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A Practical Guide to the Bones of the Horse

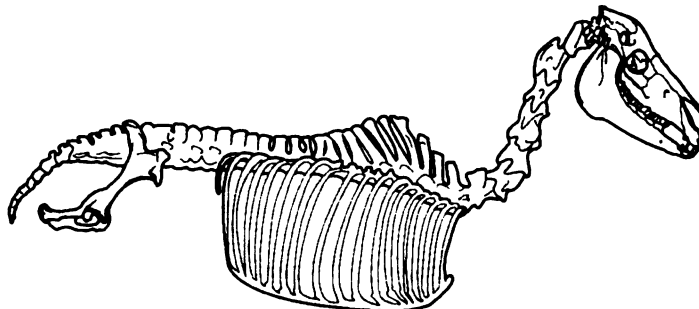
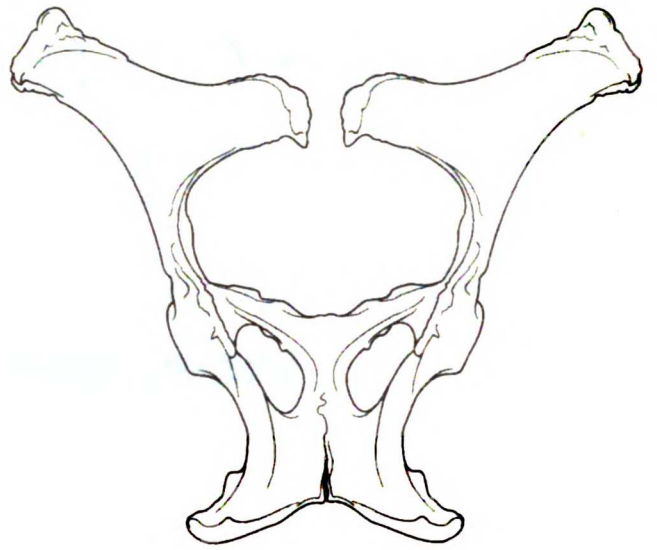
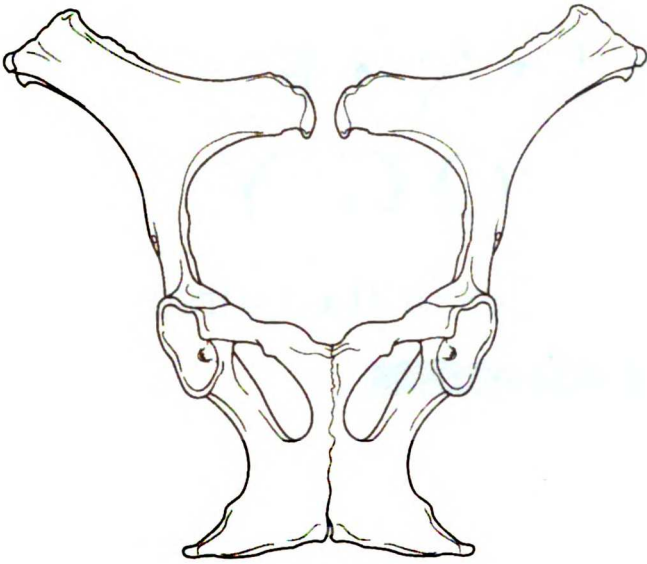


Illustration and Design by Timothy W. Krasnansky, M.A.

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O S T E O L O G Y

A Practical Guide to the Bones of the Horse





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O S T E O L O G Y

A Practical Guide to the Bones of the Horse



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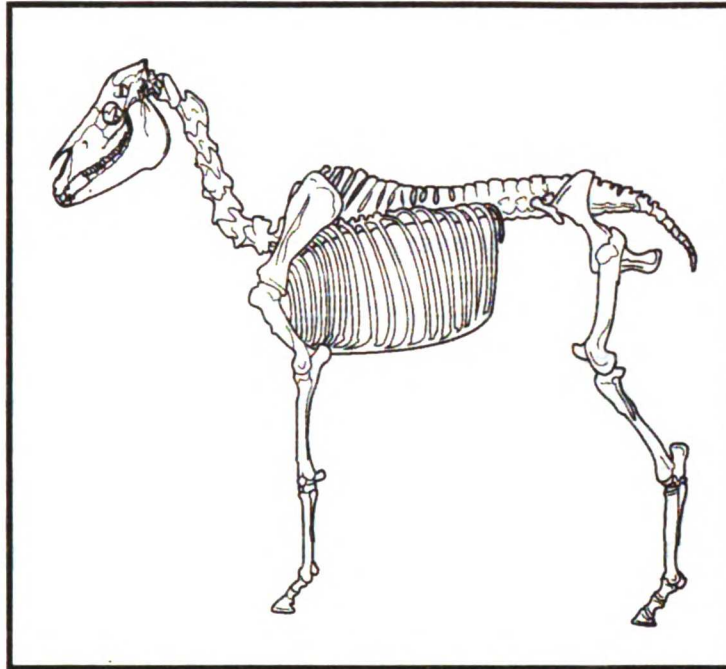
**This project is dedicated to my grandmother
FRANCES WARK
who taught me what I know about animals and their worlds;**

**and to my parents
MARVIN AND JOHANNE KRASNANSKY
for promoting the company of horses rather than the use of off-road vehicles;**

**and to the big, black Percheron with hooves the size of dinner plates,
upon whose back I rode through the snows of New York State.**

**Here's hoping his bones are at peace in that worn-out farmland,
and not being picked over in some lab in Ithaca.**

Preface



Using This Manual



pend a little time with this section, "Using This Manual", before you start to learn the bones of the horse. It will help you find what you're looking for in the manual quickly and easily, as well as helping you find that same thing on the horse.

Organization of this manual

The organization of this manual is visually represented in the Table of Contents.

This manual is organized in two parts, Part A and Part B, plus an Introduction in Chapter I.

The Introduction contains basic anatomical terminology that you'll need to know to understand the figures and find your way around the skeleton of the horse.

Part A, The Axial Skeleton, is composed of chapters II - V, which cover the skull, the vertebral column, the ribs and sternum, and the pelvis.

Part B, The Appendicular Skeleton, consists of two chapters, VI and VII, which contain material on the thoracic limb and the pelvic limb.

Understanding the labeling system:

Reference Numbers

The labeling system used in all the figures in this manual is designed to help you find the skeletal features that you're studying.

Roman numerals always refer you to a chapter. For example, anytime you encounter the roman numeral II, it refers you to Chapter II, The Skull.

Regular numerals are assigned to individual bones within a chapter. For example, the number II.6 always (and only) indicates the frontal bone, a bone of the skull. And separate features of each individual bone are assigned a lower case letter. So, II.6.a is the reference number given to the supraorbital foramen, a small hole in the frontal bone of the skull. Anytime you encounter this particular reference number, it can be only one thing: the supraorbital foramen. And so on, for every osteological feature of the horse.

However, you need not worry about memorizing all those reference numbers; each osteological feature is also named where-ever it appears in the text or figures. The reference numbers are included to help you get around between the figures and text and to help you quickly index the structure of interest.

Figure Numbers

Don't confuse the figure numbers with the reference numbers. The figures are sim-

ply labeled sequentially as they appear in the chapters; Figure II.1 is the first illustration in the Chapter II, The Skull, and Figure II.5 is fifth illustration of the skull. The figure numbers are always presented following the word "Figure" or the abbreviation "fig.". So, the reference number II.6.a can appear in both Figure II.1 and Figure II.4.

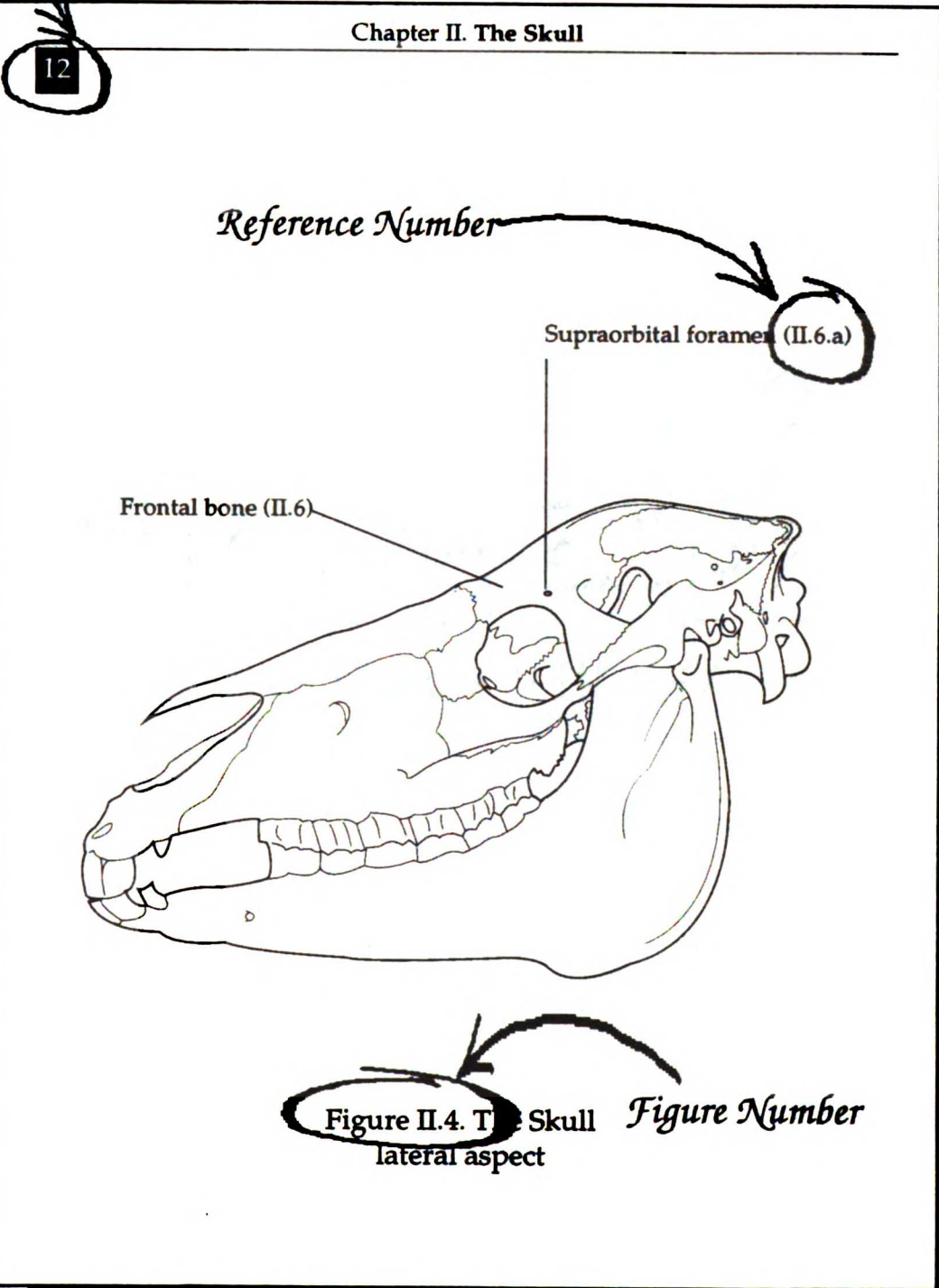
The Index

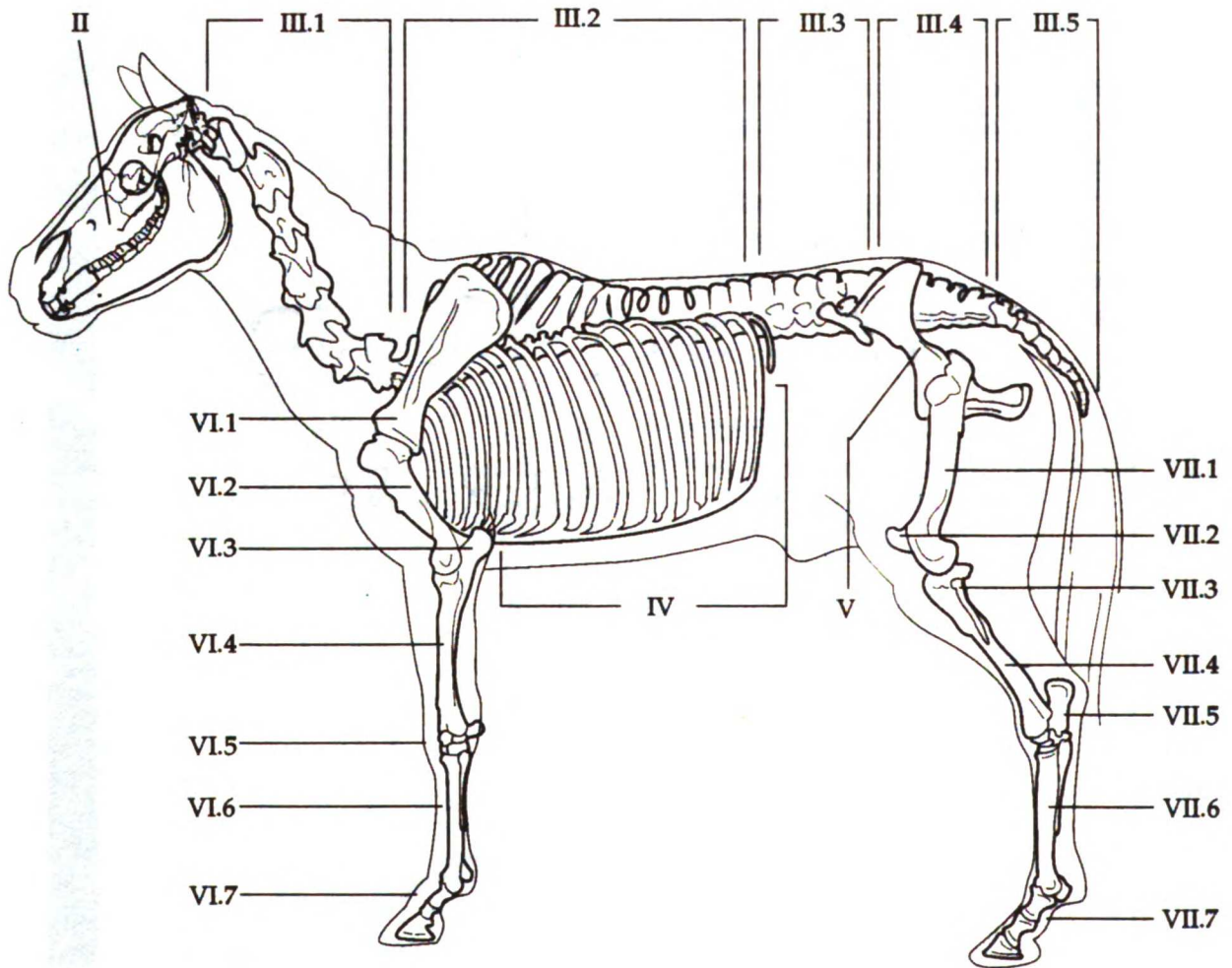
All of the anatomical and osteological features that are mentioned in the text or depicted in the figures are indexed alphabetically, first by page number (p. or pp.), then by figure number (fig.), and then by reference number (ref). For example, the entry in the index for the supraorbital foramen appears as follows (under foramen):

foramen

supraorbital f., pp. 14,17; fig. II.1,II.4;
ref. II.6.a.

Page
Number





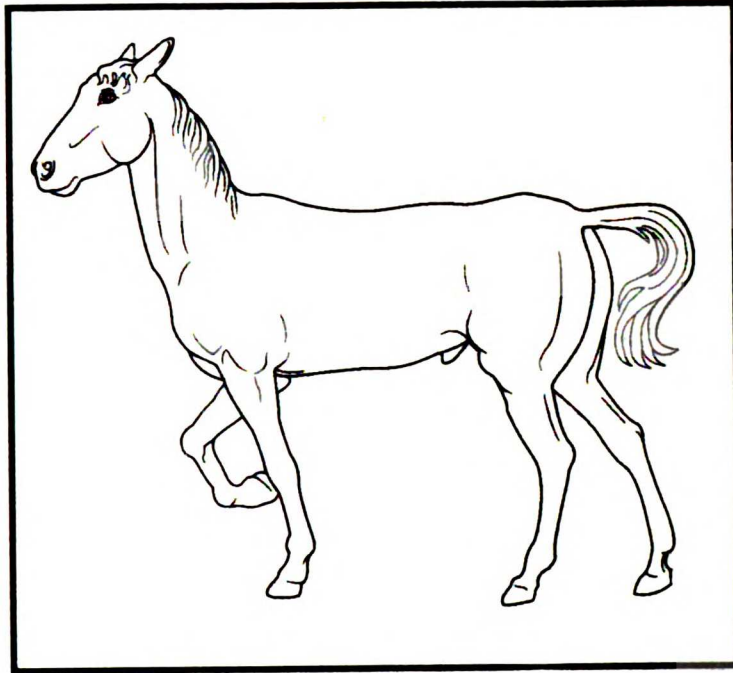
The Horse Skeleton lateral aspect

For key to labels, see Table of Contents on facing page.

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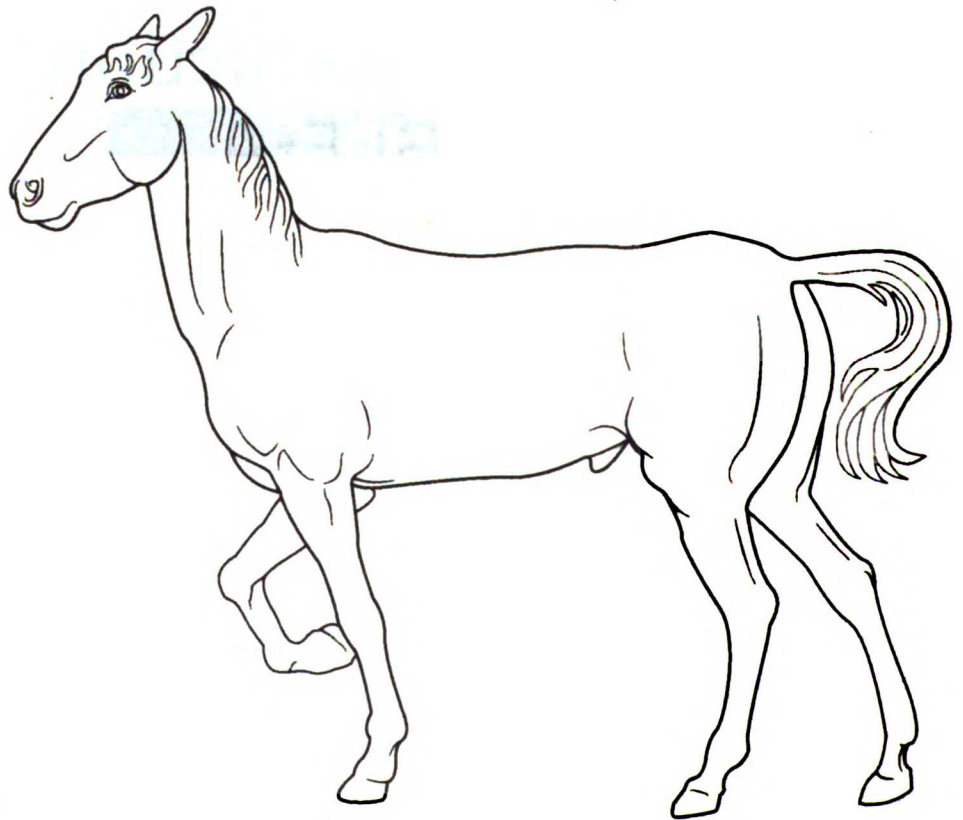
Chapter I.



