

INTRODUCTION: THE RAT AND MAN

Much of human history can be understood in terms of the relationship between man and the rat. As a host to the carriers of diseases such as bubonic plague (the Black Death), typhus, rat bite fever, and many others, the rat has been responsible for enormous loss of life. During the fourteenth century it is estimated that one quarter to three quarters of the population of continental Europe was wiped out by the Black Death.

In agriculture there is a constant battle raging between man and the rat for the fruits of the harvest. At one time it was even believed that mice and rats were spontaneously generated from grain seeds.

The rat is the most widely used animal in experimental studies. These include the areas of disease pathology, biological assay, and nutritional as well as behavioral research.

THE MAMMALS

For most students this will be your first major dissection. A few words of introduction are in order.

Both the rat and man belong to the class of vertebrates known as *Mammalia*. Mammals are the most highly developed animal forms. While our major dissection subject is the rat, we will be making constant reference to man in both the text and the diagrams presented.

Since we are about to study the structures and function of a type of mammal, we ought first to consider this class of vertebrates more closely.

Mammals range in size from minute shrews, which weigh only about 2 grams (0.002 kg) to giant blue whales, which weigh up to 115 tons (115,000 kg).

Besides mammals, the *Vertebrates*, or backboned animals, include the:

- Fish
- Amphibians (frogs, toads, and salamanders)
- Reptiles (lizards, snakes, turtles, alligators, and crocodiles)
- Birds.

The two chief mammalian characteristics, which set these animals apart from the other classes of vertebrates, are:

- Skin covered with hair or fur
- Milk-producing glands (mammary glands) in the female to nurse the young.

The most primitive living mammals belong to the Order *Monotremata*. These animals, native to the Australian region, include the duck-billed platypus and the spiny anteater. They lay a reptilian type of egg. When hatched, the young receive nourishment from the mother's mammary glands.

A more advanced form of mammal, belonging to the order of the pouched mammals, the *Marsupialia*, gives birth to live young (viviparous). However, the young are born at a very early stage of development and continue their maturation in a pouch, where they attach to nipples of the mammary glands. Australian kangaroos and American opossums are members of this order.

The true placental mammals are grouped into the subclass *Eutheria*. Almost all other mammals belong to this subclass, which includes the rat as well as man. Their embryos are retained in the uterus and are nourished by the placenta for a longer time and they emerge more highly developed. Most can walk and even run within a few days of birth; man is helpless for the longest period of time.

Man, *Homo sapiens*, belongs to the Order *Primates*, which also includes the apes and monkeys. The rat belongs to the Order *Rodentia*, which also includes the mouse, squirrel, gopher, muskrat, beaver, and porcupine. Rodents constitute the largest order of Mammals. There are probably more species of rodents today than all other mammals combined.

THE RAT

Two major varieties of rat are identified. The first is the *black rat*, which is known scientifically as *Rattus rattus*. It probably originated in India and arrived in Western Europe during the thirteenth century. It is also known as the *ship rat*, as it is found in the world's port cities. Its habitats, however, may extend to towns and remote villages and farms. It has superior climbing ability and can establish itself in the tallest buildings by utilizing electrical poles, pipes, elevator cables, and plumbing systems.

The *Norwegian rat*, also known as the *brown rat*, or *Rattus norvegicus*, is larger and more stocky than the black rat. It is more widespread in urban and rural areas. It probably originated in China or Siberia and was first seen in Western Europe at about the beginning of the eighteenth century. It was brought to America aboard the ships of the early settlers. It generally lives in burrows and other places on the ground. It is not as agile a climber as the black rat, but it is much more expert at swimming.

The *white laboratory rat* has been developed as a result of repeated selections during the past seventy years. It is a pink-eyed *albino* form of the *Norwegian rat*. It differs from the wild rat in being less prone to fighting amongst the males, and more readily handled by man without struggling or biting. Physically, the laboratory rat fails to achieve the size or weight of its wild cousin. It also has a smaller brain, spinal cord, and adrenal glands.

The scientific name of the white laboratory rat has been subject to controversy among *taxonomists* for many years. It has undergone periods where one or the other has enjoyed greater popularity and acceptance. The names include: *Mus norvegicus*, *Mus norvegicus albinus*, *Rattus norvegicus*, and *Rattus rattus norvegicus*. Today, however, most authorities prefer the name *Rattus norvegicus albinus*. (The word "albinus," meaning unpigmented, white, refers to a variety or sub-species.) It is the name that will be used throughout this book.

Summary of the Classification of the White Rat

Kingdom — Animalia
Phylum — Chordata
Sub-Phylum — Vertebrata
Class — Mammalia
Order — Rodentia
Family — Muridae
Genus — *Rattus*
Species — *norvegicus*
Variety — *albinus*

Breeding and Lifespan of the White Rat

The female white rat can begin to breed at 3 months of age. The breeding seasons for wild rats are mainly in the spring and autumn. Under laboratory conditions breeding is continuous throughout the year. The average litter consists of 8 young. A litter can be produced every 21–25 days, that being the period of *gestation*, during which the embryo develops in the uterus.

The newborn young are pink-skinned, hairless, and quite helpless. They are blind, their ear passages are closed, they are without teeth, and they are unable to walk. The young are suckled for about 3 weeks.

The lifespan of the wild rat is about 12–18 months. In the laboratory the rat's lifespan is about 36 months, with the female usually outliving the male. When fully mature, the white rat weighs from 200–400 grams.

Students in the Health Sciences, please note that although your primary interest is the human organism, most organs and tissues of the rat are structurally and functionally similar to those of man. Even their names are quite similar, most often identical. Charts, models, and skeletons of human anatomy should be made available to you while you are studying comparable features of the rat.

