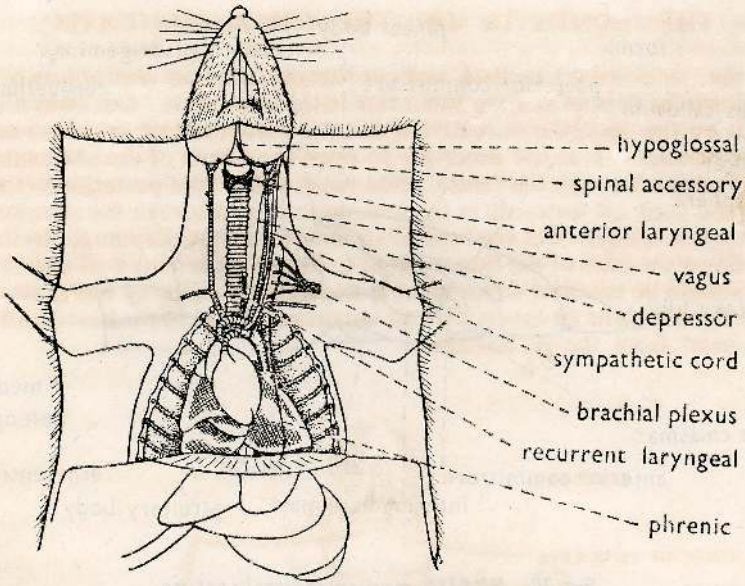

Fig. 29. **NECK NERVES** (of left side)

Although there are eight pairs of cervical spinal nerves emerging from the spinal cord in the region of the neck these nerves are not of primary importance in this dissection. The nerves that have to be displayed are the last three cranial nerves (the tenth, eleventh and twelfth), the sympathetic chain in the neck region, and the phrenic nerve. The tenth cranial nerve, the vagus, comes out of the skull through the posterior lacerated foramen. Soon after it emerges, the vagus gives off a branch which divides again into a short laryngeal nerve to the larynx and a much longer depressor nerve which runs backwards along the inner side of the carotid artery to innervate the heart. The main branch of the vagus runs back lateral to the common carotid artery and, in the thorax, by the side of the oesophagus to enter the gut wall in front of the stomach. Before it does so, however, at the base of the neck, it gives off a branch which curves behind and above the aortic arch on the left side and behind and above the subclavian artery of the right side to run forward again along the side of the trachea as a recurrent laryngeal nerve. The eleventh cranial nerve (spinal accessory) also emerges from the posterior lacerated foramen. It is a short nerve which runs dorsalwards to supply the muscles of the back of the neck. The twelfth cranial nerve (hypoglossal) comes out of the skull through the hypoglossal canal and turns forward ventrally to supply the hyoid region and the muscles of the tongue. The cervical sympathetic chain extends along the neck medially to the main branch of the vagus. The chain shows three enlargements—anterior, middle, and posterior cervical sympathetic ganglia. Fibres given off from the fifth cervical spinal nerve, sometimes joined by fibres also from the fourth cervical spinal nerve, form a phrenic nerve which runs backwards through the thoracic cavity to terminate on the diaphragm.

THE CONTENTS OF THE THORACIC CAVITY

Pin the rat down on its back and cut through the mid-ventral line of the skin, pinning down the flaps of skin on either side in the usual way. Cut away and remove the glands on the neck, the sternohyoid and the sternomastoid muscles and also the pectoralis muscles. It is not necessary to open the whole of the abdominal cavity. Make an incision through the ventral abdominal wall a little posterior to the xiphoid cartilage and then cut forwards in the mid-ventral line through the sternum to open up the thoracic cavity. Cut the ventral attachment of the diaphragm to the thorax, then pin down the sides of the thorax, so as to bring its contents well into view. The clavicles should be trimmed down without damaging the nearby blood vessels. Remove the thymus gland (it covers over an important region of the heart) and carefully free the heart from the pericardium.

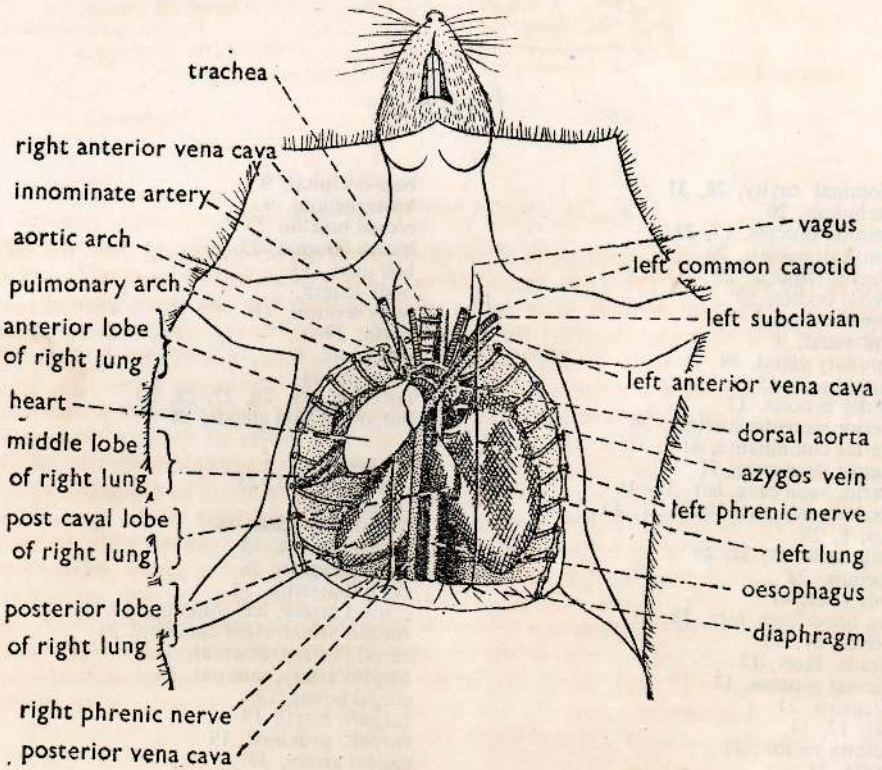

Fig. 30. CONTENTS OF THE THORAX

The contents of the thoracic cavity observed (Fig. 30) should include the following:—(1) the four chambers of the heart; the pulmonary arch; the aortic arch with the origins of the innominate, the left common carotid and the left subclavian arteries; the right anterior vena cava, the left anterior vena cava with the azygos joining it, and the posterior vena cava. (2) The vagus nerves with the branching of the recurrent laryngeal of the left side and the phrenic nerves. (3) The bronchi and the four lobes of the right lung and the single lobe of the left lung. (4) The oesophagus.

It is difficult, in this dissection to display the main pulmonary veins. It is also not easy to display much of the dorsal aorta and intercostal arteries as these vessels are dorsal in position and are covered by the more ventrally situated lungs and the oesophagus.

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