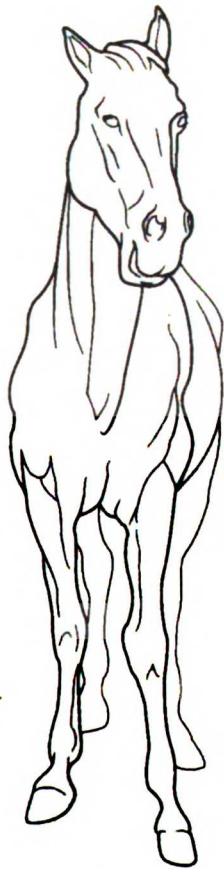
Introduction



Figure I.1. COMMON DESCRIPTIVE ANATOMICAL TERMINOLOGY OF POSITION is illustrated on this and the facing page. The lateral aspect or side view is shown in (a). The anterior aspect is a view looking at the front of the animal (b) and the posterior aspect is a view looking at the animal from behind (c). In (d), the ventral aspect is a view looking at the underside from below, and the view from above looking down at the back is the dorsal aspect (e). The medial aspect is not depicted. See text.



a. Lateral aspect



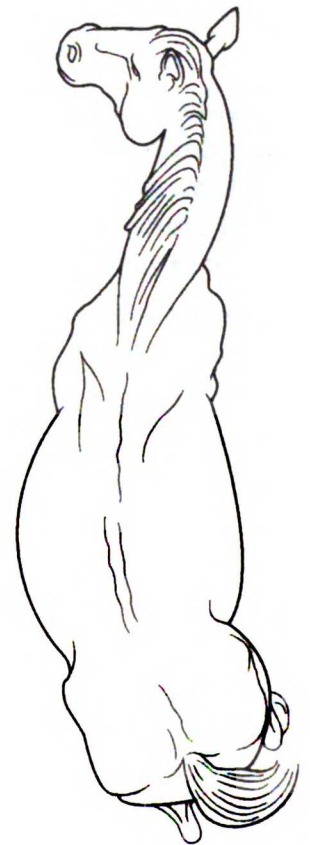
b. Anterior aspect



c. Posterior aspect



d. Ventral aspect



e. Dorsal aspect

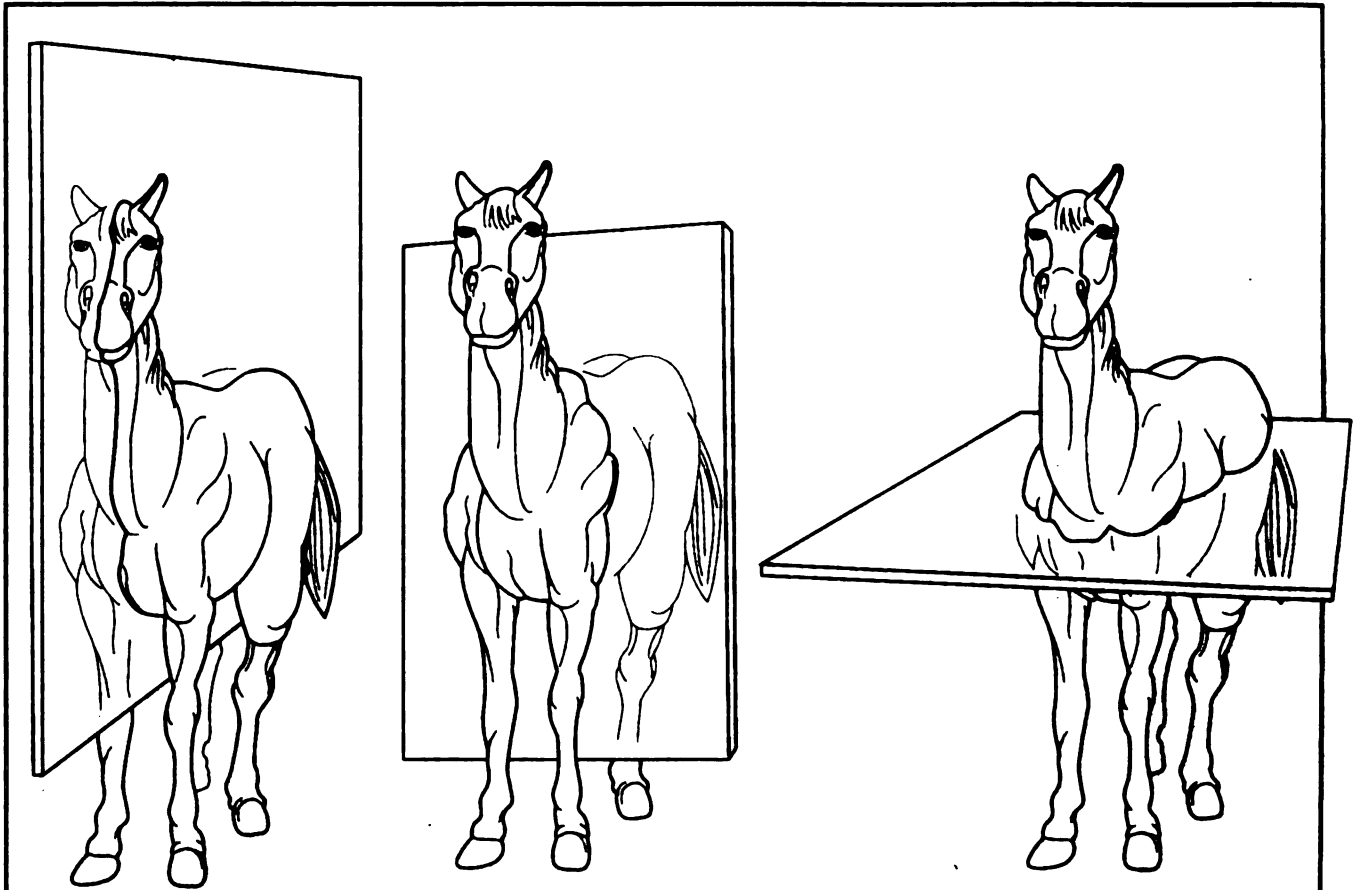


Figure I.2. ANATOMICAL PLANES OF REFERENCE are illustrated on this page. The **median sagittal plane** (above left) is a mid-line vertical plane extending in an anterior-posterior orientation. A **parasagittal plane** is any plane parallel to and to either side of the median sagittal plane. A **cross-sectional plane** through the thorax is shown above center, and a **horizontal plane** is shown at right above.

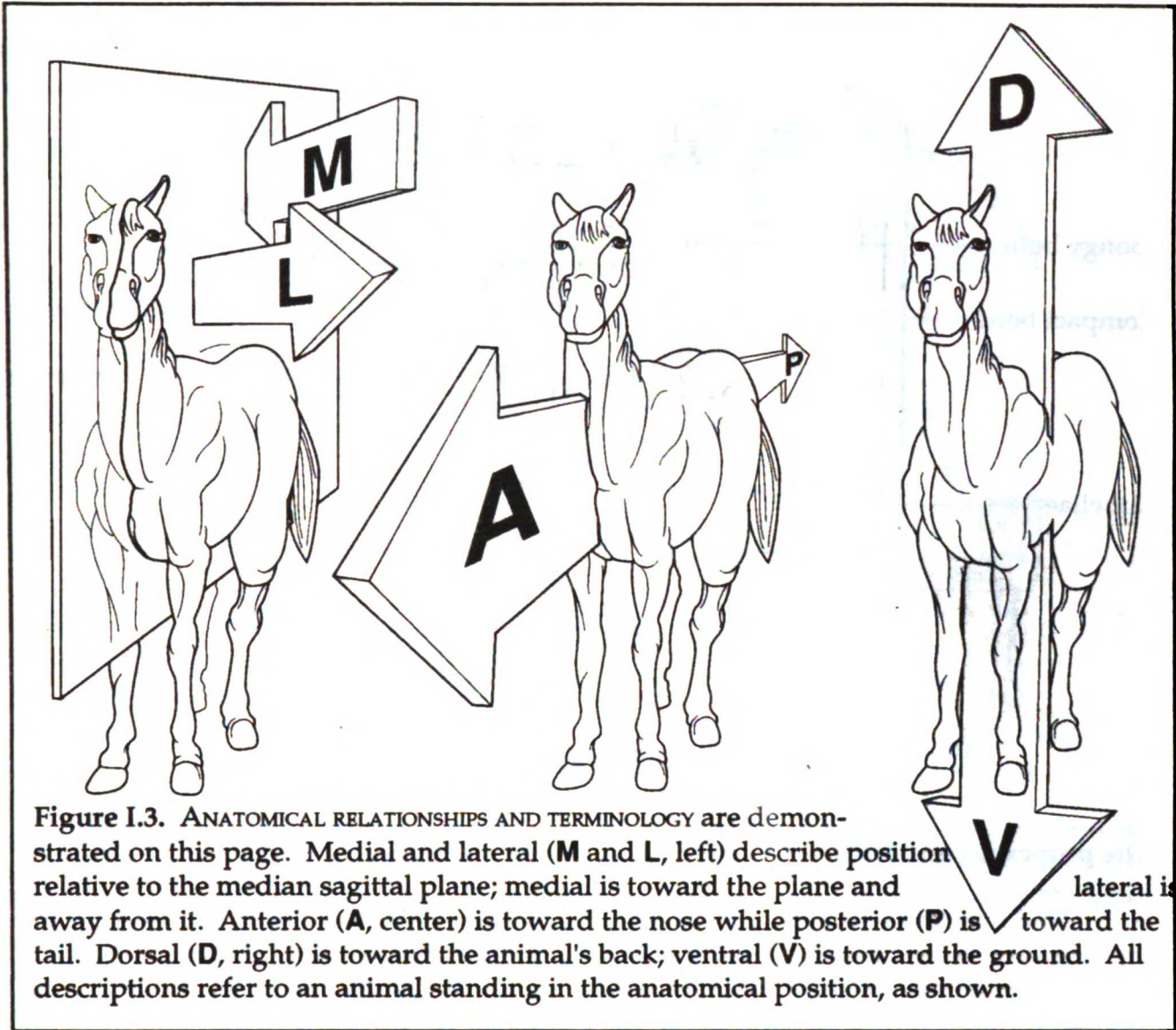


Figure I.3. ANATOMICAL RELATIONSHIPS AND TERMINOLOGY are demonstrated on this page. Medial and lateral (**M** and **L**, left) describe position relative to the median sagittal plane; medial is toward the plane and away from it. Anterior (**A**, center) is toward the nose while posterior (**P**) is toward the tail. Dorsal (**D**, right) is toward the animal's back; ventral (**V**) is toward the ground. All descriptions refer to an animal standing in the anatomical position, as shown.

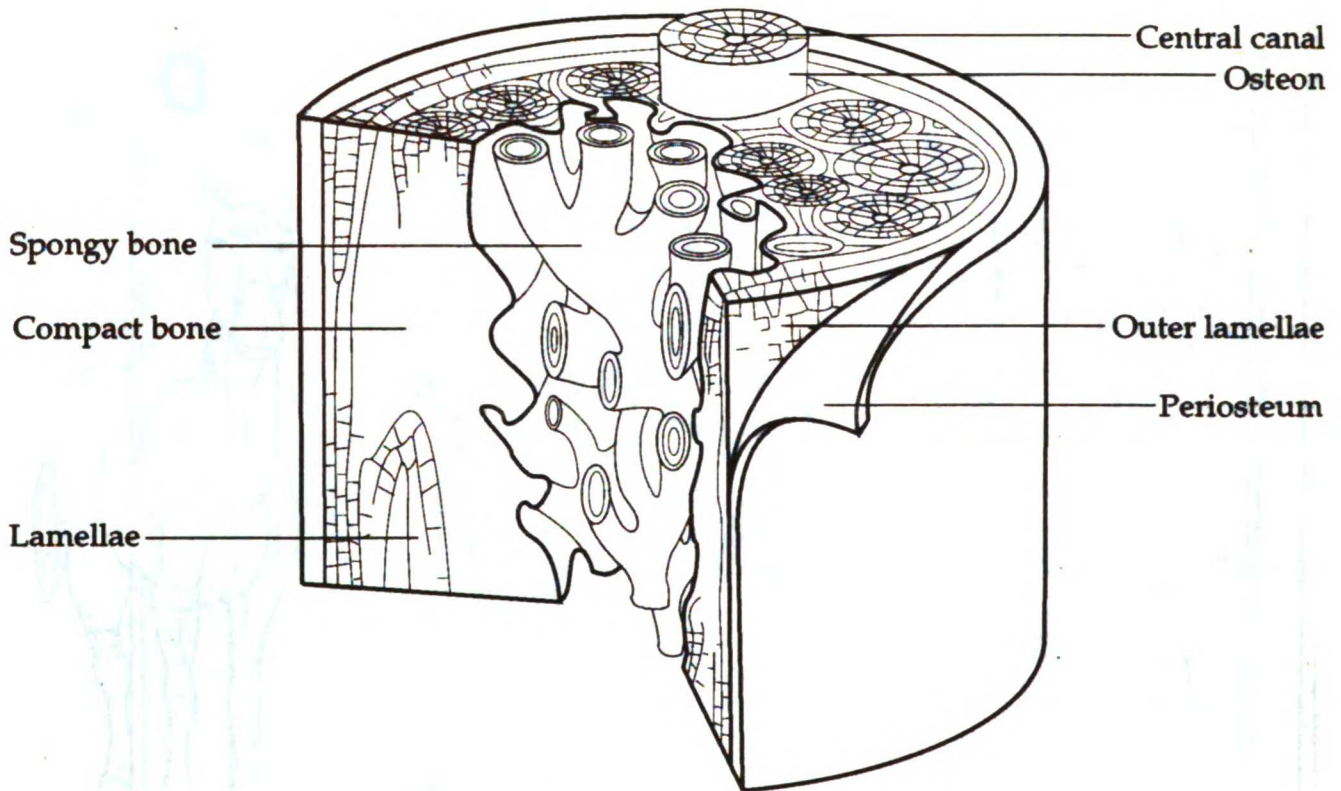


Figure I.4. The Structure of Bone

The properties and structure of bone

The functions of the skeleton as a whole and of its separate components include providing mechanical support for the entire animal. Simply put, without a hard, bony skeleton, any large land animal like a horse would simply collapse of its own weight. The structure of bone must be able to provide this mechanical support without unnecessary additional weight.

Skeletal components also provide anchor points for the attachments of muscles (via tendons). Bones must be able to withstand the pull of muscles attached to them. The qualities of strength and lightness become readily apparent with one look at the size of the muscles of a Thoroughbred and the fineness of its bones.

At the joints, where bones pivot around an axis or axes, the skeleton must be

rigid enough to perform the motion yet elastic enough to withstand the shocks of movement. The attachment of bone to bone at the joints by ligaments adds additional stresses.

Bones also provide mechanical protection to other organs. The brain is encased within the bony box of the skull, and the heart and lungs are protected by the rib cage.

Bone as a tissue is able to meet all of these stresses because of its structure. Bone is a composite material, being made of two components, one organic and the other inorganic. The organic component, a complex network of collagen fibers, provides elasticity and resistance to elongation. The inorganic component, a mineral matrix called hydroxyapatite, is hard and rigid and resists compression. The resulting composite provides greater rigidity than the elastic fibers by themselves, and is less brittle than the mineral.

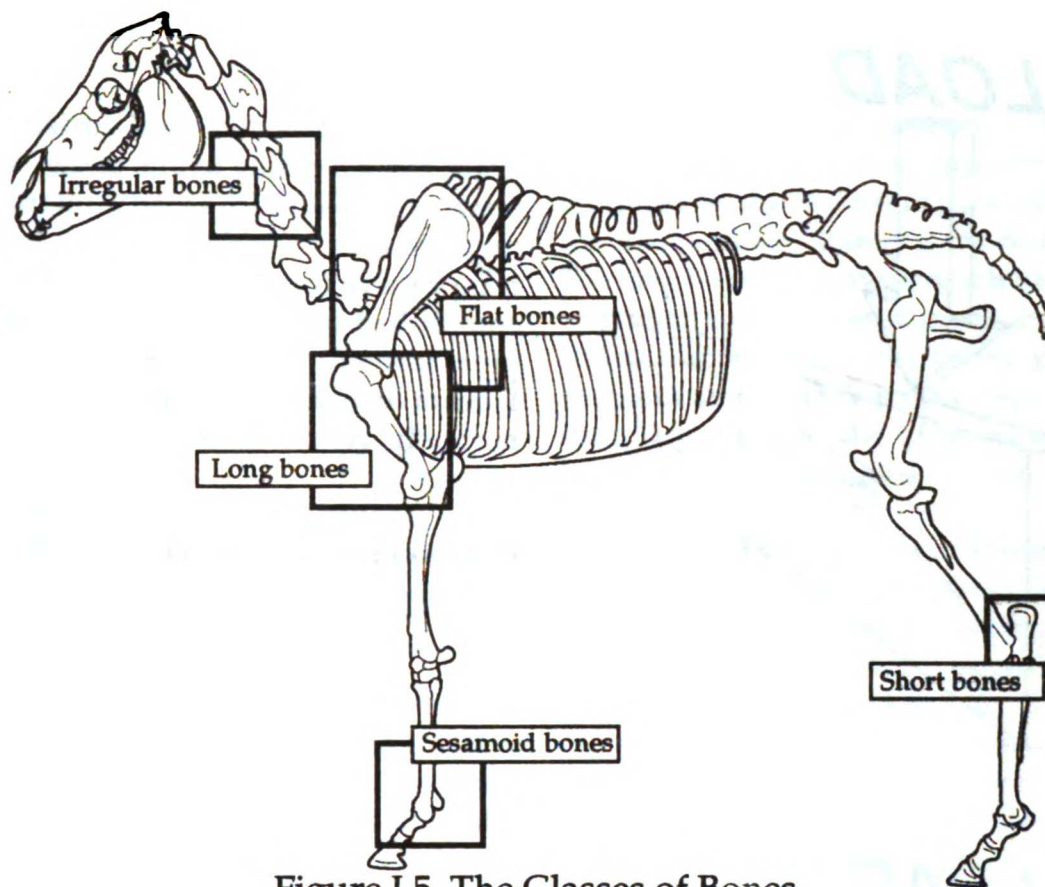


Figure I.5. The Classes of Bones

Bone may be either compact or spongy. Compact or dense bone has narrow spaces or channels. Compact bone is generally found in the cortex, or outer region of a bone. Spongy or cancellous bone, found in the center of a bone, is more highly vascularized than compact bone and has relatively large marrow spaces. See figure I.5.

Like wood, bones have "grain" that resists forces in different planes. The grain of bone is determined by the osteons, which are composed of lamellae oriented in concentric circles around a central canal. The orientation of the elastic fibers, the canals and the osteons determines the strengths and resistances in various planes.

Bone is a living tissue. The living bone cells, osteocytes, are found in lacunae, small pits within the lamellae. Bone is not static, but dynamically responds to the stresses applied to it, and changes its structure to accommodate those stresses. The minerals contained within

bone are in a state of flux, and function as a pool in response to a number of factors, including nutrition, exercise, growth, reproduction, and injury.

The classes of bones

The various bones of the horse skeleton are shaped differently because they are called upon to perform different functions. The stresses applied to a horse's cannon bones are different from those applied to its carpal bones. Bone are described and grouped on the basis of their appearance into the following categories:

- a. flat bones;
- b. long bones;
- c. short bones;
- d. sesamoid bones;
- e. irregular bones.

and Each of these categories is described below. See also figure I.5 above.

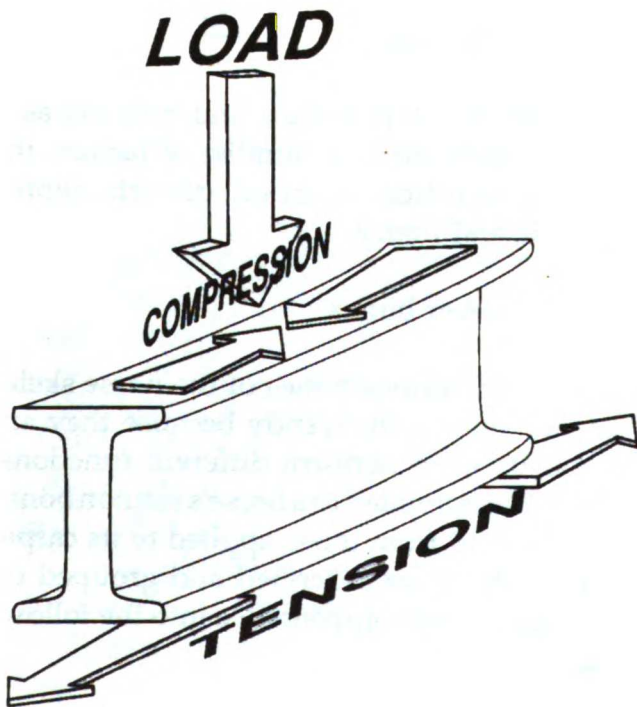
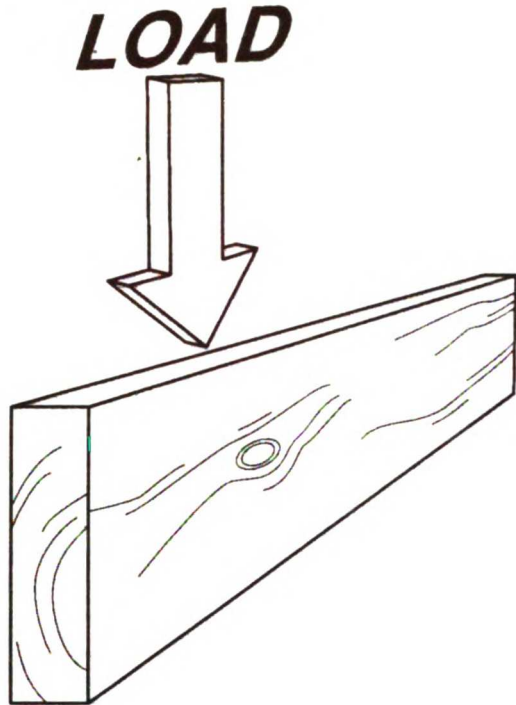


Figure I.6. A wood joist (top) is strongest when loaded vertically. When loaded vertically downward, a steel I-beam (bottom) is compressed on the top and tensed on the bottom.