ANATOMICAL TERMINOLOGY

Some basic biological terminology should be studied at this time. Familiarize yourself with the following words and learn to use them in referring to the location of the body parts of your specimen.

DIRECTIONS OR POSITIONS

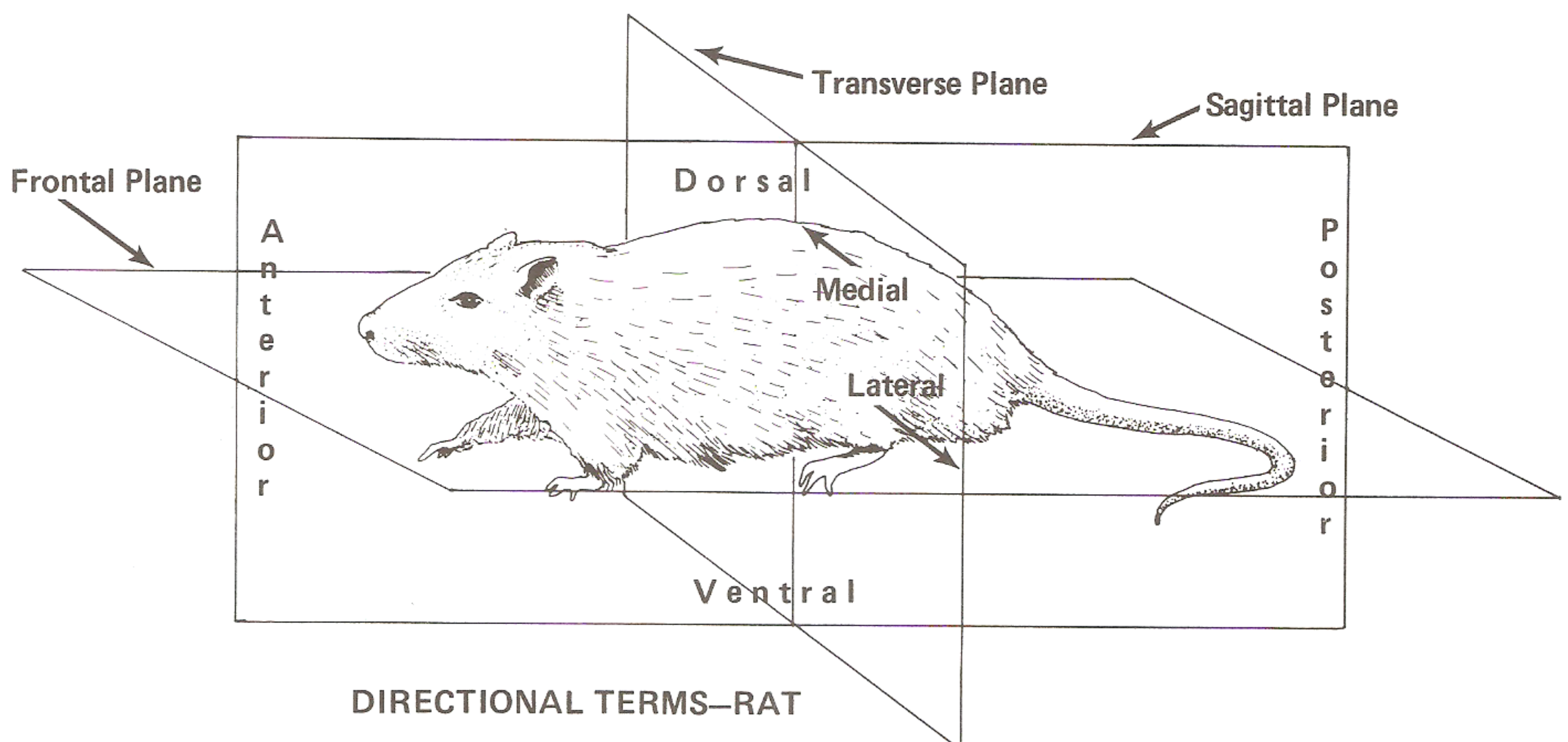
Anterior (Cranial)	— toward the head	Medial	— toward the midline
Posterior (Caudal)	— toward the tail	Proximal	— lying near the point of reference
Dorsal (Superior)	— toward the backbone	Distal	— lying further from the point of reference
Ventral (Inferior)	— toward the belly		
Lateral	— toward the side		

Note: The terms listed in parentheses above are synonymous only when referring to a quadruped such as a rat. In man these terms have different meanings (see diagrams at the end of this section).

PLANES OR SECTIONS THROUGH THE BODY

Transverse (Cross Section)	— perpendicular to the long axis of the body
Sagittal	— a longitudinal section separating the body into right and left sides
Frontal (Coronal)	— a longitudinal section dividing the specimen into dorsal and ventral parts

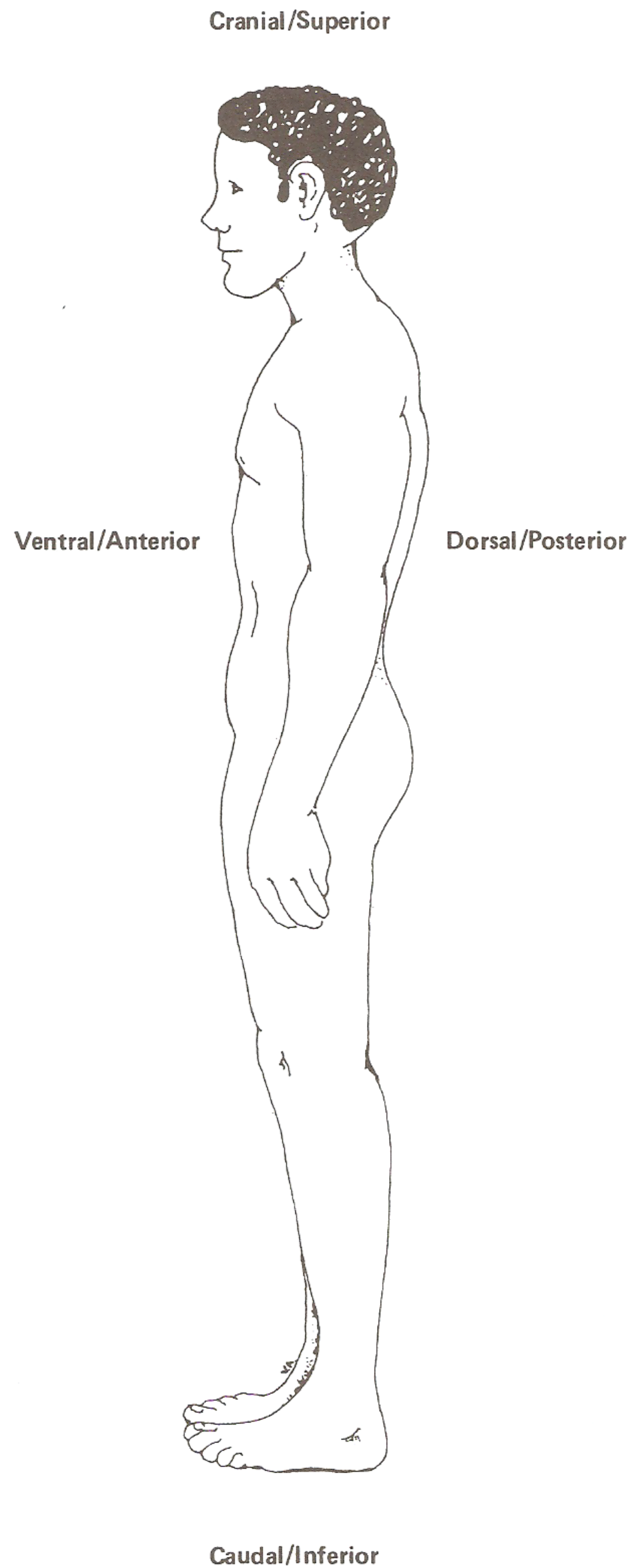
DIRECTIONAL TERMS FOR THE RAT AND MAN



In man, the *anterior* and *ventral* surfaces are identical; both terms refer to a person's front or belly side. Similarly, the terms *posterior* and *dorsal* are identical, referring to a person's back surface, the area near the spinal cord.

In the rat and other four-legged animals these terms are not at all identical. *Ventral* still refers to the belly portion, but the rat's belly is not at its *anterior* or head end, but on the lower (*inferior*) surface. *Dorsal* still refers to the area of the spinal cord, but the rat's spine is not located along its *posterior* or tail end, but on its upper (*superior*) surface.

Other terms indicating position or direction will appear in the text. For example, the terms *superficial* (or external) and *deep* (or internal) will be used when describing muscles. The terms *cranial* and *caudal* will indicate the head and tail ends respectively.



DIRECTIONAL TERMS—MAN

EXTERNAL FEATURES

PRELIMINARY PROCEDURES

When you receive your specimen, remove it carefully from the plastic bag and place it in a dissection pan. Do not discard the preservative fluid in the bag. The animal will be returned to the bag at the end of each lab session and the fluid will keep the specimen in good moist condition.

Obtain an identification tag and a rubber band for your specimen bag. At the close of each session, after the rat has been returned to the bag, twist the top of the bag and seal tightly with the rubber band. Then attach the tag. Write your name, your partner's name, the section number, and the instructor's name on the tag.

OVERALL DESCRIPTION

Examine the specimen you have received. Lay the rat in the dissection tray as in the photograph on page 9.

The body is divided into four readily identifiable areas:

- head (cranial)
- neck (cervical)
- trunk (thoracic, abdominal, and sacral)
- tail (caudal).

The appendages (forelimbs and hind limbs) and the external differences between male and female rats will be described along with the trunk.

The Head

Locate the following parts of the head:

NOSTRILS — these are found at the edge of a hairless zone called the *rhinarium*, the most anterior point of the rat's body.

LIPS — Note that the upper lip is split in two medially, with the cleft extending to the nostrils. The lower lip is not divided.

TEETH — The rat has two prominent *incisors* and six *molars* (three on each side) in the upper jaw and an equal number of teeth in the lower jaw. The incisors grow throughout the life of the rat and are constantly worn down and honed into sharp chisels by gnawing on hard substances.

Behind the incisors the upper lips roll inward toward the mouth to meet a fold of skin from the cheeks. This area, the *diastema*, separates the gnawing from the chewing areas of the mouth.

The *molars* cannot be seen at this time. It is necessary to cut the bones at the angles of the jaw before

these can be seen. This will be done and described in the chapter on the digestive system, later in the book (see page 76).

EYES — The eyes are protected by an upper and lower *eyelid*. Spread the upper and lower eyelids. In the inner (anterior) corner of the eye, locate a third lid-like transparent structure, the *nictitating membrane*, which in the live animal may be drawn across the eyeball.

In the white rat the eyes are not pigmented and appear *pink*.