Flat bones

Flat bones, like steel girders or wood joists, resist bending in one plane. When flat bones are subjected to a load in one plane, they must be able to withstand both tensile and compressive forces. While this could be accomplished by a cylindrical structure like a pipe, material is conserved by the use of an I-beam or joist where the load on the bone is normally restricted to one, often vertical, plane.

Shown here is a scapula and mandible; other examples of flat bones include the bones of the pelvis.

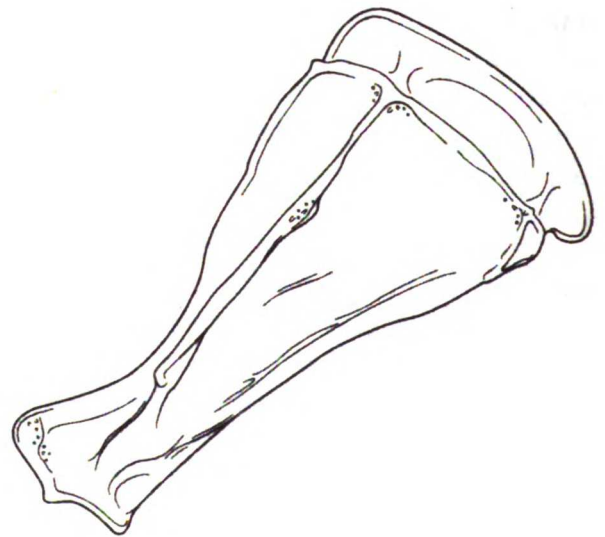
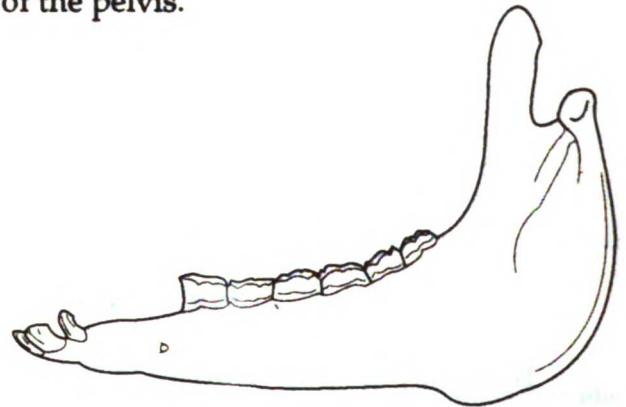


Figure I.7. The flat mandible (top) and scapula (bottom) are strong and rigid when subjected to vertical forces, but are much weaker when subjected to forces in other planes.

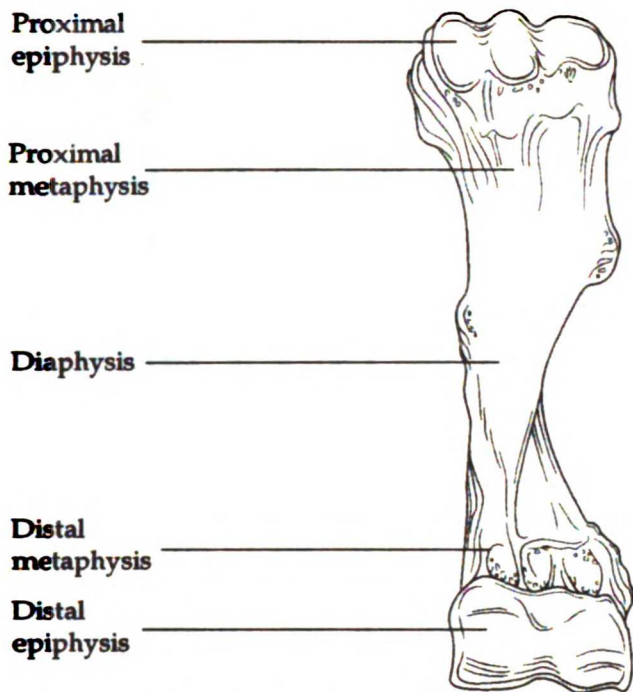


Figure I.8. The typical long bone is a hollow shaft (diaphysis) with enlarged ends (metaphyses and epiphyses). The parts are indistinct in a mature animal. Shown above is a left humerus from the front.

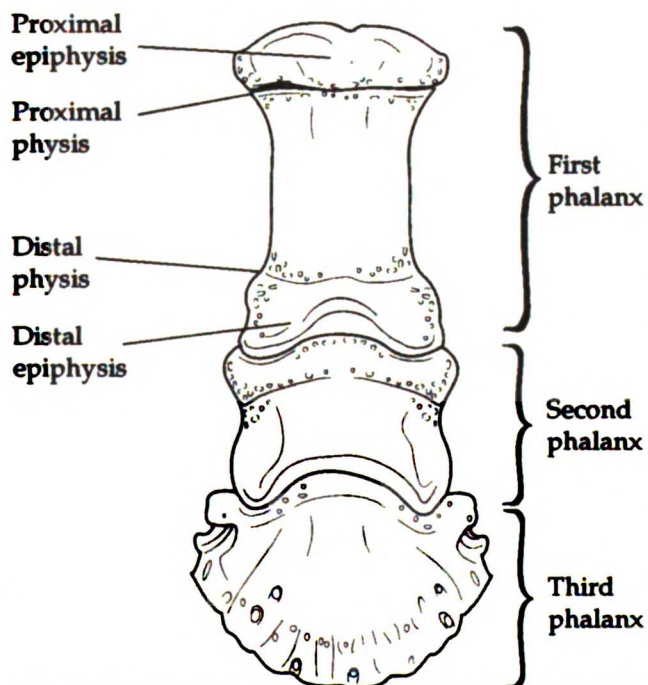


Figure I.9. The physes are still visible in the phalangeal bones of a foal. The distal epiphysis of P1 fuses before birth, while the proximal end fuses when the foal is about one year old.

Long bones

Form follows function; that is, the shape and structure of natural systems is determined by the tasks that they will be called upon to perform. Rarely is the converse true. The long bones of active animals like the horse are called upon to resist many and complex strong forces. Rotational, sheering, compressive, and tensile stresses may often be applied simultaneously to the long bones, as they function both as columns of support and levers for motion.

So, the long bones of running mammals like the horse have developed strong, hollow, roughly cylindrical shafts or diaphyses (singular—diaphysis) capable of withstanding these complex forces.

The enlarged ends or epiphyses (singular—epiphysis) of the long bones are not hollow cylinders, and as such they are better able to withstand the forces exerted upon them by muscle origins and insertions and the attachment of ligaments. Note that the metaphyses, the widened ends of the shafts, also are not hollow, and can withstand the forces exerted upon them by tendon and ligament attachments.

The physis (epiphyseal plate, line, or disc, or growth plate) separates the epiphysis from the metaphysis in the young animal, and is the site of bone growth. The physes, visible radiographically and externally on the legs of foals, becomes indistinct as growth slows and stops in a mature animal. The "open knee" of a foal is the distal radial physis, seen under the skin.

The spongy bone of the epiphyses and metaphyses can function as shock absorbers within a range of tension and compression. Any forces, such as those created during play or by improper corrective shoeing, that exceed the bone's natural range of elasticity can damage the growth plate of a young, rapidly growing foal and result in limb deformities.

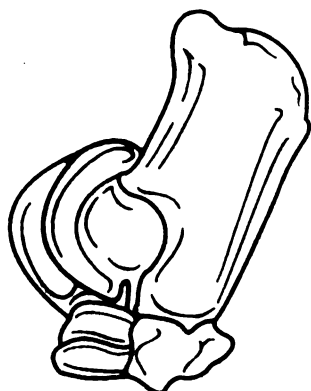


Figure I.10. The Tarsal Bones

Short bones

The short bones of the carpal and tarsal regions (figure I.10) are roughly cuboid in appearance, having similar dimensions in width and length. These bones function to absorb impact in a moving horse, as well as contributing to the joints of the hock and knee.

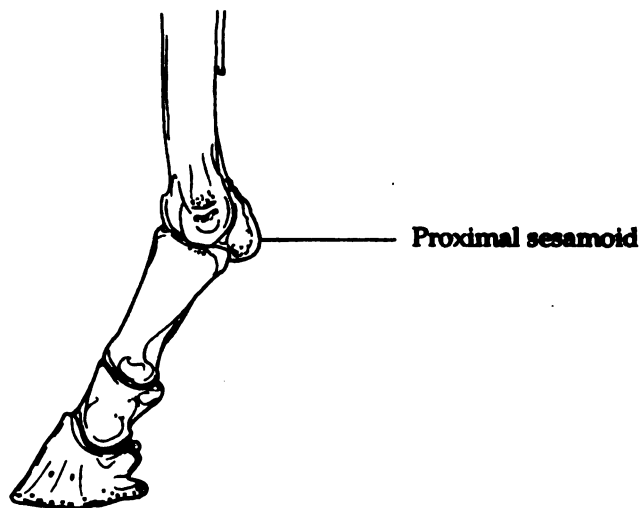


Figure I.11. The Proximal Sesamoids

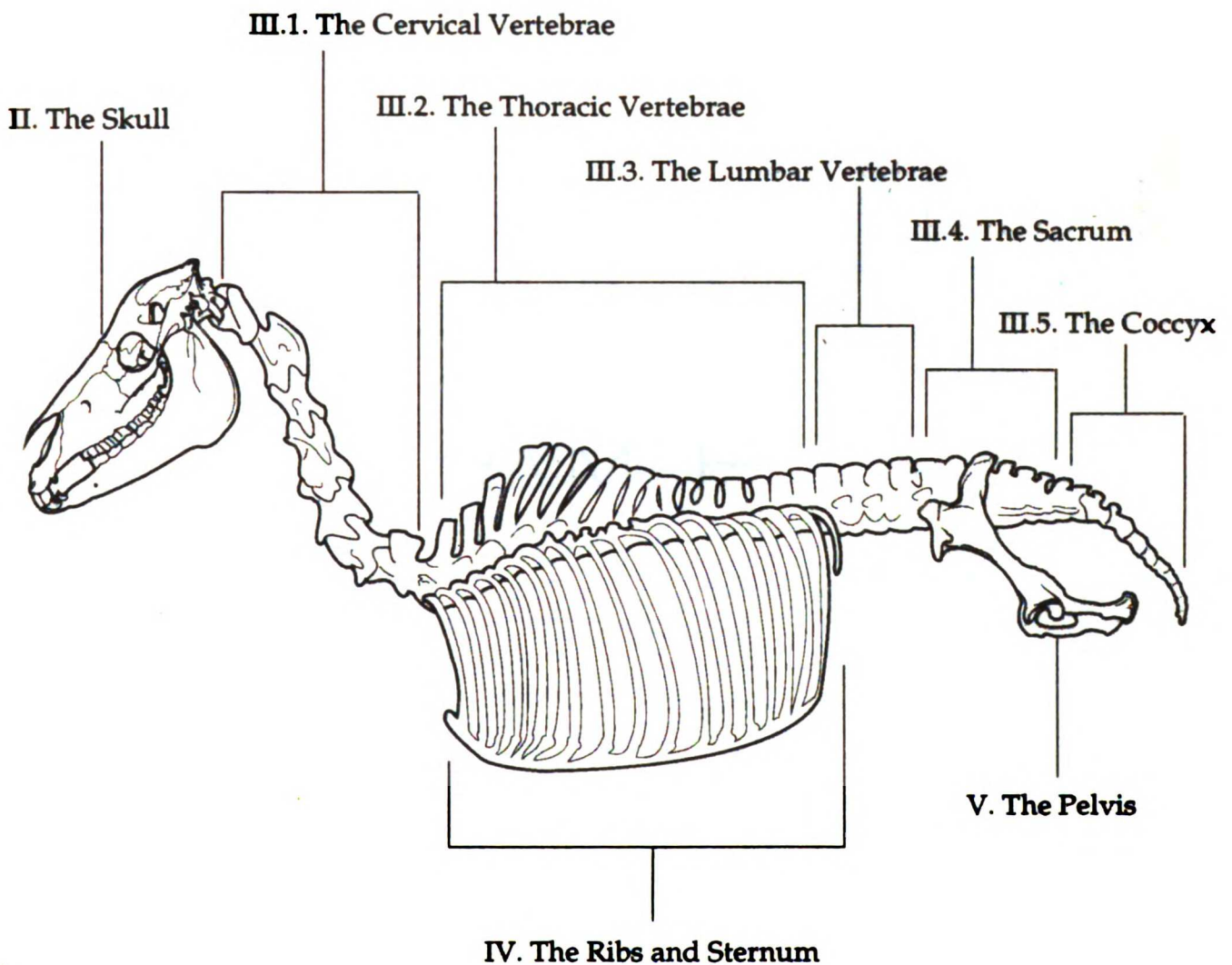
Sesamoid bones

Sesamoid bones are relatively small bones found embedded in joint capsules or tendons. They function to change the direction of a tendon, or reduce friction as a tendon travels over a bend at a joint. The patella, navicular, and proximal sesamoids are in this category (figure I.11).

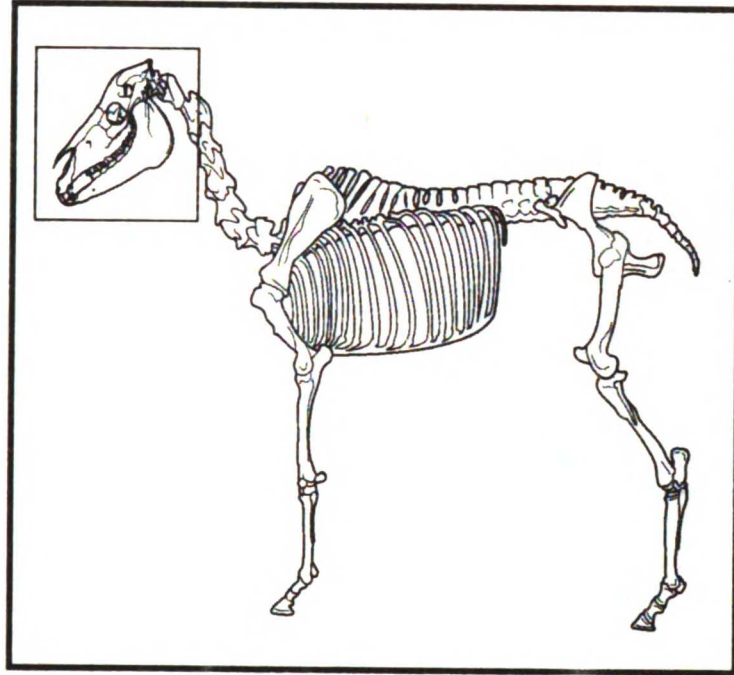
Part A.

The Axial Skeleton

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Chapter II.



The Skull



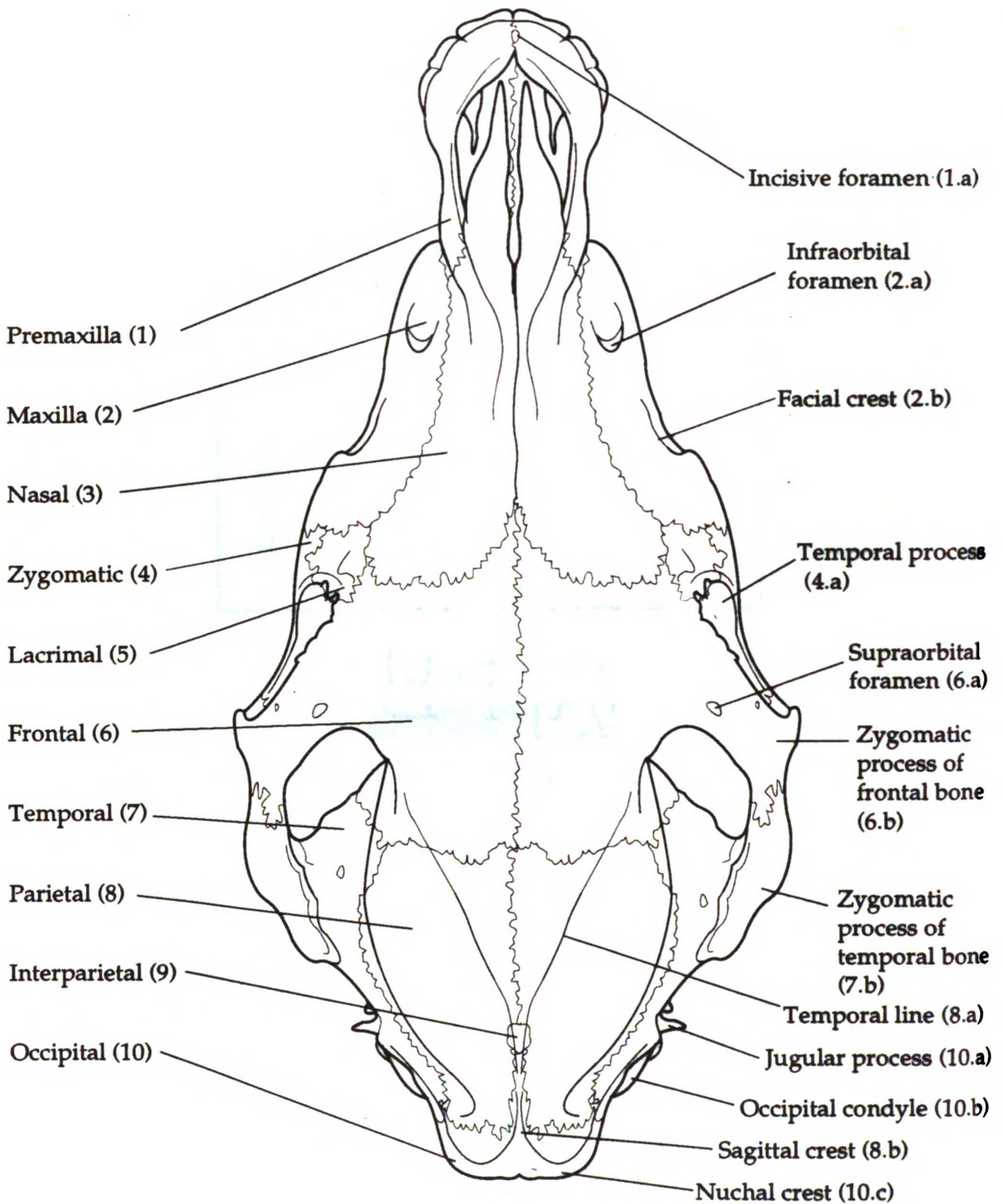


Figure II.1. Bones of the Skull
dorsal aspect

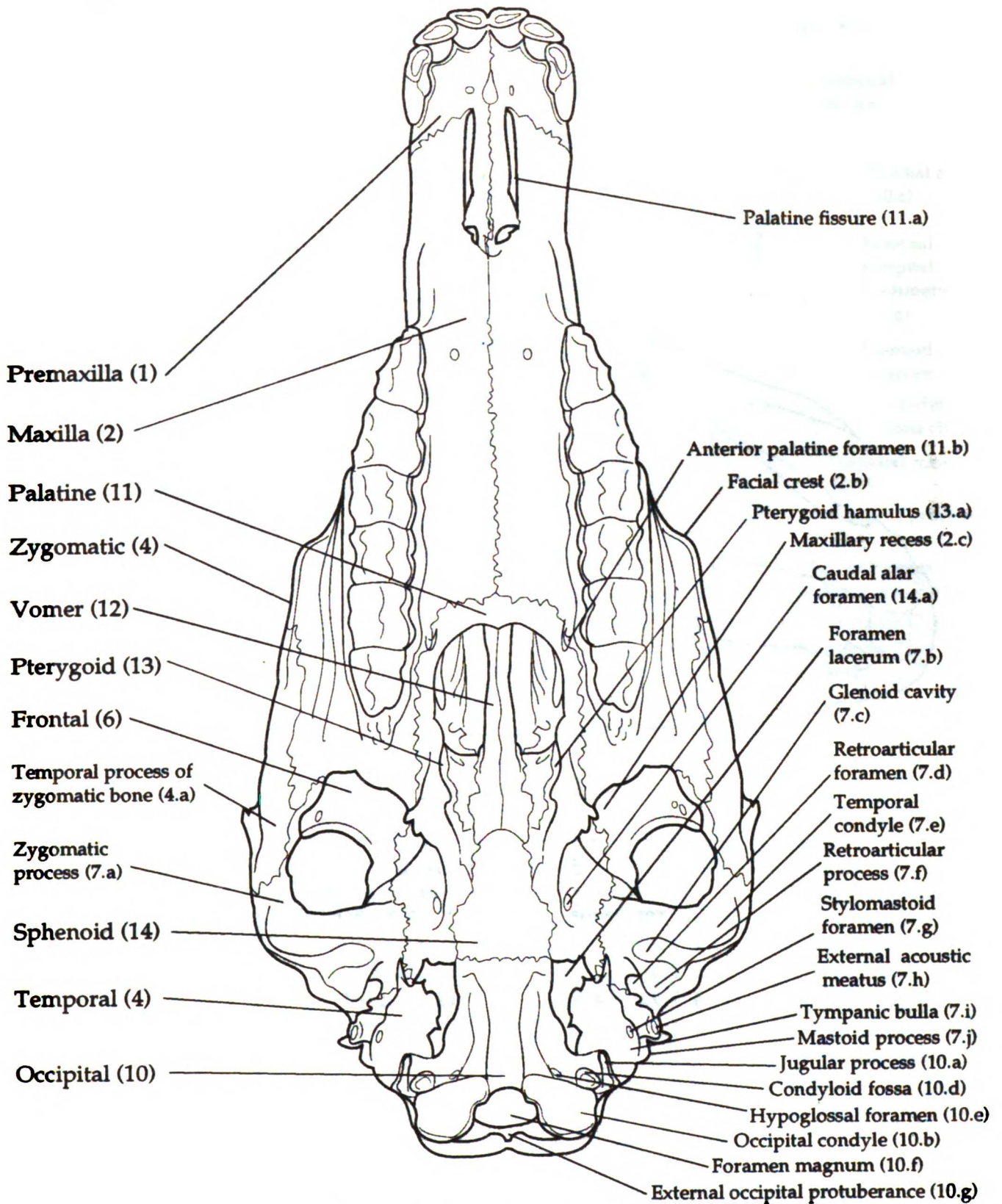
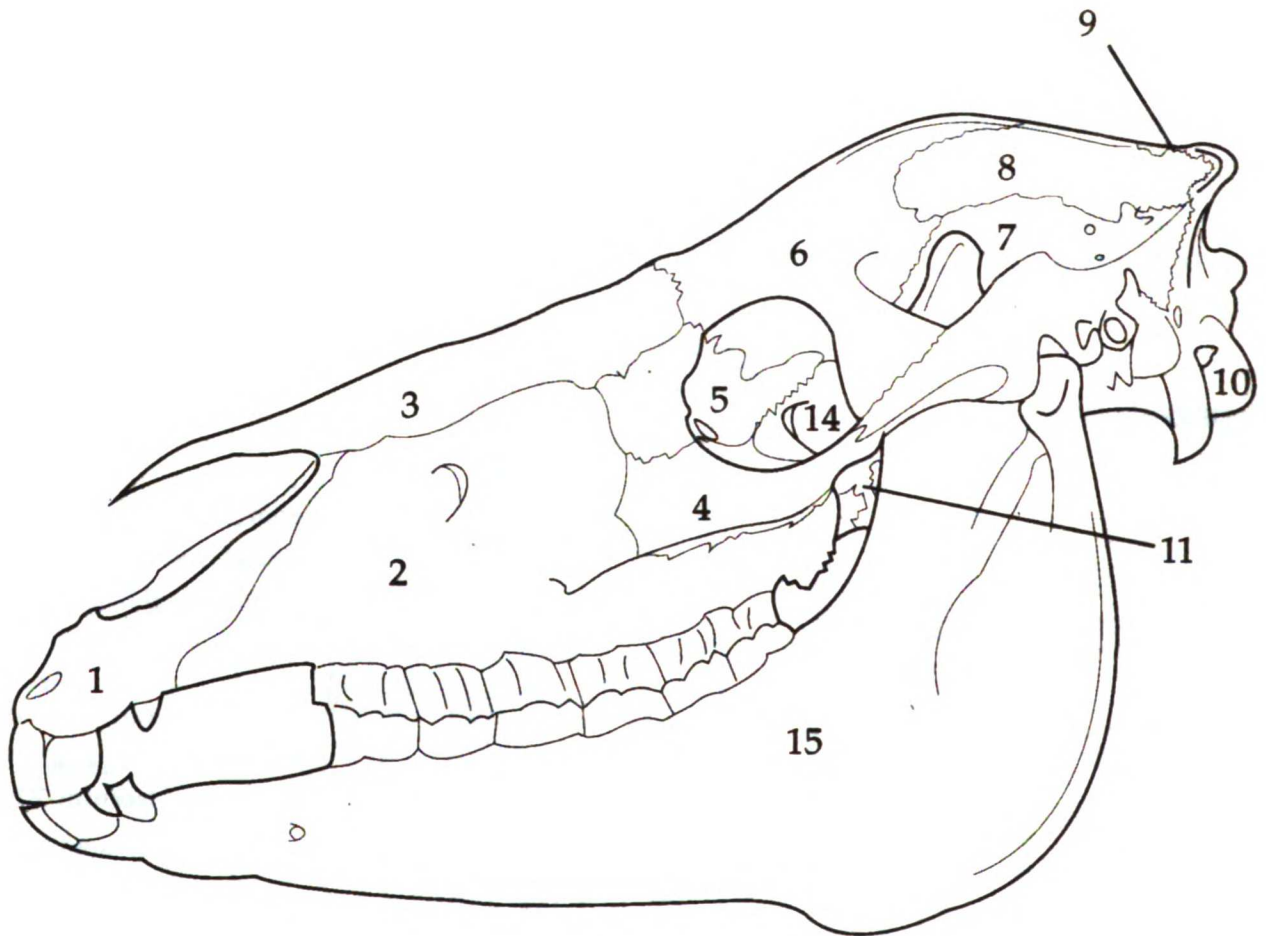


Figure II.2. Bones of the Skull
ventral aspect



Bones of the Skull

1. Premaxilla	9. Interparietal
2. Maxilla	10. Occipital
3. Nasal	11. Palatine
4. Zygomatic	12. Vomer*
5. Lacrimal	13. Pterygoid*
6. Frontal	14. Sphenoid
7. Temporal	15. Mandible
8. Parietal	*not seen in this view

**Figure II.3. Bones of the Skull
lateral aspect**

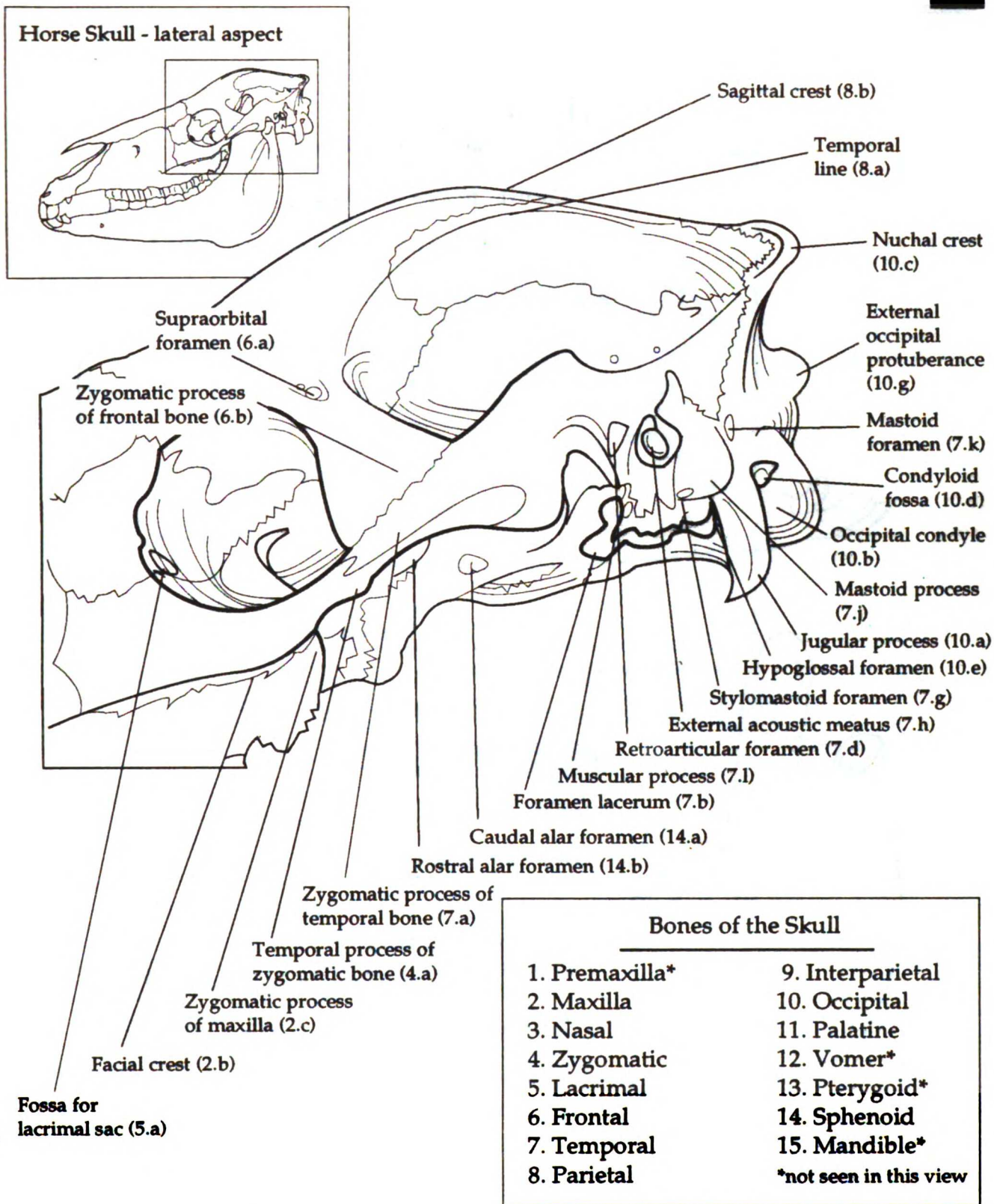


Figure II.4. The Skull - Cranial and Orbital Regions lateral aspect

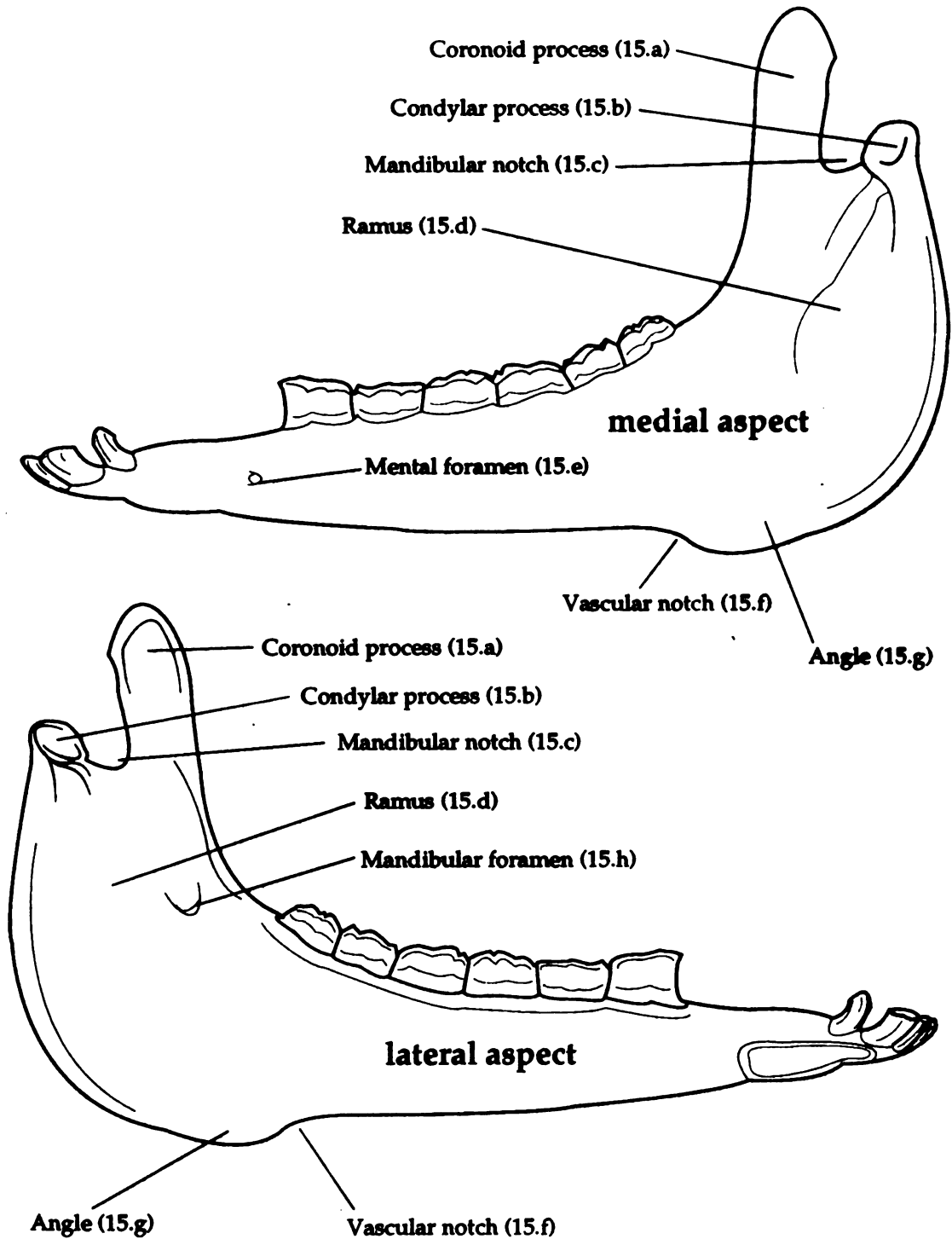
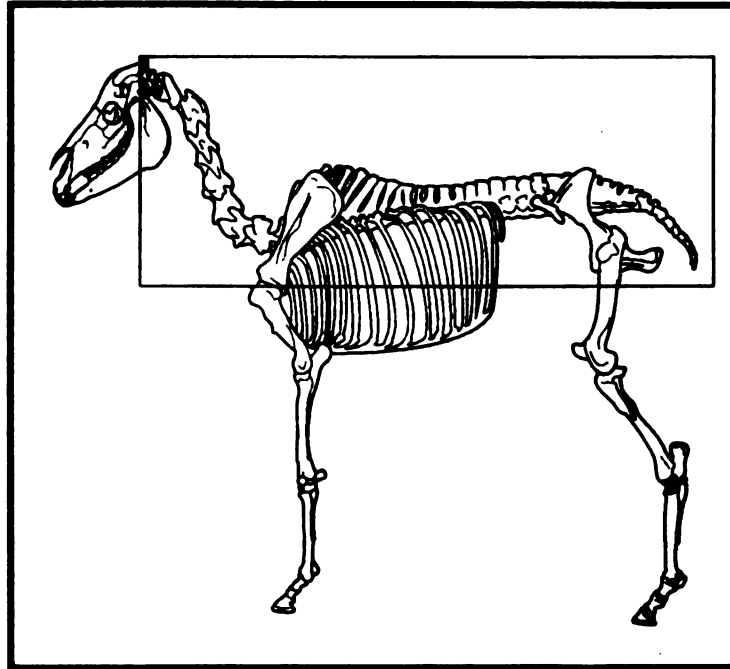


Figure II.5. The Mandible medial and lateral aspects

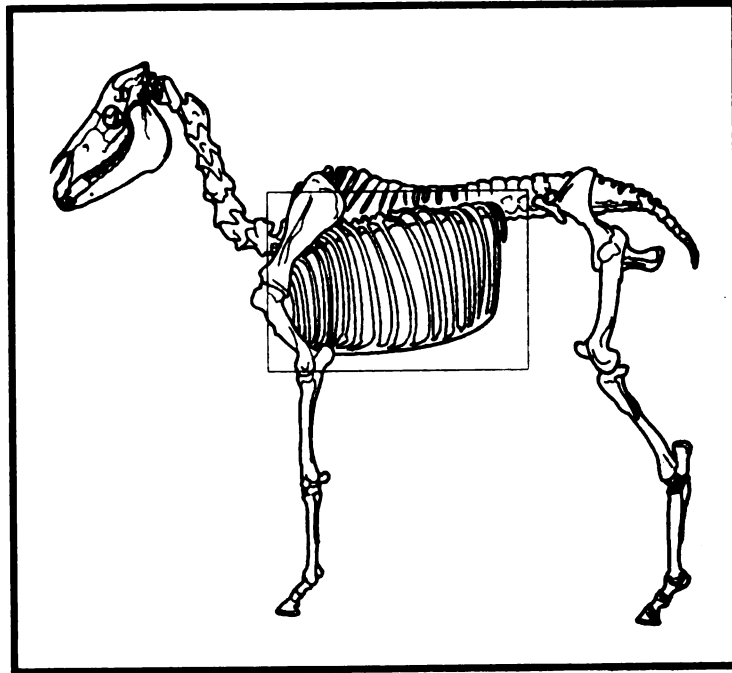
Chapter III.



The Vertebral Column



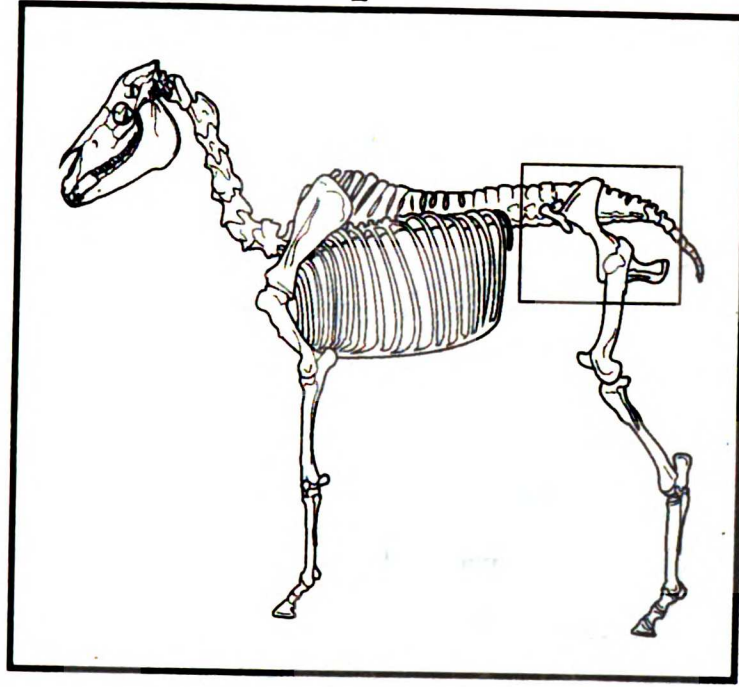
Chapter IV.



The Ribs and Sternum



Chapter V.