VIBRISSAE — These are the long *whiskers*, or stiff hairs, extending from the anterior portions of the rat's head; its nose, lower jaws, cheeks, chin, and the area over the eyes. The vibrissae are sensory in nature, each having a coil of *sensory nerve endings* at its base within the follicle. They are extremely sensitive to the slightest stimulus of touch and possibly also to changes in air pressure.

PINNAE — These are the external ears. They are smaller and furrier than those of the black rat (*Rattus rattus*). The ear folds are supported by cartilage. Sound waves are directed inwards toward an opening, the *external auditory meatus*.

Trunk

The trunk is divided into two sectors, the more anterior *thorax* and the more posteriorly located *abdomen*. Internally, a muscular *diaphragm* separates the two. Press the ventral surface of the trunk and note that the thorax is firmer than the abdomen. This is due to the presence of *ribs* around the thorax.

Appendages

Two pairs of appendages originate from the trunk, two forelimbs and two hind limbs. The forelimbs are for grasping and holding. The much more powerful hind limbs are used mainly in running, climbing, and jumping, as well as for support.

Each of the four limbs is *pentadactyle*, having *five digits*. The first digit, the thumb, is much reduced in the forelimb. Also, unlike the other digits, the nail (claw) of the thumb, while fully developed, is flattened, not sharp and pointed.

DIGITAL PADS and **FOOD PADS** — These are swollen, horny thickenings located on the medial surface of the forefoot and hind foot. The *digital pads* are located at the tips and bases of the digits, while six *foot pads* are located on the sole of each foot.

The rat is a *quadruped*, in contrast to man, who is a *biped*. This refers to four- and two-legged locomotion, respectively. The rat walks on the toes, with the remainder of the foot elevated. This is called *digitigrade* locomotion. Man walks on the sole of the foot. This is called *plantigrade* locomotion.

In the photograph on page 9, note the positions of the elbow and wrist, ankle and knee. Count the digits (fingers and toes) on each foot. You will find each to have *five* digits.

Male or Female?

Male and female rats can readily be differentiated by observation of the *external genitalia* and *mammary papillae*.

External Genitalia

Examine the posterior ventral abdominal surface of your specimen. (See photograph, page 11.)

FEMALE — If your rat is a female, note three separate apertures.

Urethral (Urinary) Aperture — This is the most anterior of the three. Also visible here is a short projecting organ, the *clitoris* (homologous with the male penis).

Vaginal Aperture — This is the female rat's genital opening, leading to the vagina and uteri. It is closed in young females by the *hymen* until puberty, about the tenth week of life. The term *vulva* refers to the female external genitalia, which include the labia majora, the labia minora, the clitoris, and the vestibule of the vagina.

Anus — This, the most posterior of the three apertures, is located at the base of the tail. It can be seen by simply lifting the tail. It is the opening for the rectum, discharging the rat's solid wastes.

MALE — If your rat is a male, note the following:

Urogenital Aperture — This is the opening of the *penis*. It is located mid-ventrally in the posterior abdominal region. As the name indicates, both urinary wastes and the products of the male genitals are discharged through this opening to the outside. Compare to the female rat where the urinary and genital apertures are separate.

Scrotum — This is a double pouch, two *scrotal sacs*, located posterior and lateral to the urogenital opening. They contain the *testes*, the male *gonads*, and thus appear swollen in mature animals. In times of danger the testes may be withdrawn from the scrotum into the abdominal cavity.

Anus — As in female rats, this is the most posterior aperture. As the opening for the rectum, it serves to discharge the rat's solid wastes. This opening is often hidden by the overhanging scrotum. It can readily be seen by lifting the tail.

Mammary Papillae

NIPPLES or **TEATS**, the external papillae of the mammary glands, are more readily visible in pregnant or lactating females. In immature females they are smaller and usually hidden by fur.

The teats are usually *twelve* in number, six thoracic, two abdominal, and four inguinal, located along two parallel latero-ventral lines (the milk lines). See photograph, page 12.

Can you find teats on the male rats?