The Pelvis



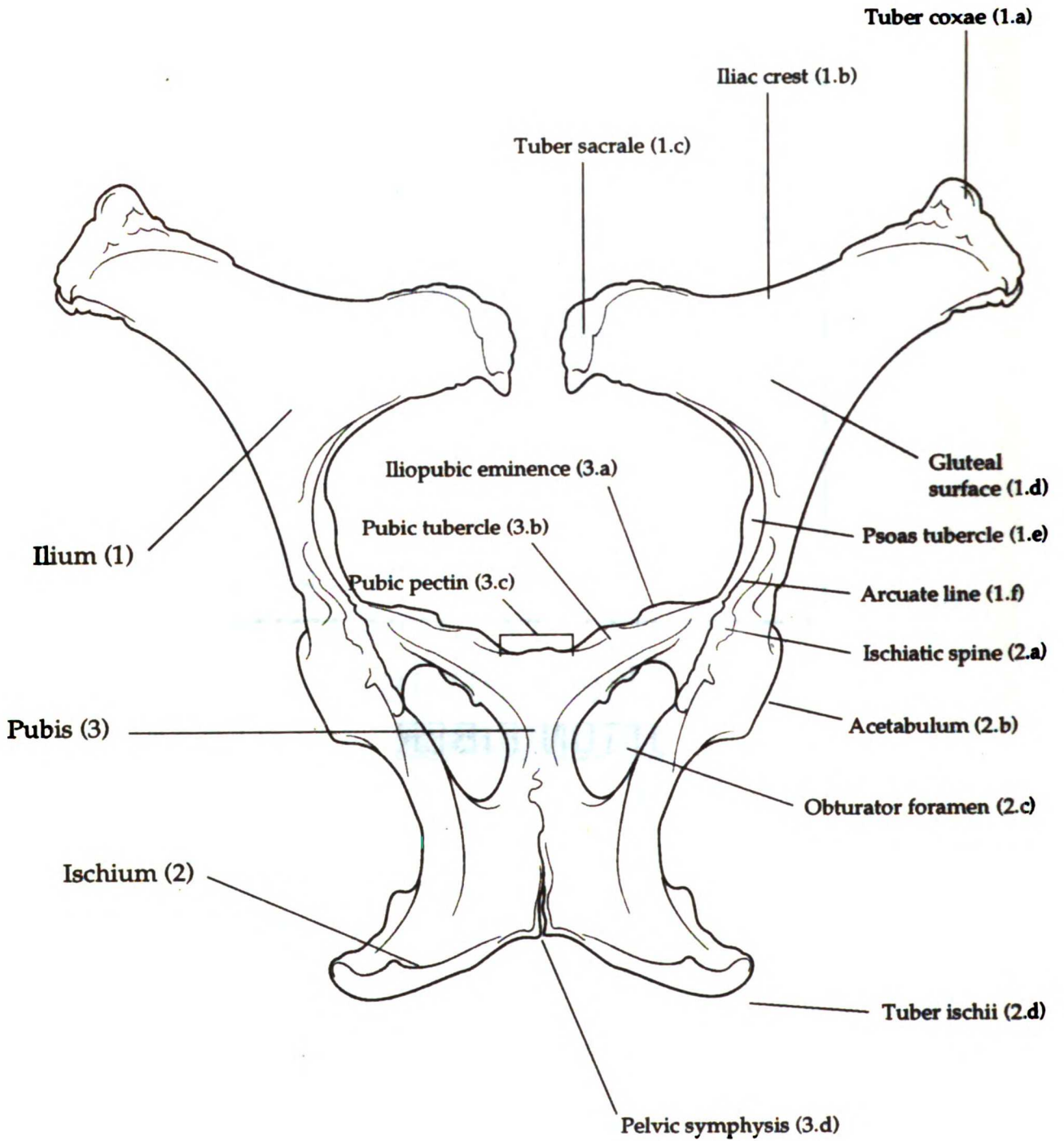


Figure V.2. The Pelvis dorsal aspect

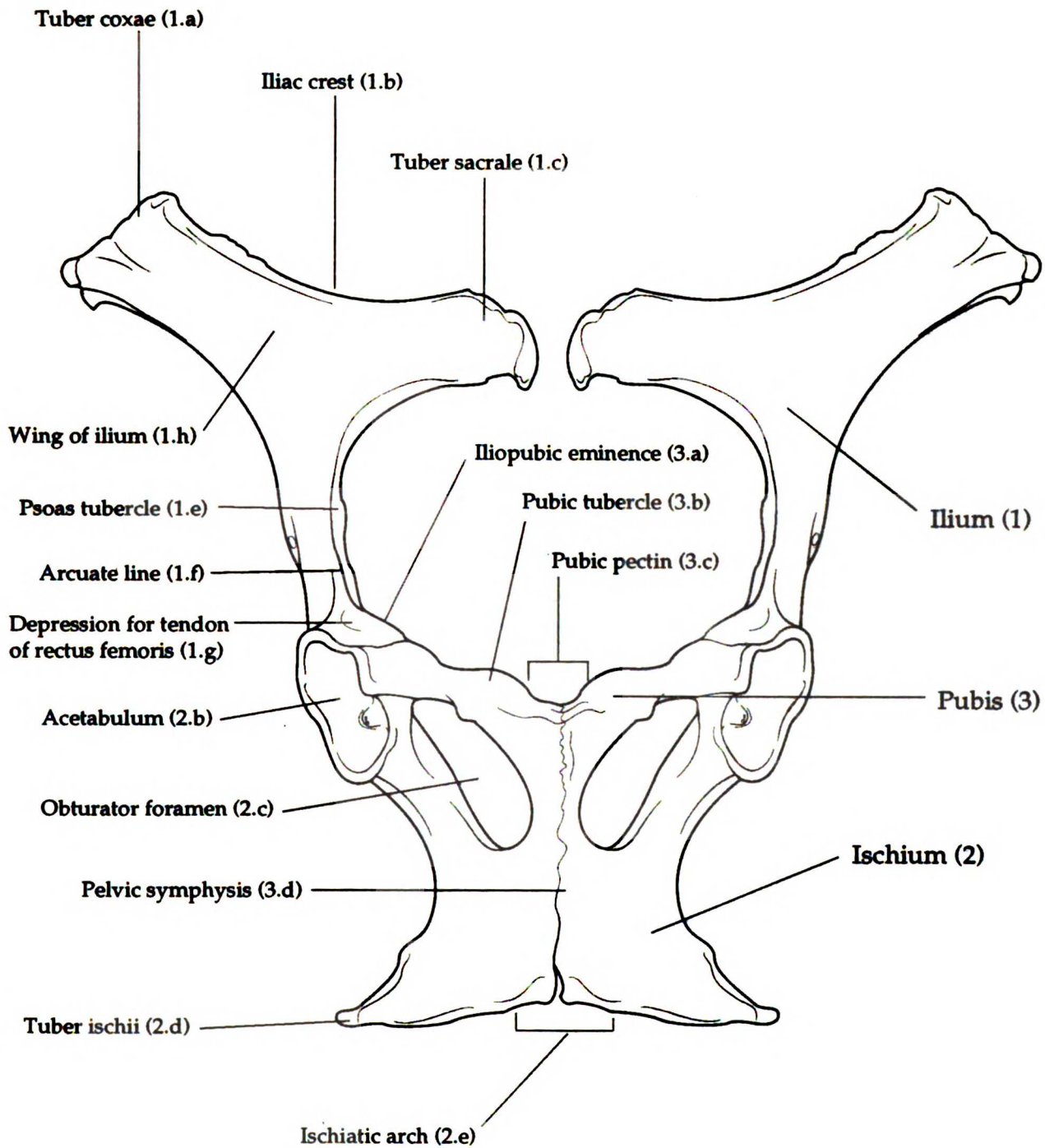


Figure V.3. The Pelvis ventral aspect

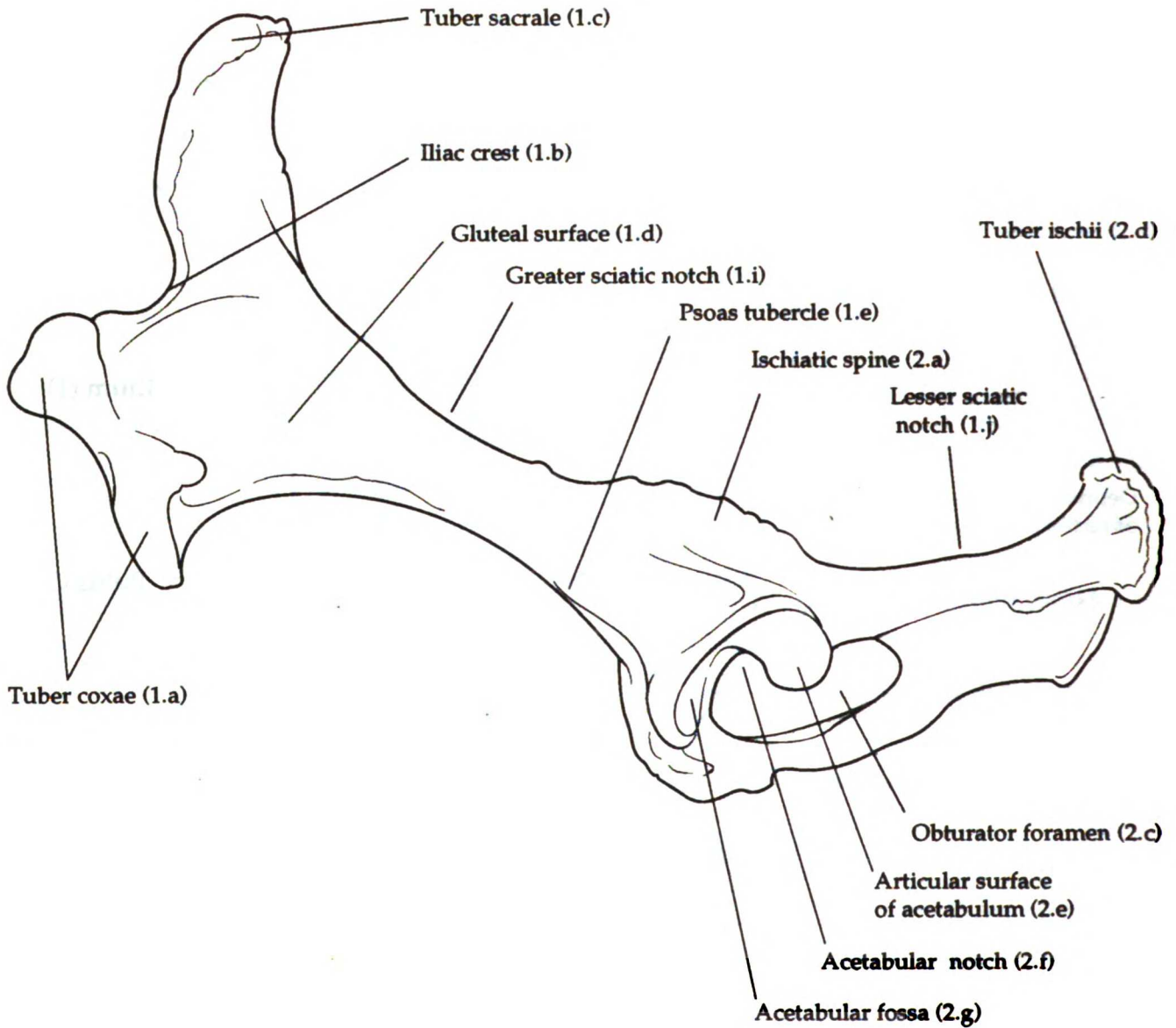


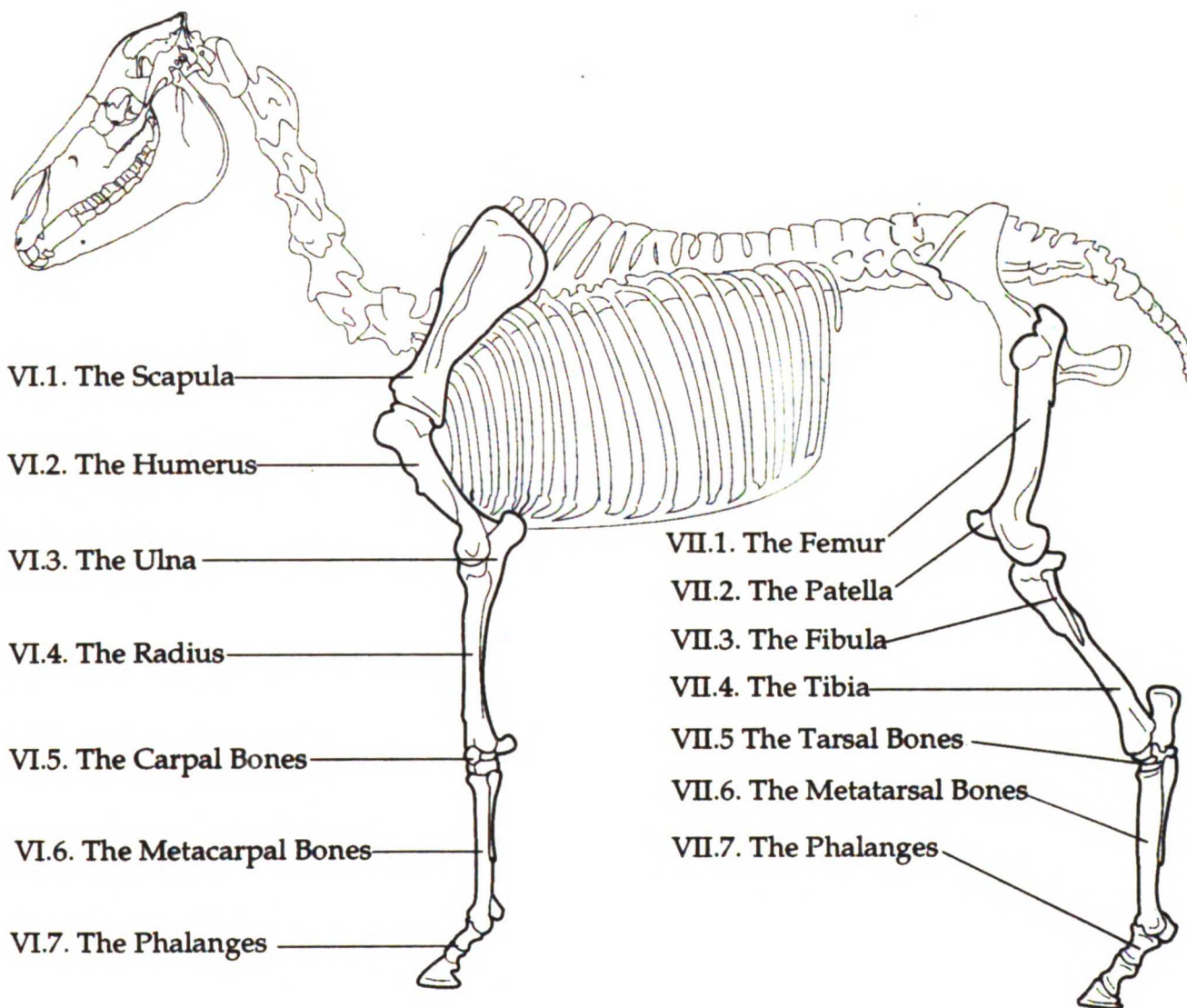
Figure V.4. The Pelvis lateral aspect

Part B.

The Appendicular Skeleton

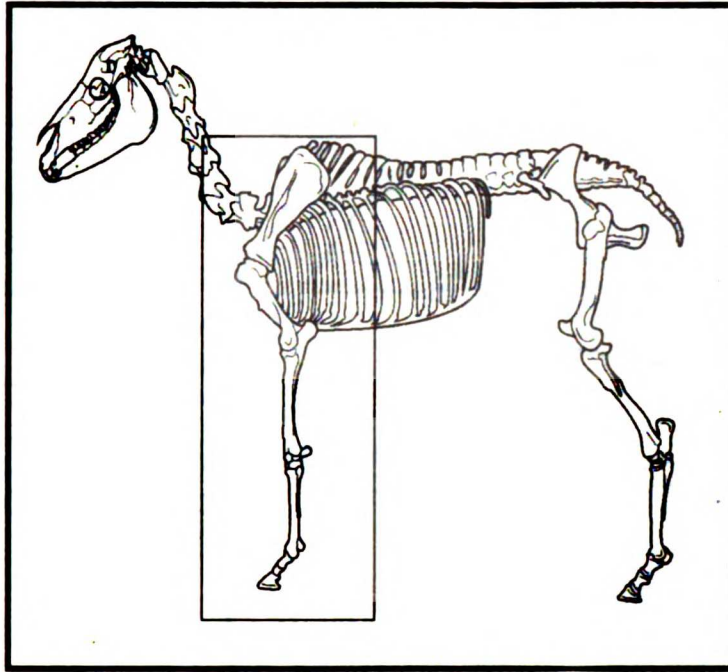
Chapter VI. The Thoracic Limb _____

Chapter VII. The Pelvic Limb _____



The Appendicular Skeleton
lateral aspect

Chapter VI.



The Thoracic Limb



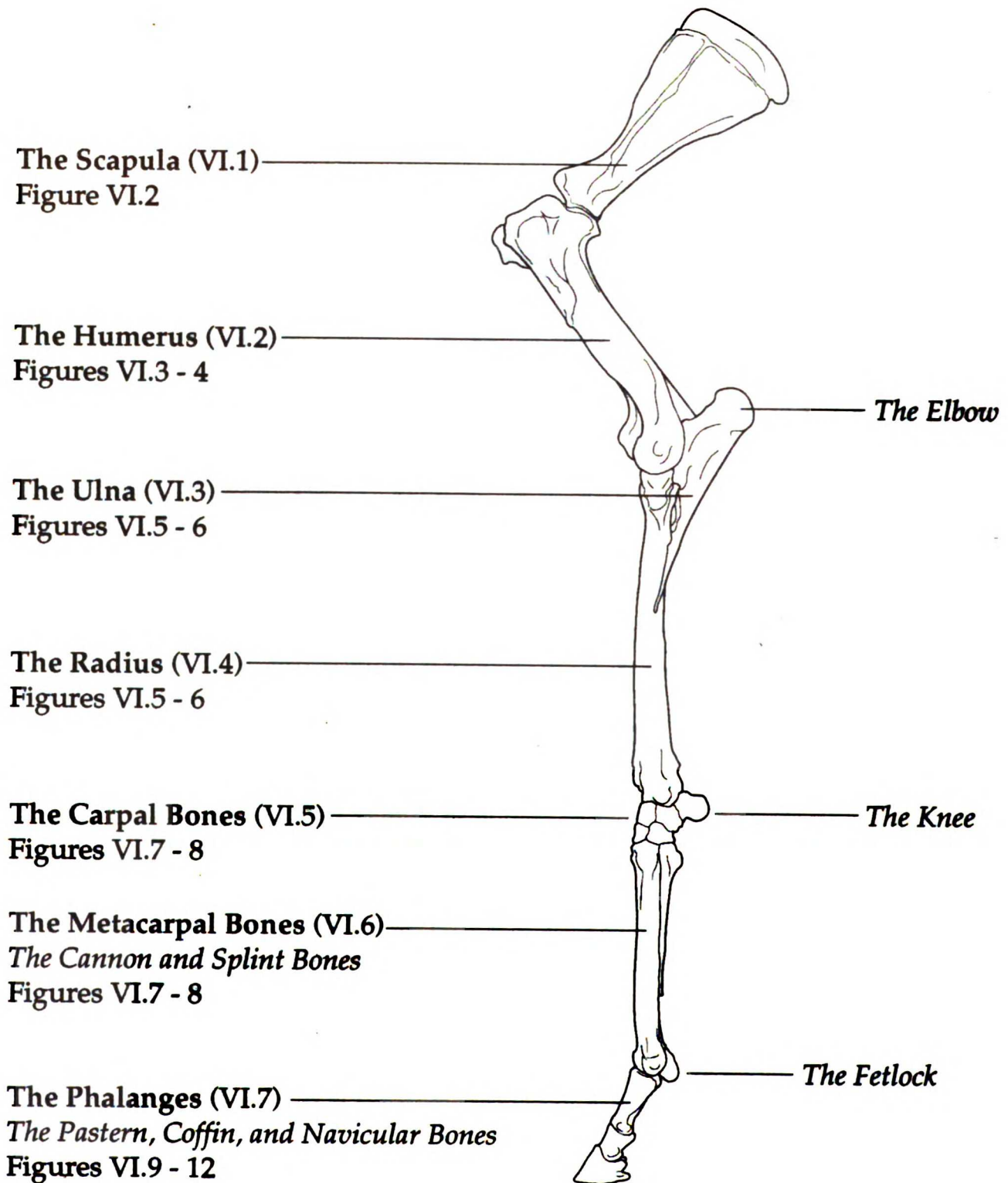
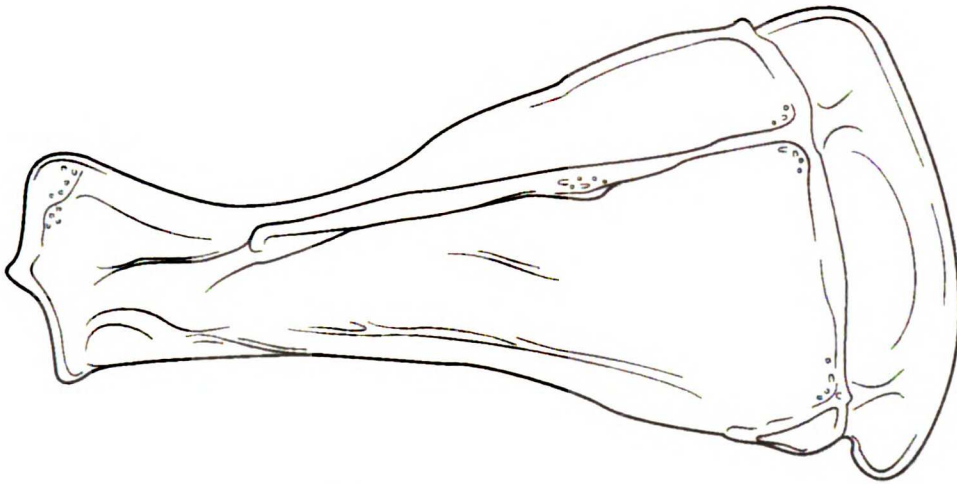
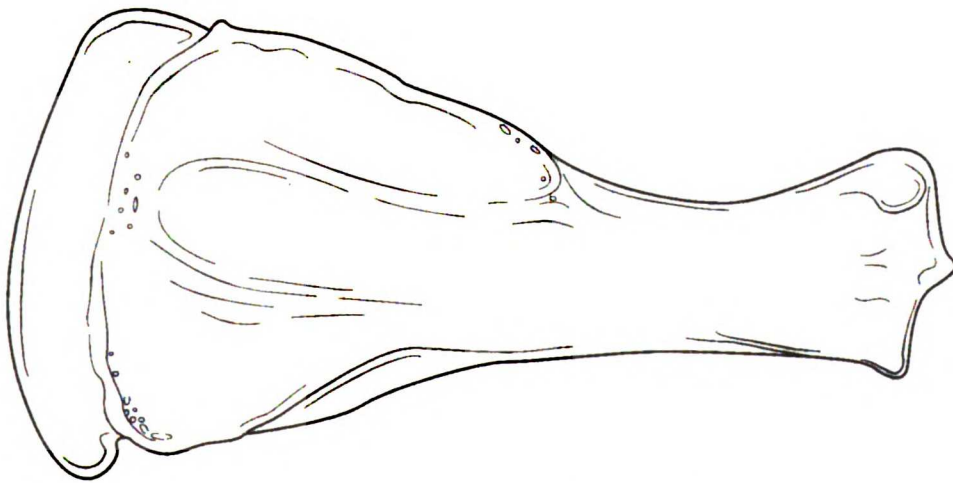


Figure V.1. The Thoracic Limb
lateral aspect

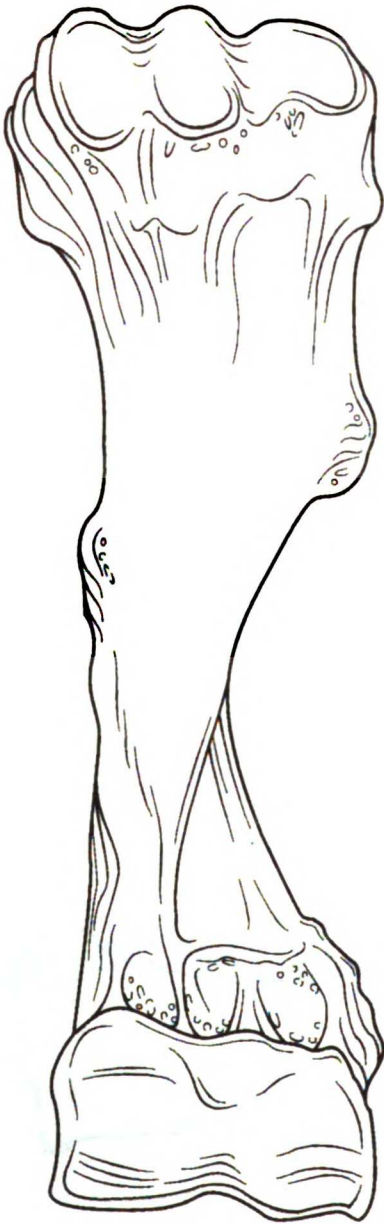


lateral aspect

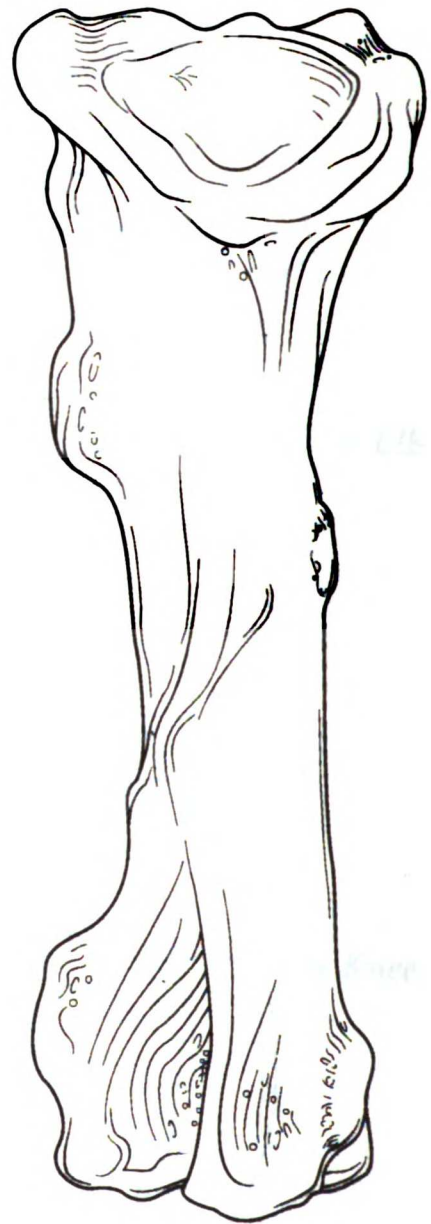


medial aspect

**Figure VI.2. The Scapula
lateral and medial aspects**

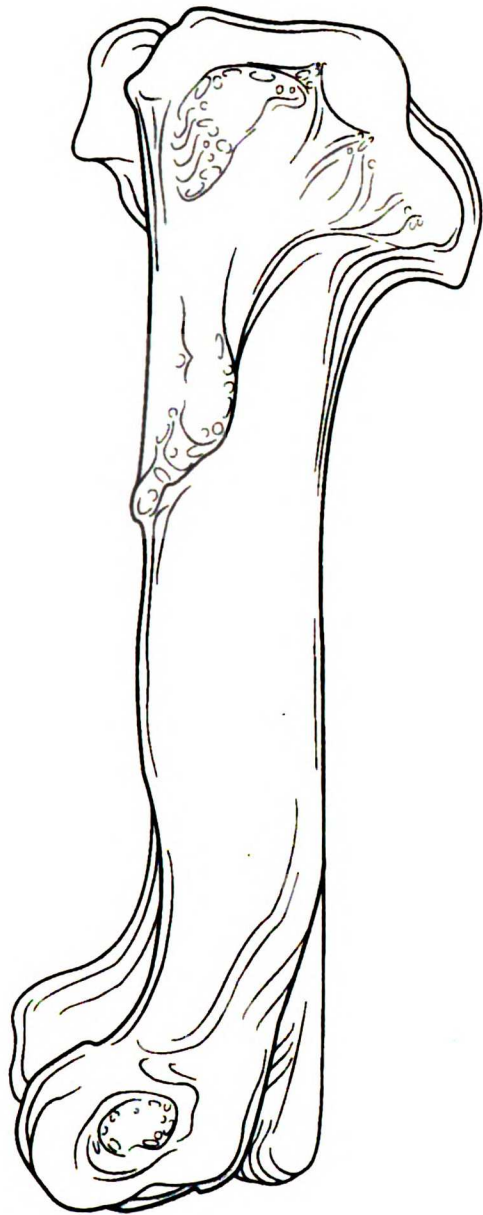


anterior aspect

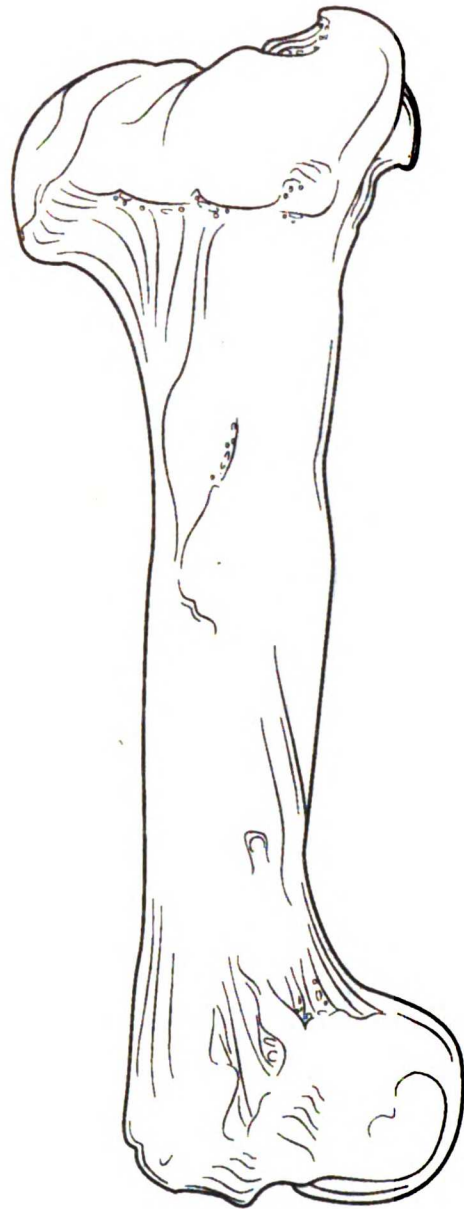


posterior aspect

Figure VI.3. The Humerus
anterior and posterior aspects

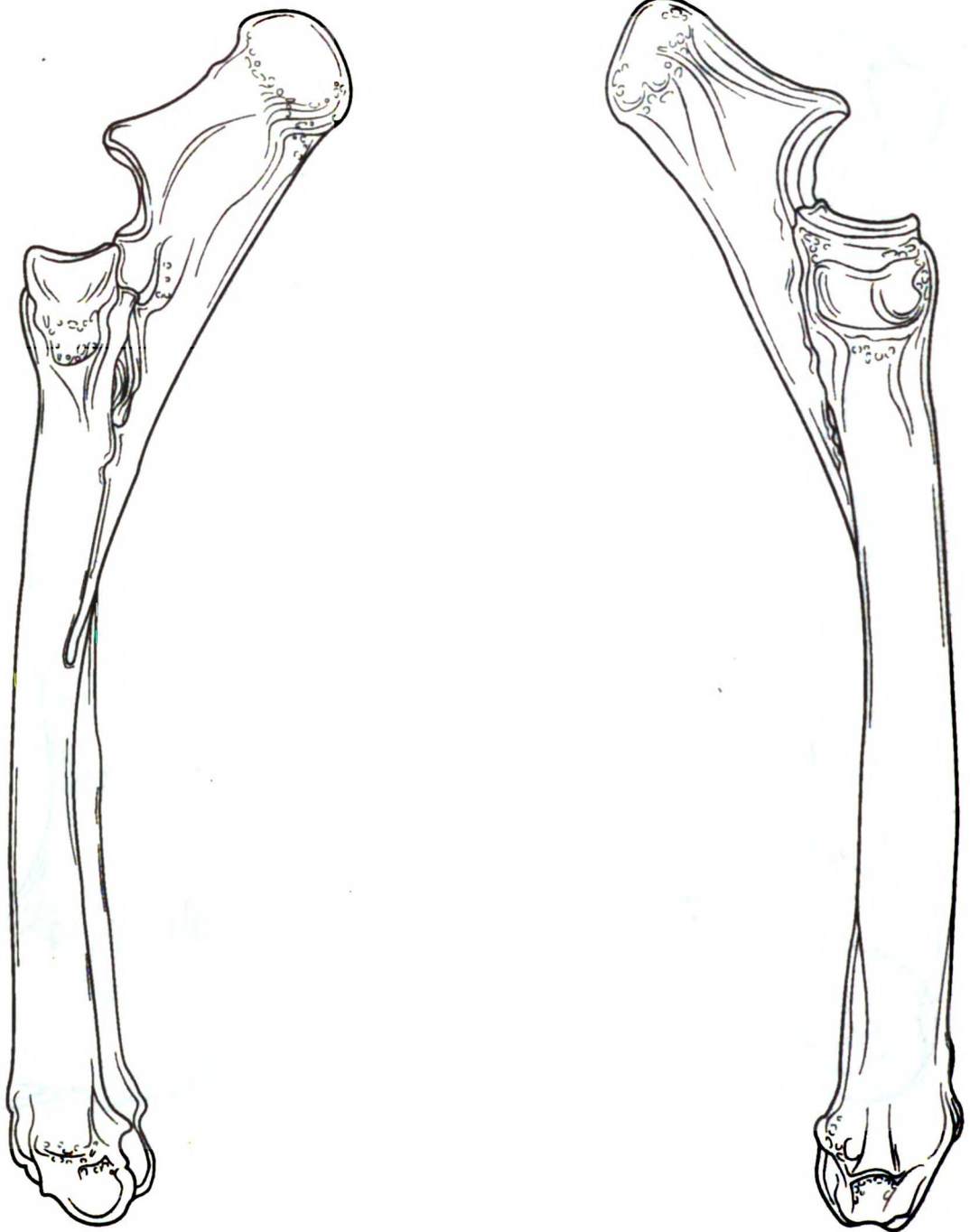


lateral aspect



medial aspect

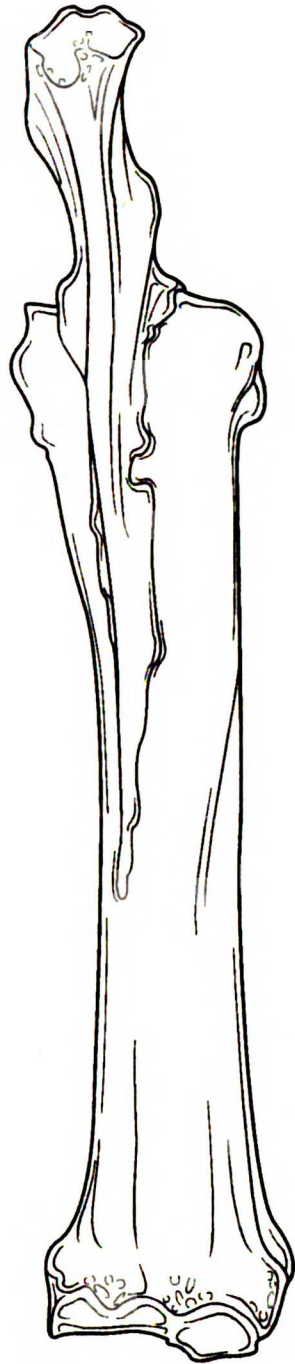
**Figure VI.4. The Humerus
lateral and medial aspects**



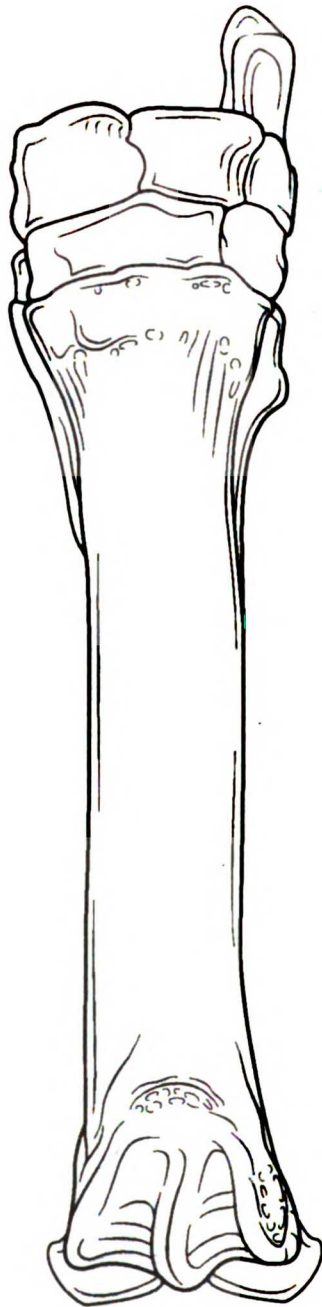
lateral aspect

medial aspect

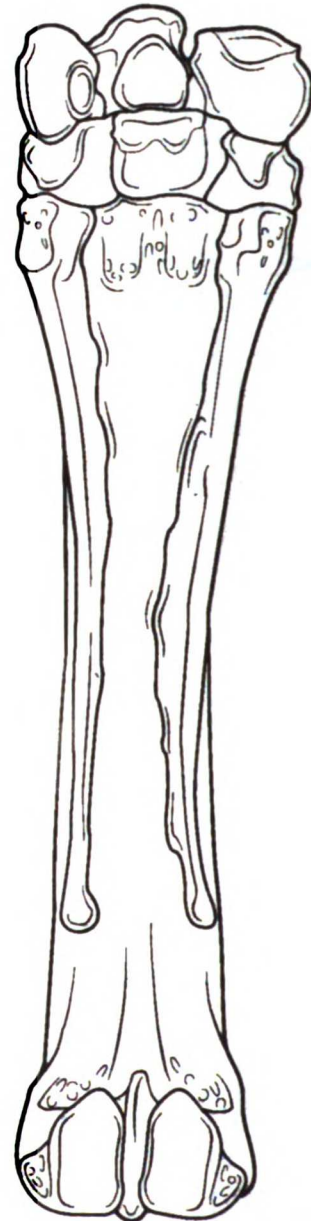
Figure VI.5. The Radius and Ulna
lateral and medial aspects



**Figure VI.6. The Radius and Ulna
posterior aspect**



anterior aspect

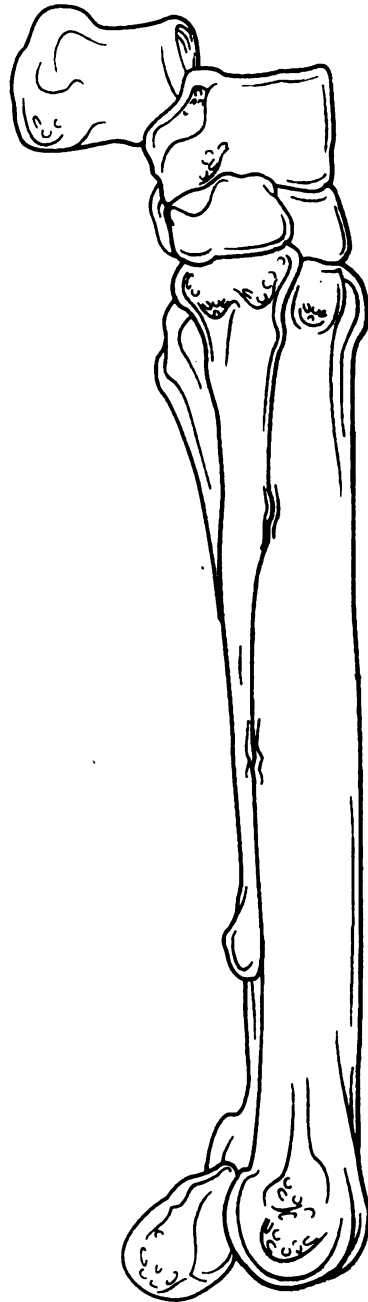


posterior aspect
(accessory carpal not shown)

**Figure VI.7. The Carpal and Metacarpal Bones
anterior and posterior aspects**

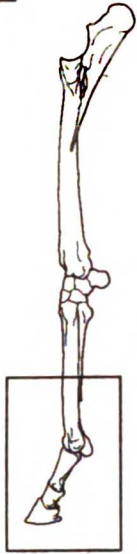


lateral aspect

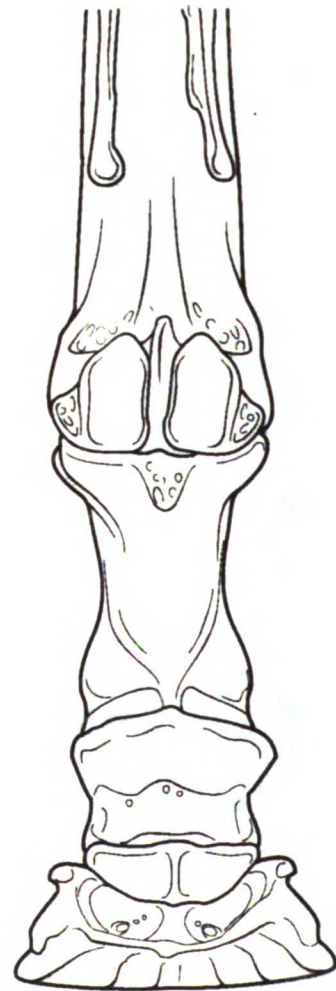


medial aspect

**Figure VI.8. The Carpal and Metacarpal Bones
lateral and medial aspects**



lateral aspect



posterior aspect

Figure VI.9. The Phalanges and Sesamoid Bones lateral and posterior aspects

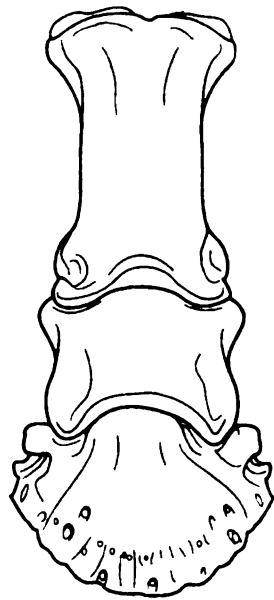
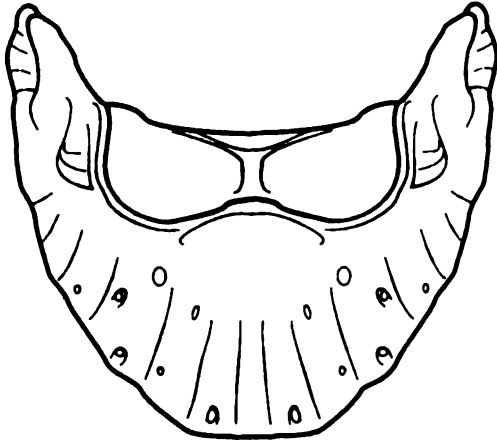
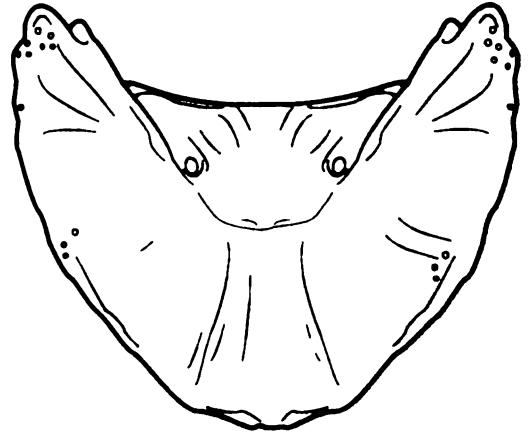