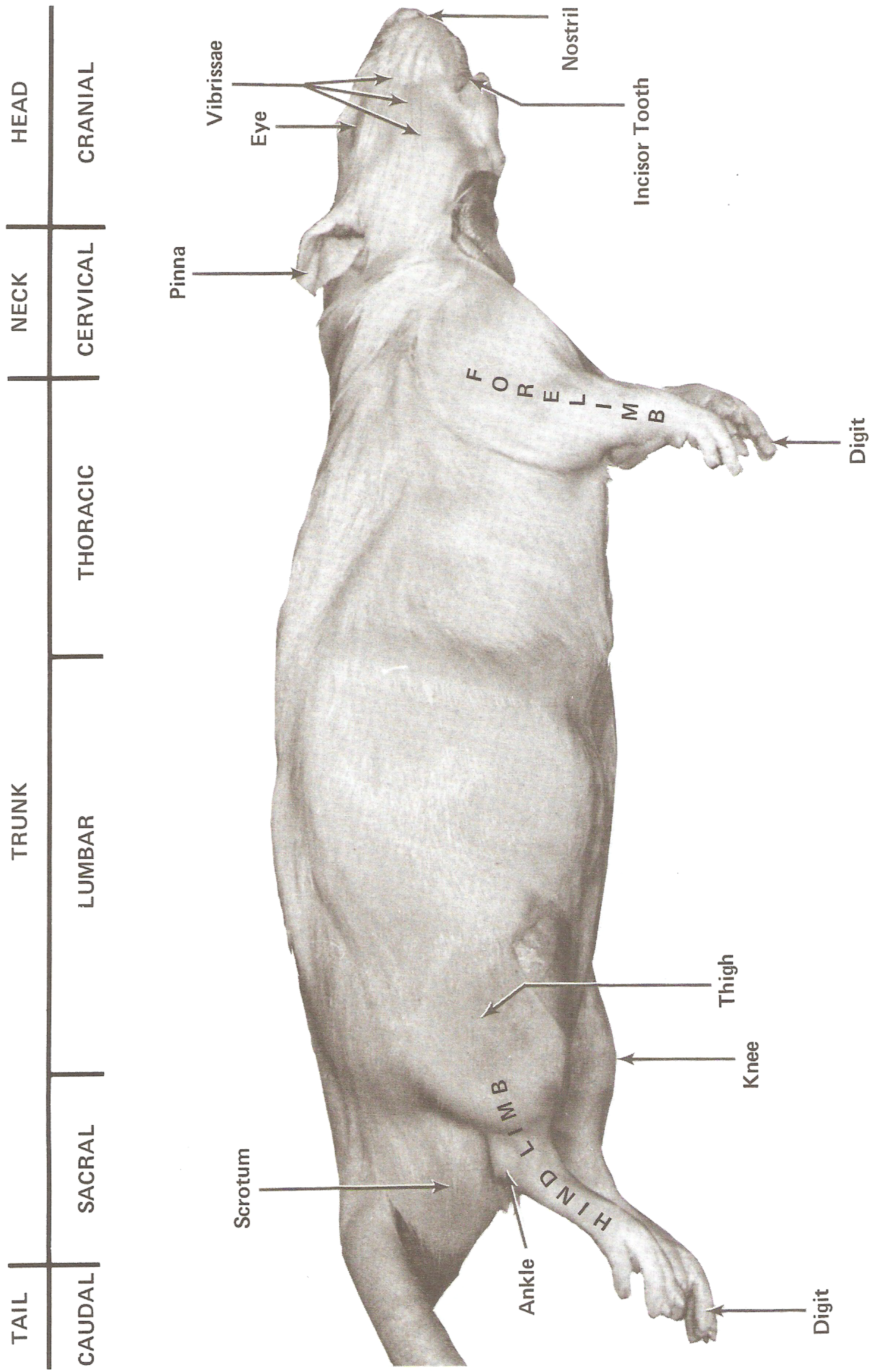
Note: Whether your specimen is a male or a female, you are responsible for knowing the external structures of each sex.

The Tail

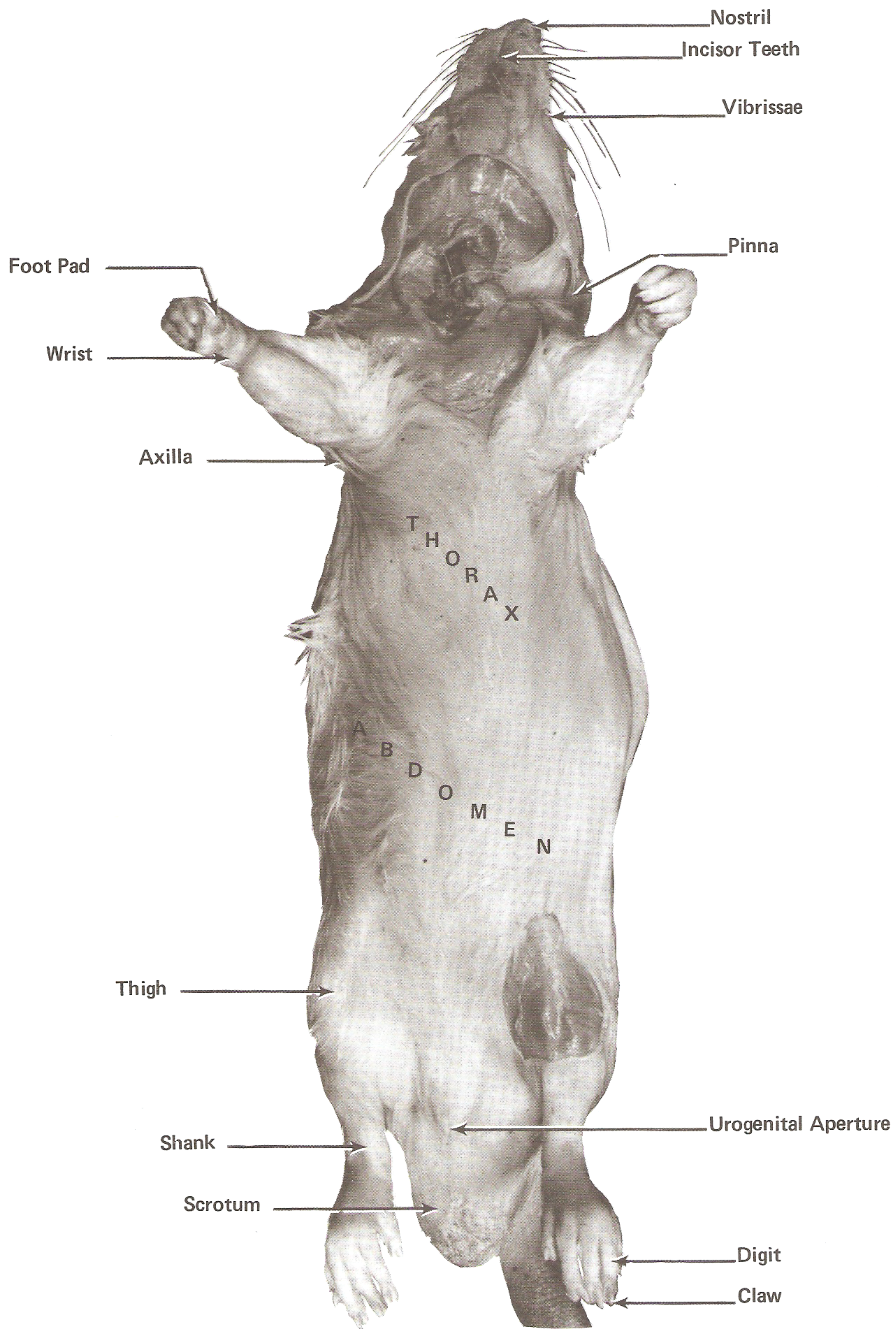
The tail of the albino Norwegian rat is about three-quarters the length of head and trunk combined. That of the black rat (*Rattus rattus*) is even longer.