Figure VI. 10. The Phalanges
antero - dorsal aspect

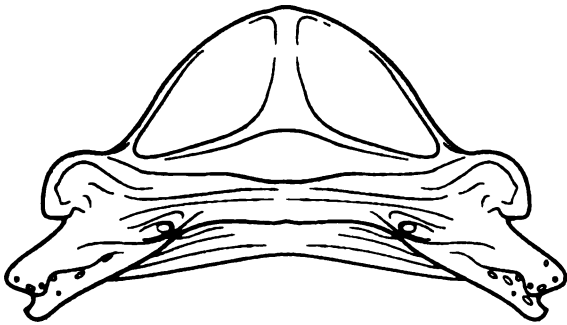


dorsal aspect

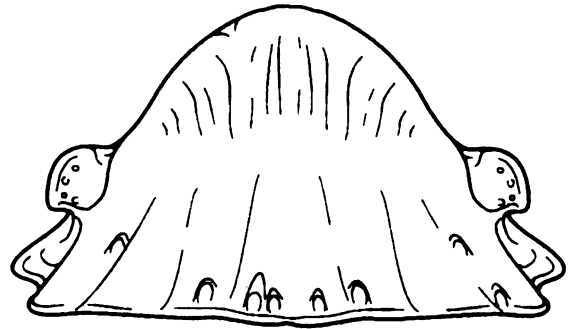


volar aspect

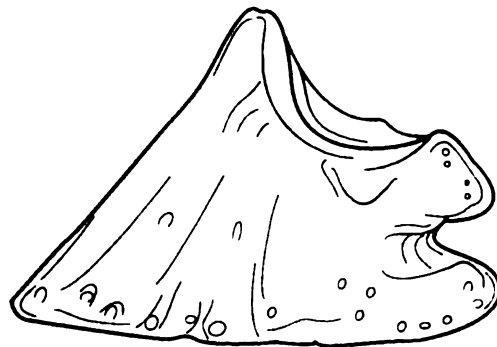
**Figure VI. 11. The Distal Phalanx of the Thoracic Limb
(The Coffin Bone)
dorsal and volar aspects**



posterior aspect



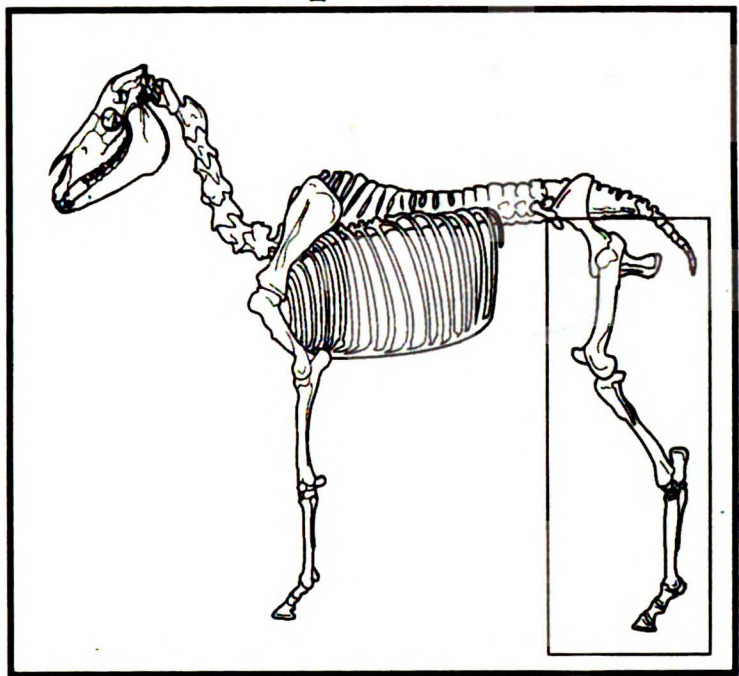
anterior aspect



lateral aspect

**Figure VI. 12. The Distal Phalanx of the Thoracic Limb
(The Coffin Bone)
posterior, anterior, and lateral aspects**

Chapter VII.



The Pelvic Limb



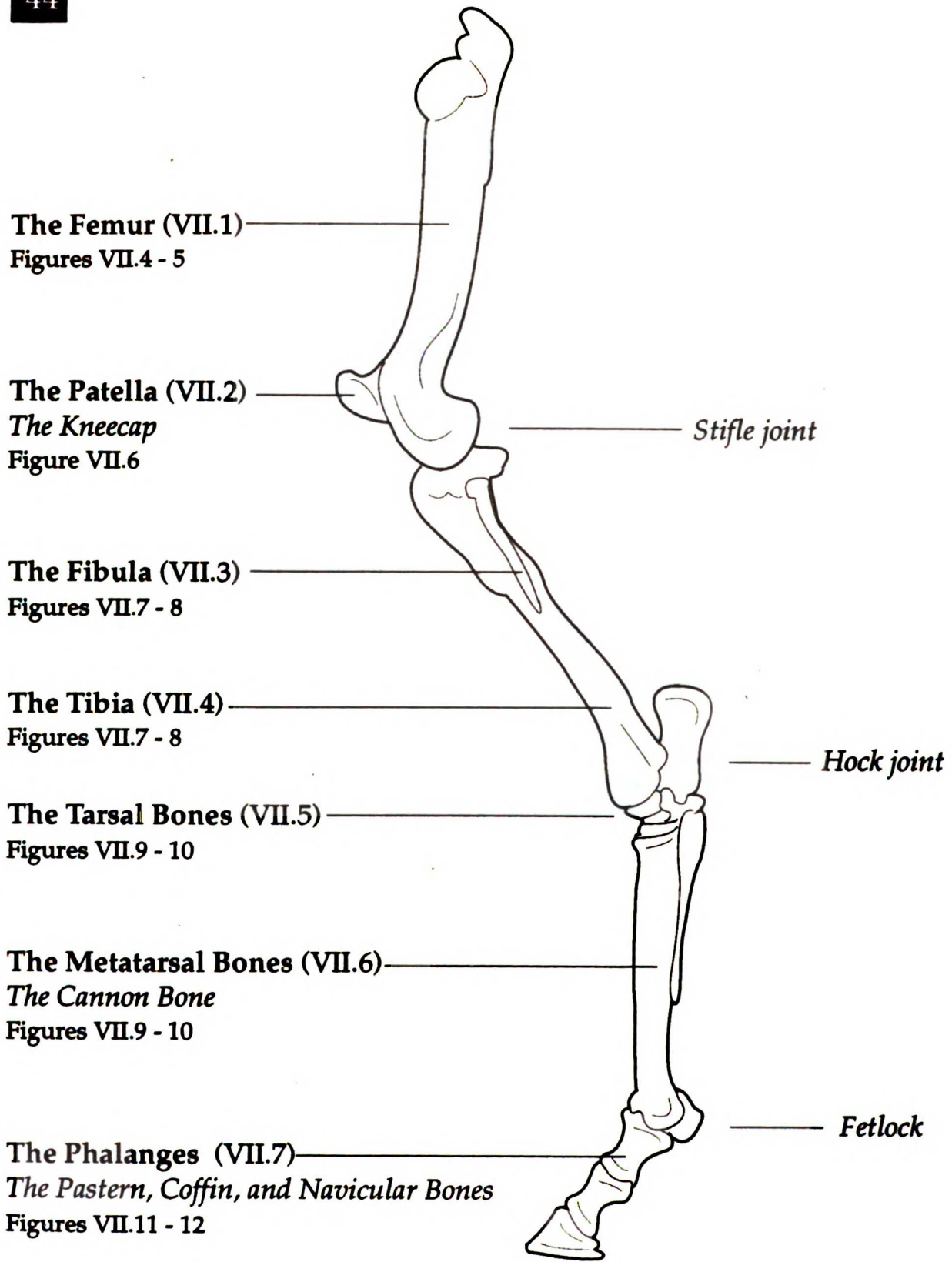


Figure VI.1. The Pelvic Limb
lateral aspect

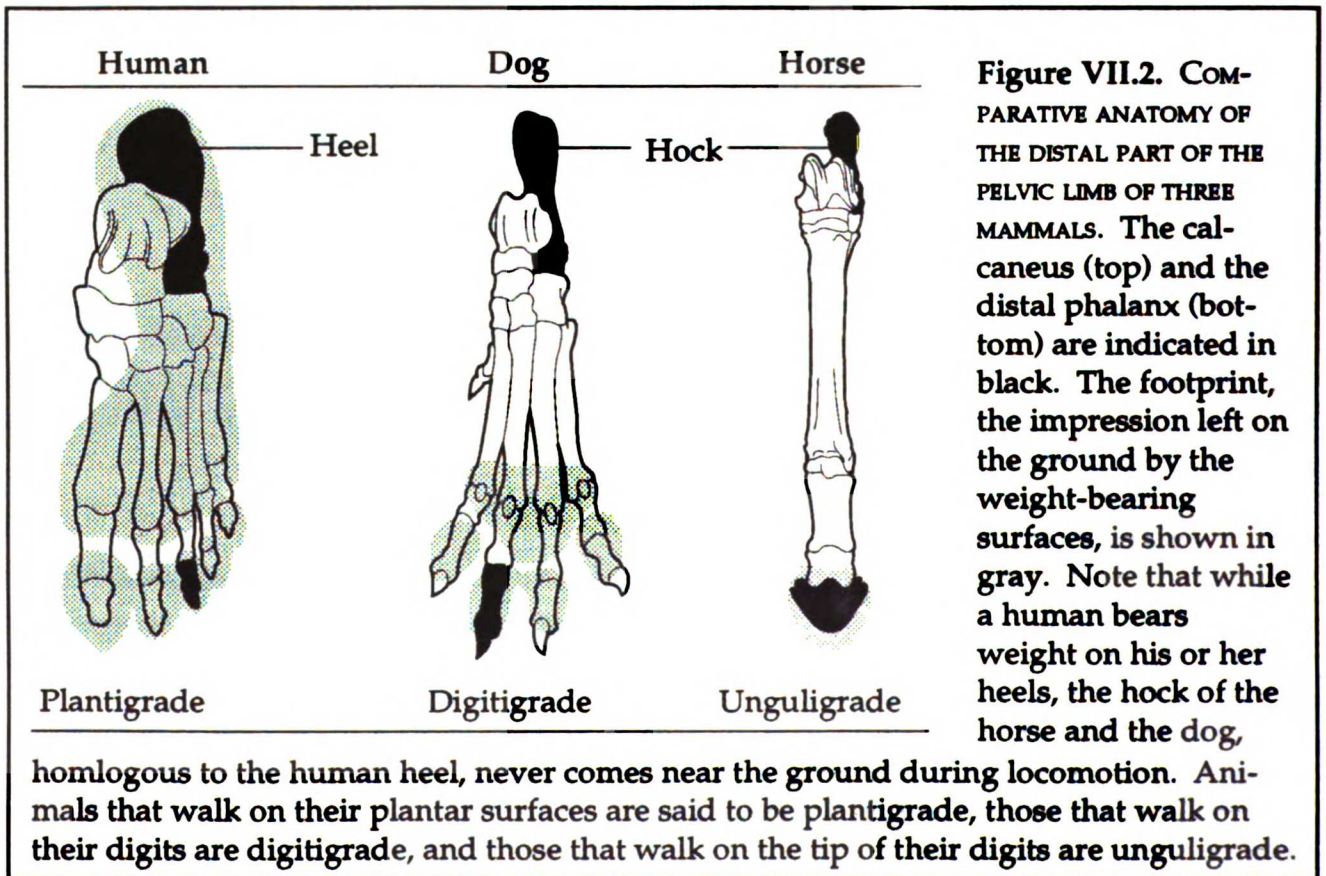
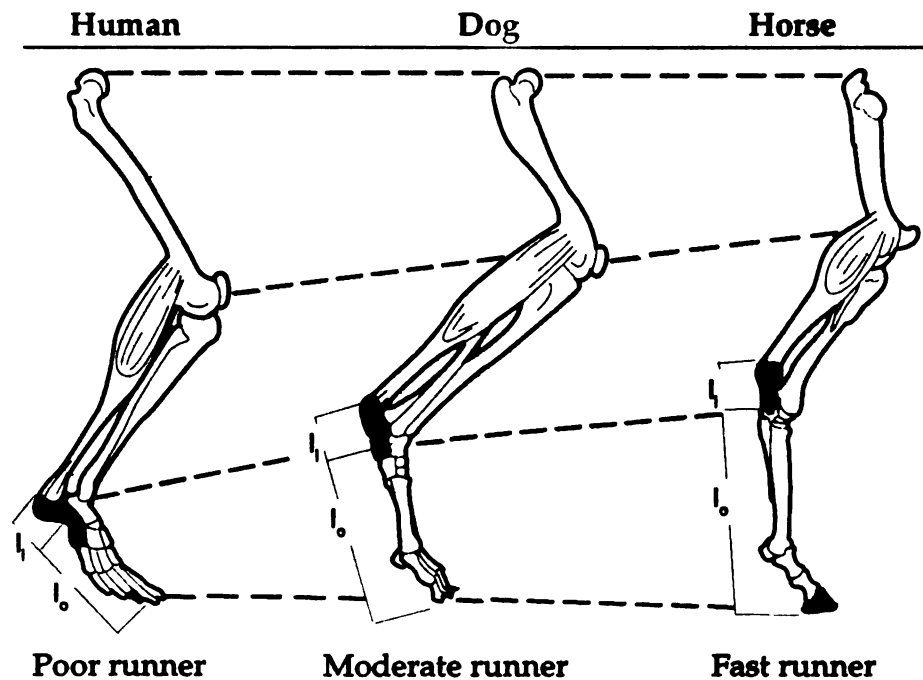


Figure VII.3. COMPARATIVE ANATOMY OF THE PELVIC LIMB OF THREE MAMMALS. The lengths of the proximal limb segments relatively decrease and the lengths of the distal segments relatively increase as the animal becomes more adapted for running (dashed lines). Also, the ratio of the out-lever to the in-lever (l_o / l_i) increases with adaptation for running. The calcaneus



[heel (human), or hock (dog and horse)] and the distal phalanx of the third digit [toe (human), claw (dog), or coffin bone (horse)] are indicated in black. See Figure VII.2. After M. Hildebrand, *Analysis of Vertebrate Structure*, John Wiley and Sons, Inc., 1982.

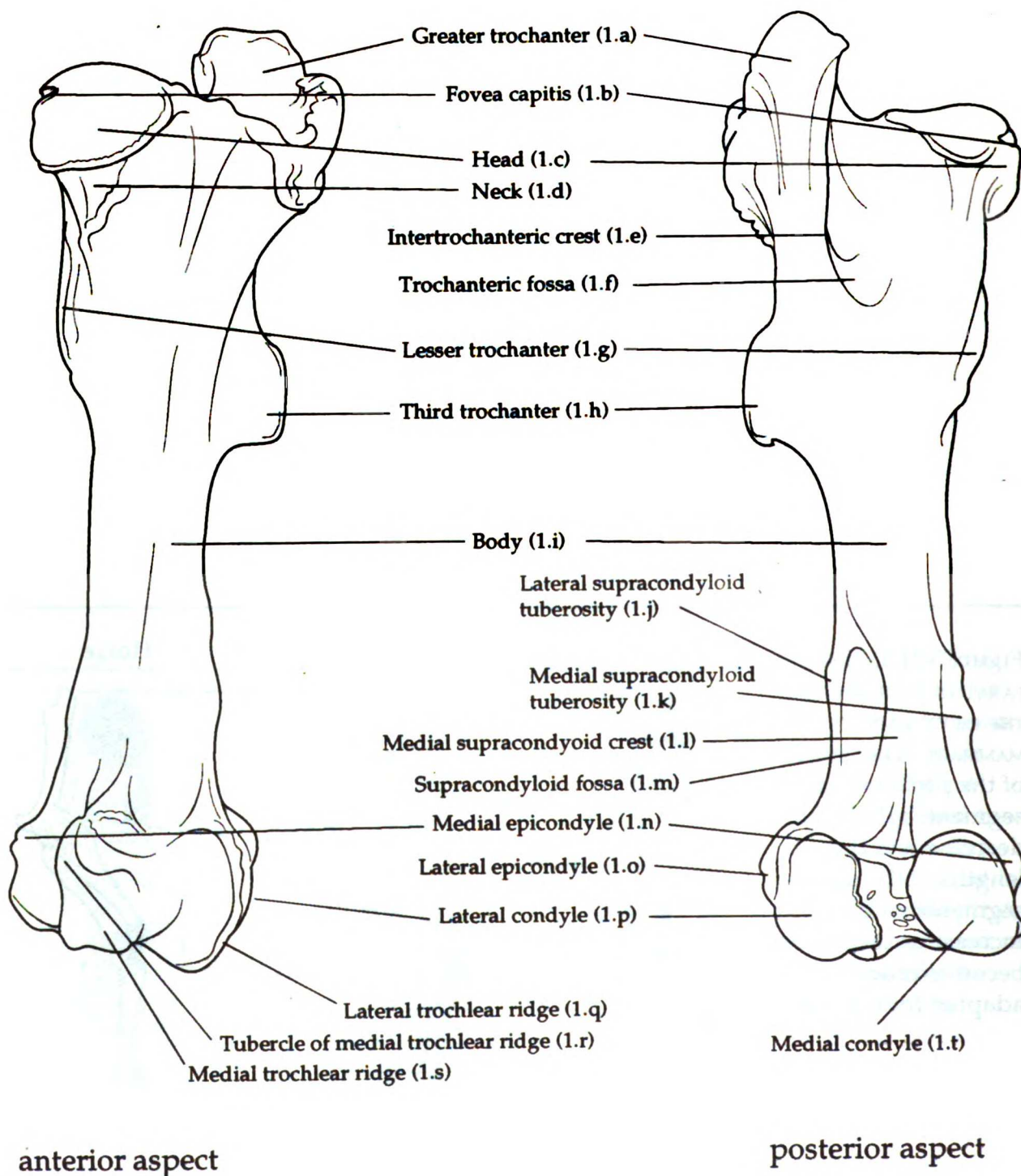


Figure VII.4. The Femur
anterior and posterior aspects

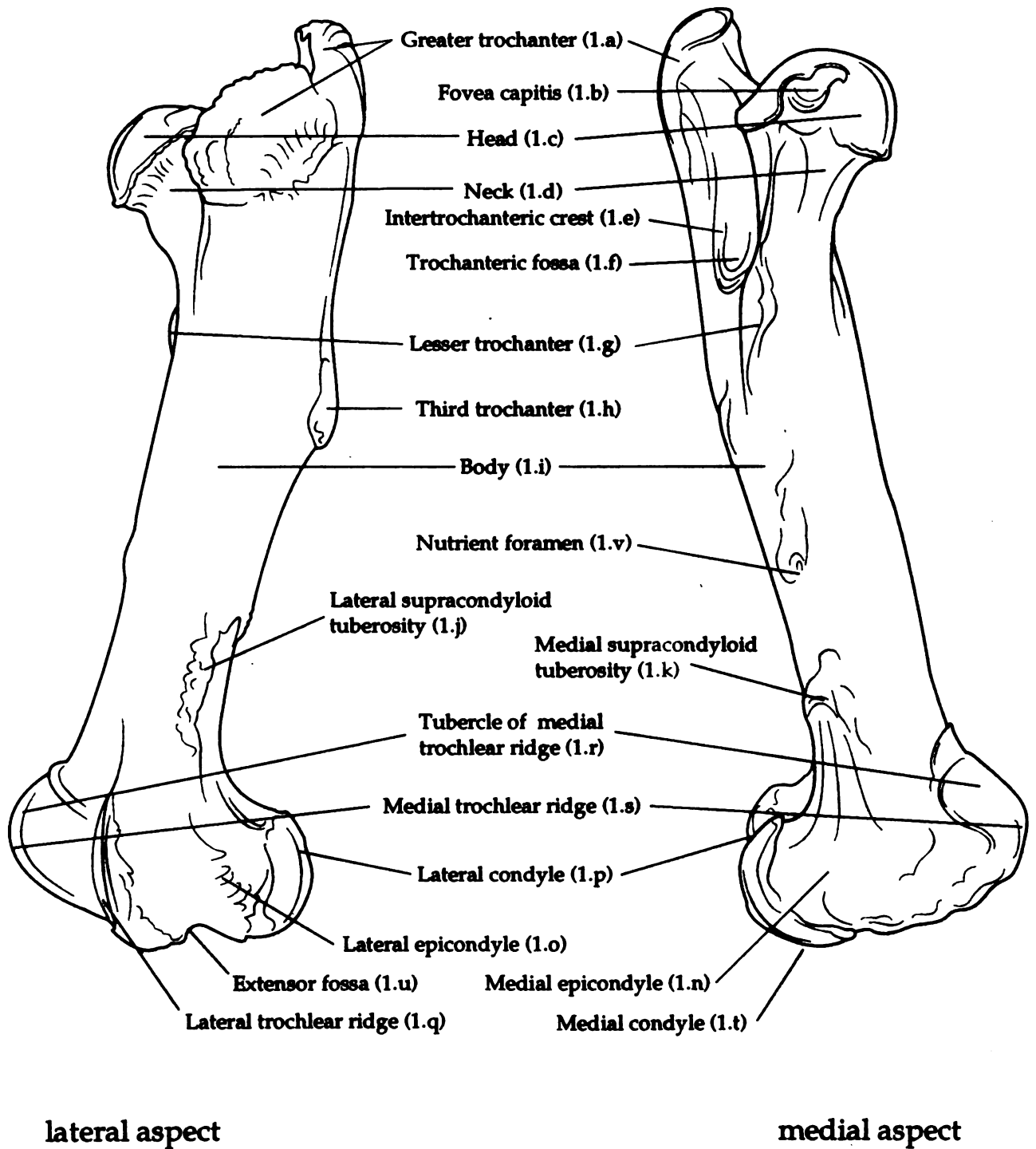
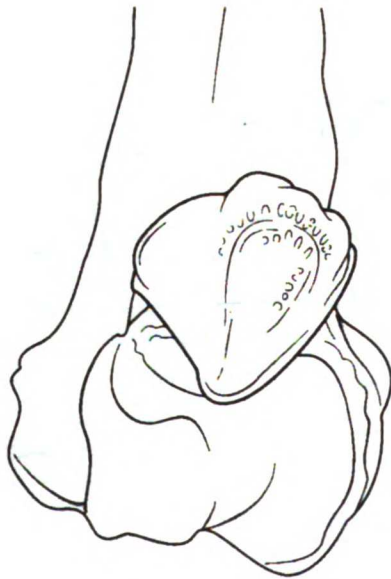
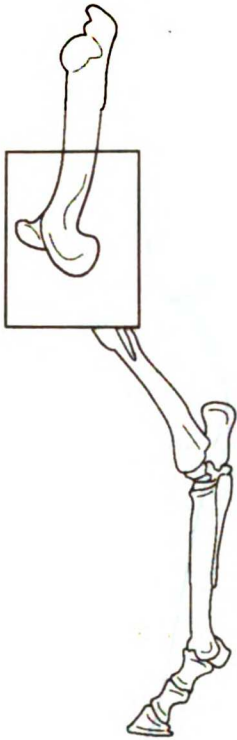