The tail is essentially a balancing organ giving stability in climbing and crossing over open areas such as water.

The surface of the tail is covered by rows of overlapping reptile-like *scales*. Three short *bristles* project from under the edge of each scale. The surface of the tail is covered with an orange-yellow, waxy grease. See photograph, page 14.

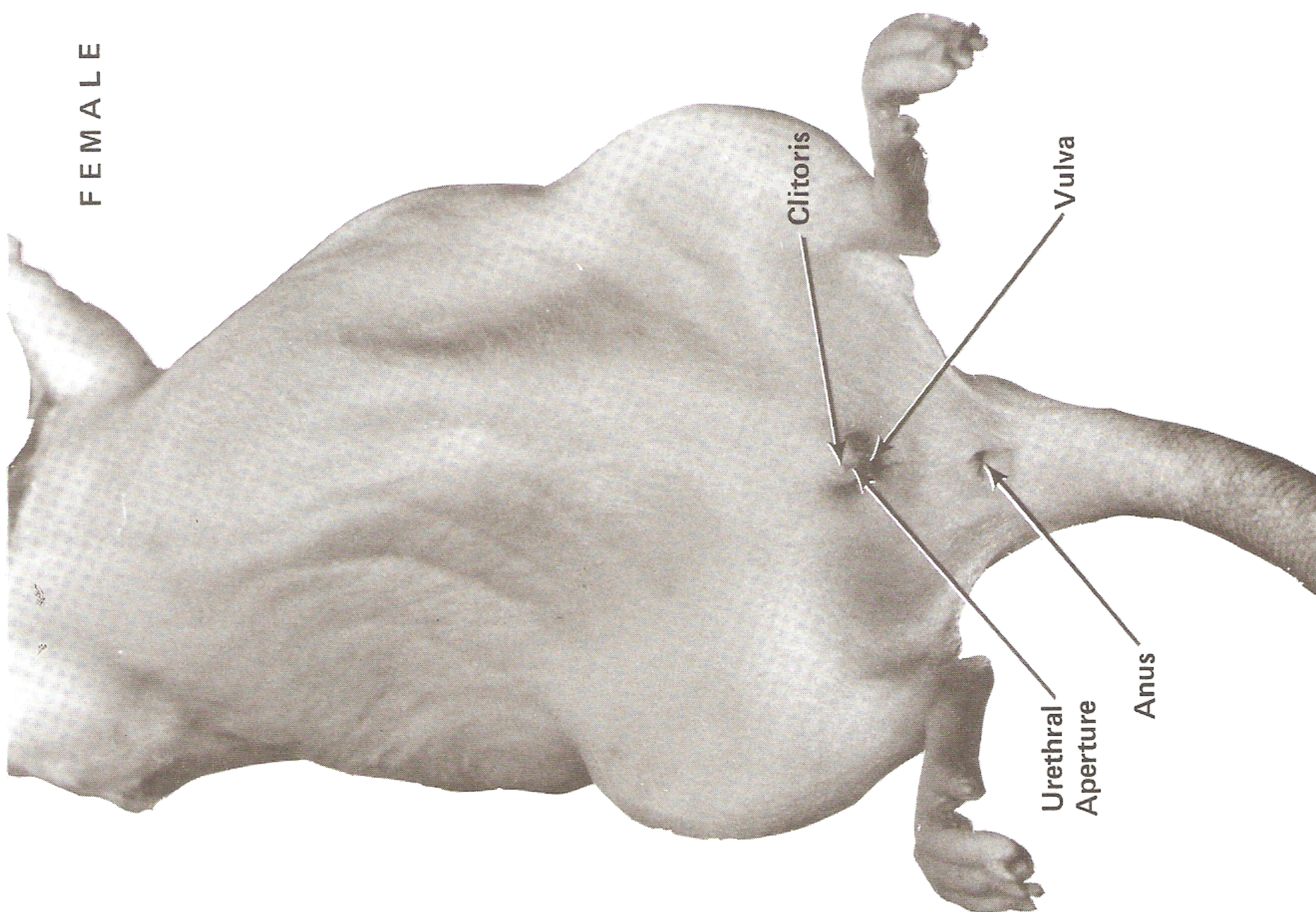


EXTERNAL FEATURES (LATERAL VIEW)

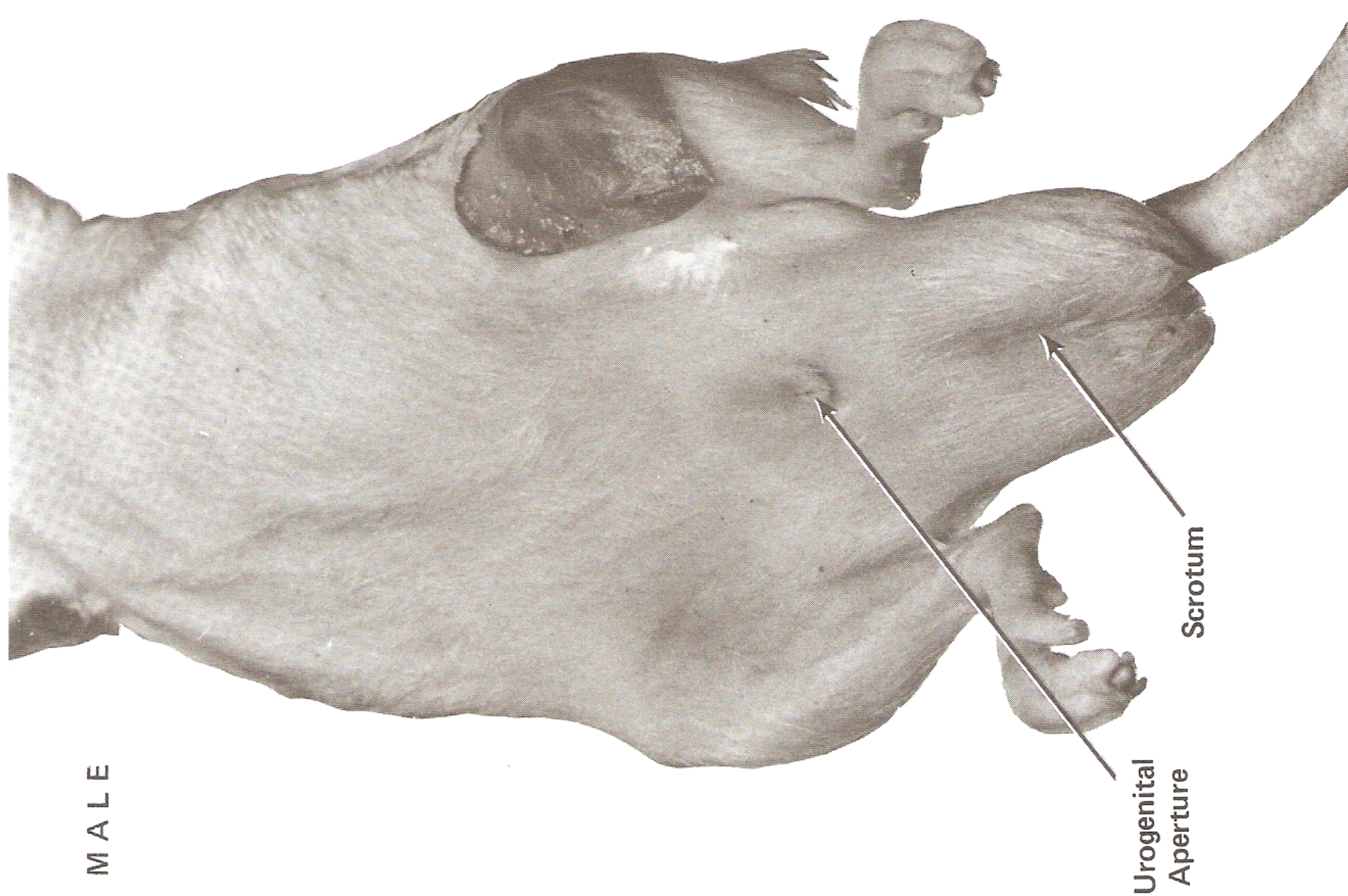


EXTERNAL FEATURES (VENTRAL VIEW)