Figure VII.5. The Femur lateral and medial aspects



anterior aspect



lateral aspect

Figure VII.6. The Distal Femur and Patella
anterior and lateral aspects

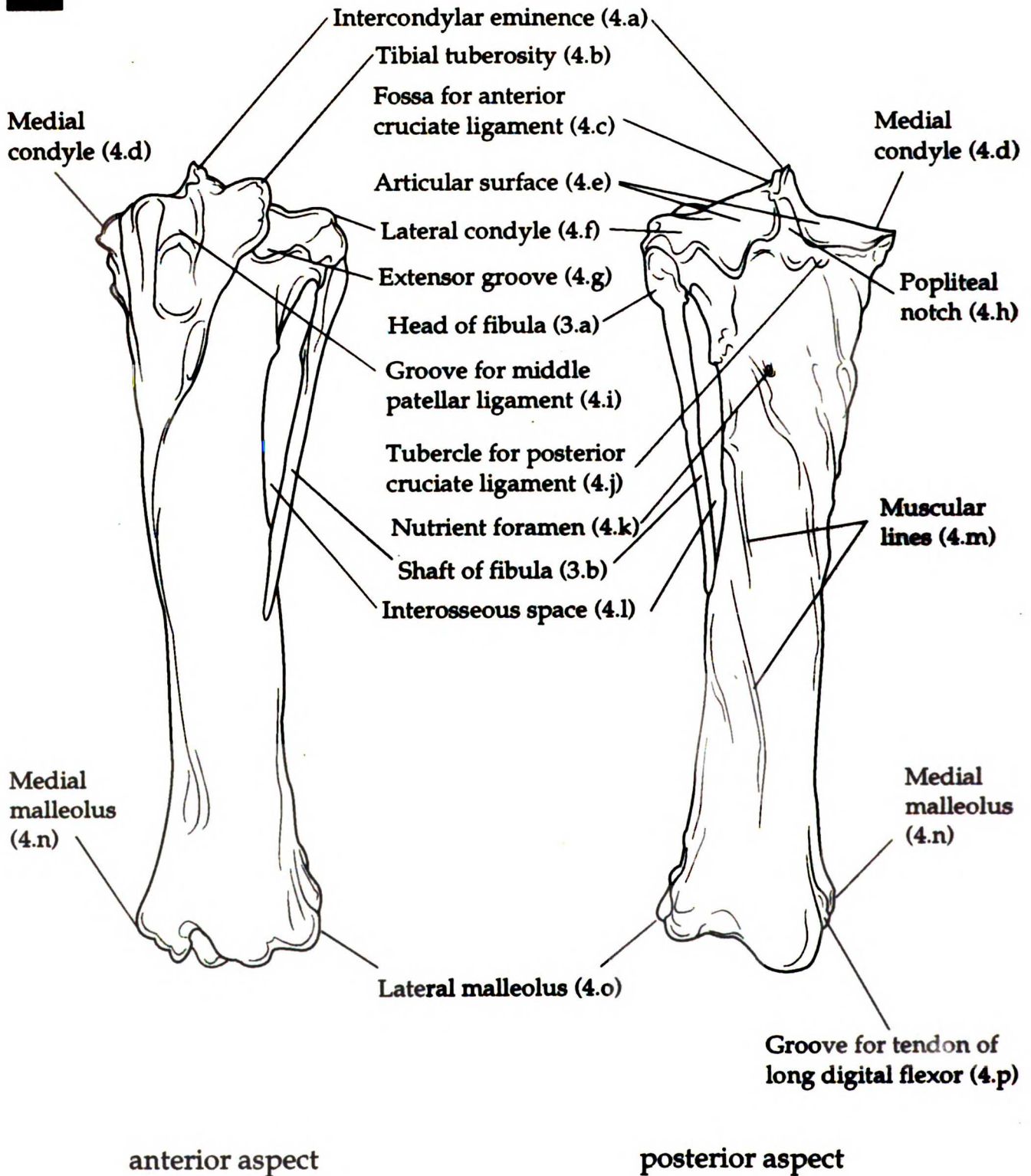


Figure VII.7. The Tibia
anterior and posterior aspects

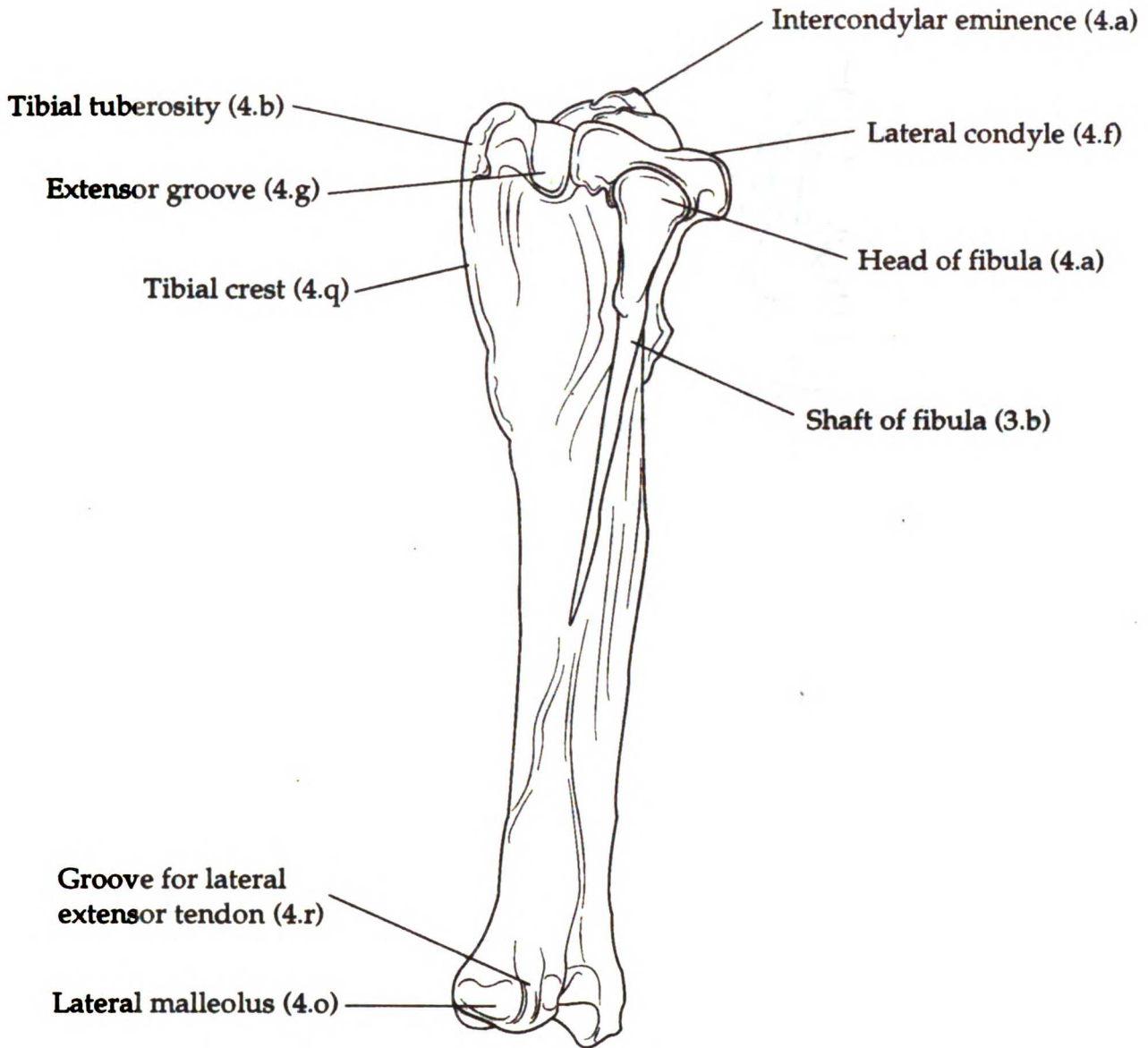
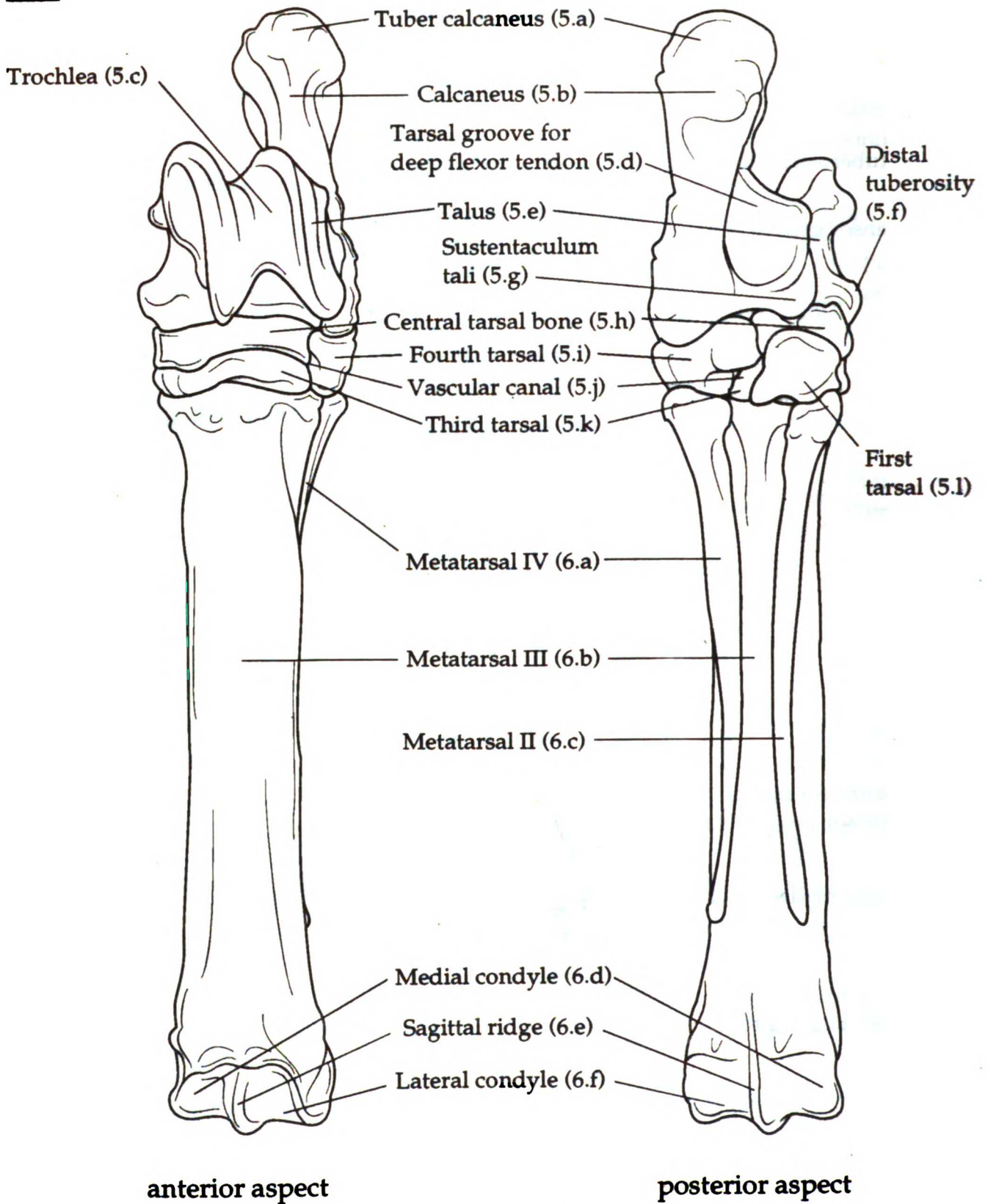


Figure VII.8. The Tibia lateral aspect



**Figure VII.9. The Tarsal and Metatarsal Bones
anterior and posterior aspects**

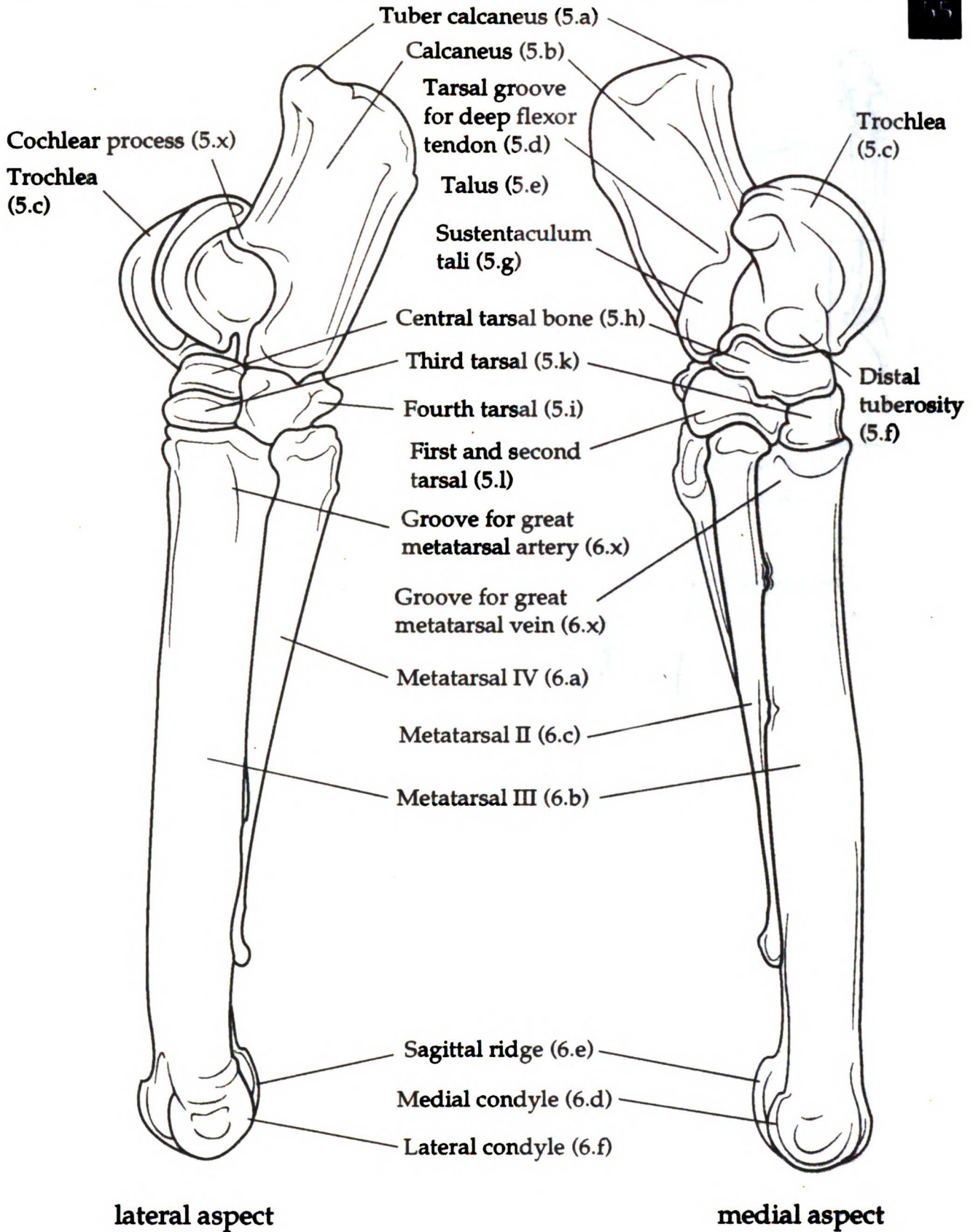
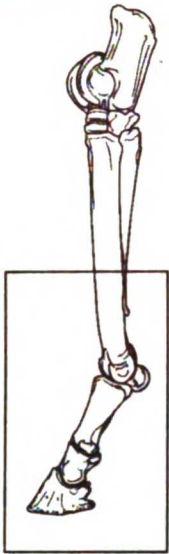
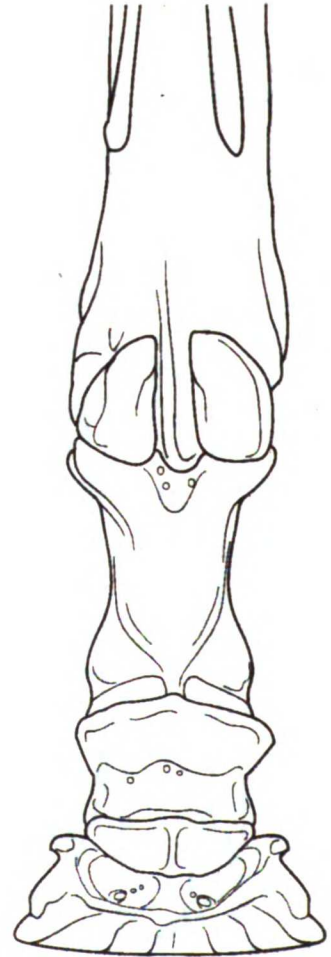


Figure VII. 10. The Tarsal and Metatarsal Bones lateral and medial aspects

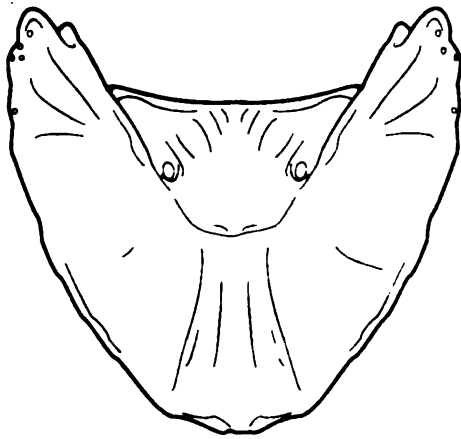


lateral aspect

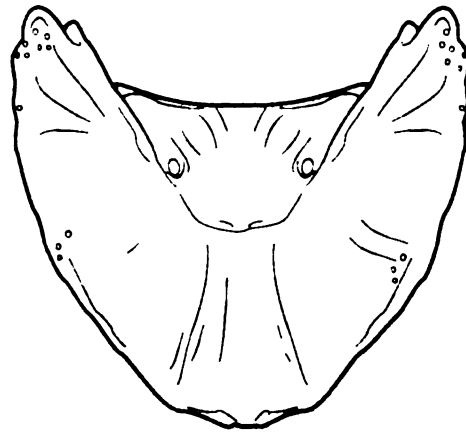


posterior aspect

Figure VII. 11. The Phalanges and Sesamoid Bones
lateral and posterior aspects



**The Coffin Bone of the
Pelvic Limb**



**The Coffin Bone of the
Thoracic Limb**

**Figure VII. 12. Comparison of the Distal Phalanges
of the Pelvic and Thoracic Limbs
volar aspect**

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