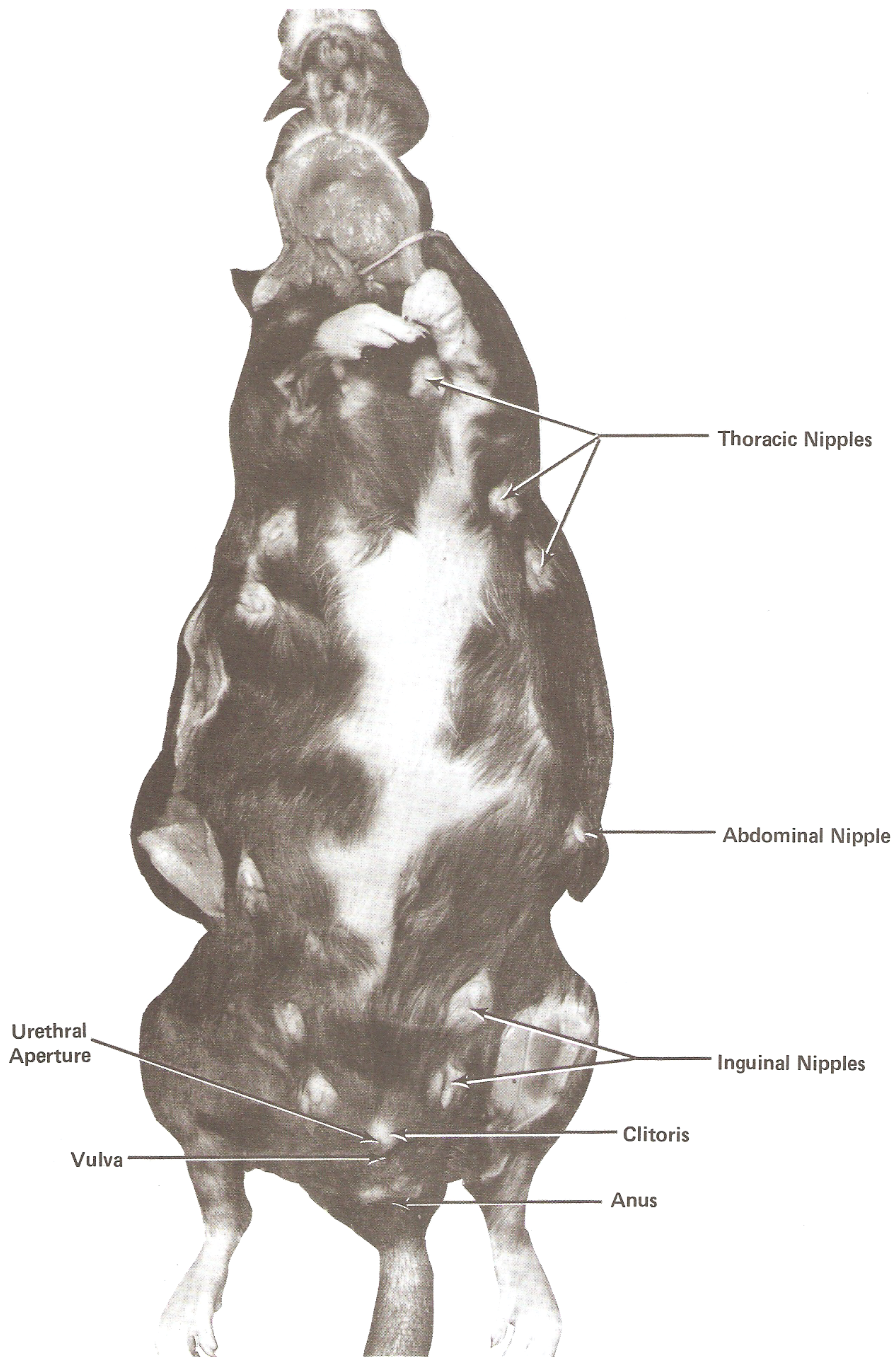
FEMALE

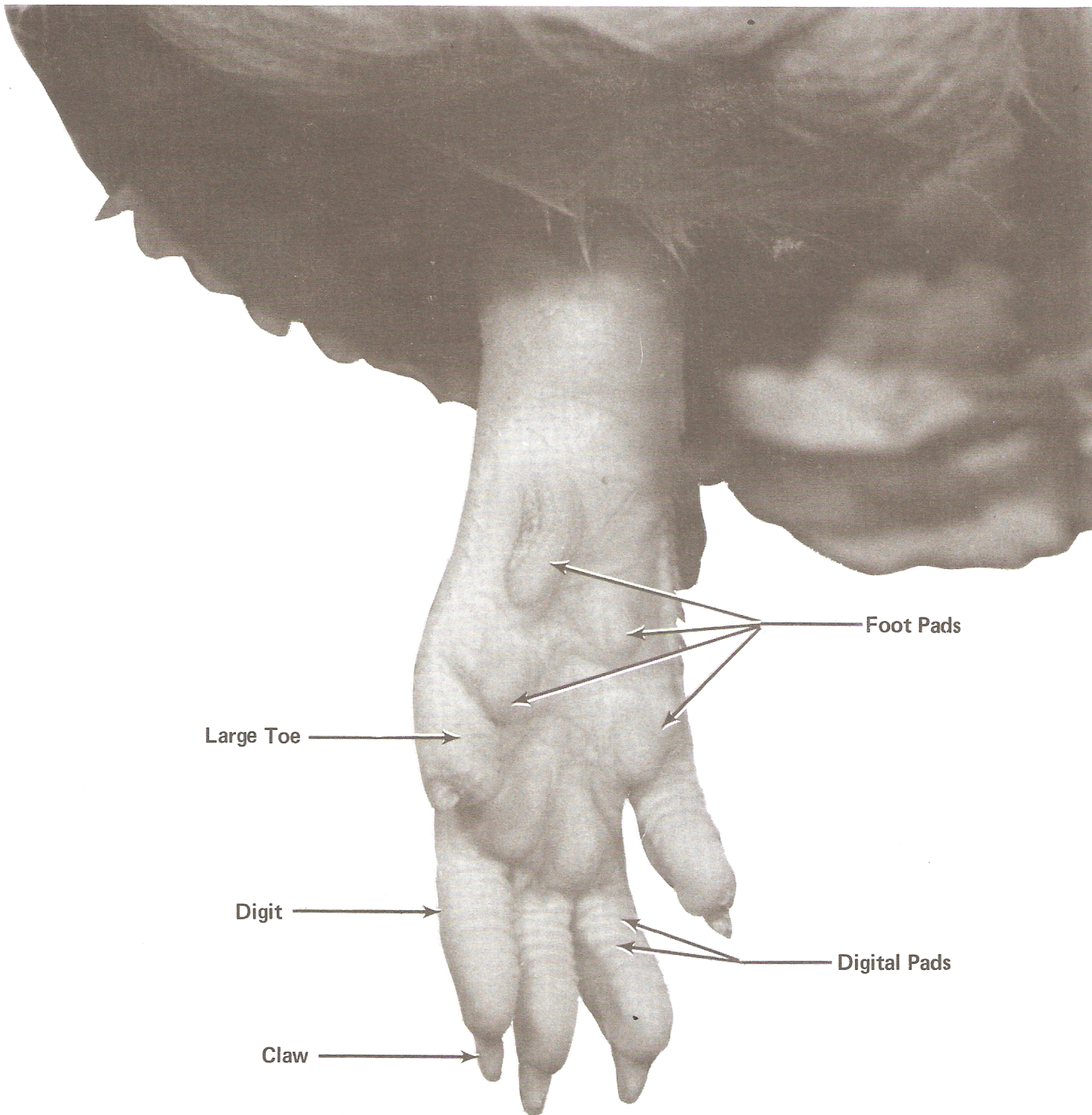


MALE



MALE AND FEMALE





RIGHT HIND LIMB

