Klaus-Dieter Budras · W.O. Sack · Sabine Röck

Anatomy of the Horse

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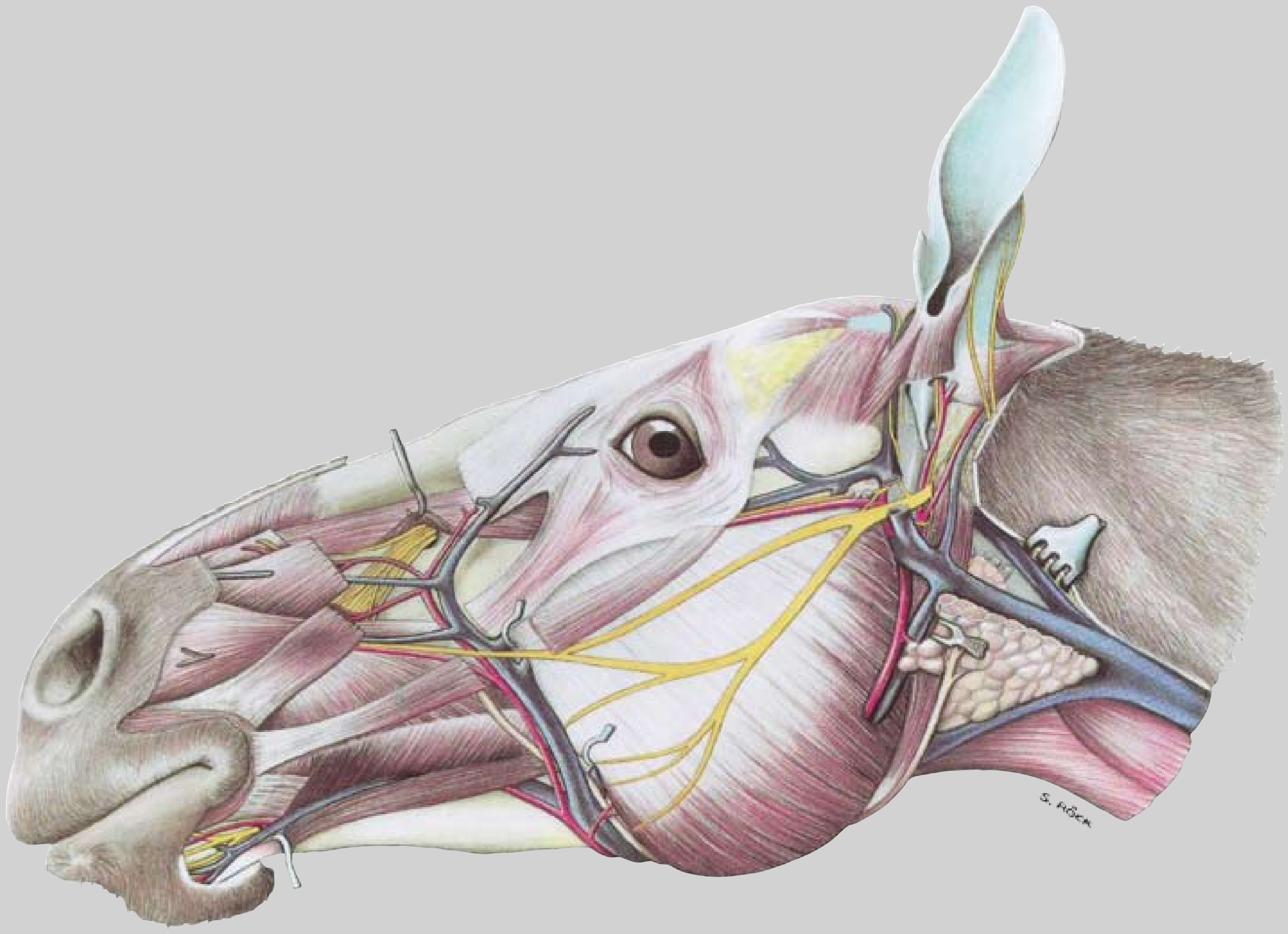

with Aaron Horowitz and Rolf Berg

Sixth edition

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Sixth Edition

Professor em. Klaus-Dieter Budras
Institute of Veterinary Anatomy
Free University of Berlin

Professor em. W. O. Sack †
Department of Biomedical Sciences
College of Veterinary Medicine
Cornell University, Ithaca, New York

Dr Sabine Röck
Institute of Veterinary Anatomy
Free University of Berlin

Professor Aaron Horowitz
Professor Rolf Berg
Dept. of Structure and Function
School of Veterinary Medicine
Ross University, St. Kitts, West Indies

Science Illustrator
Gisela Jahrmärker, Diemut Starke, Renate Richter

Contributors
Anita Wünsche, Christine Aurich, Jörg Aurich, Silke Buda,
Peter S. Glatzel, Hartmut Gerhards, Arthur Grabner,
Ekkehard Henschel †, Bianca Patan, Astrid Rijkenhuizen,
Harald Sieme, Bettina Wollanke

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Co-workers on the Atlas of the Anatomy of the Horse

Sixth Edition

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Renate Richter

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Contributions

A. Univ.-Prof. Dr. Christine Aurich, Besamungsstation, Veterinärmedizinische Universität Wien
O. Univ.-Prof. Dr. Jörg Aurich, Klinik für Geburtshilfe, Gynäkologie und Andrologie, Klinisches Department für Tierzucht und Reproduktion, Veterinärmedizinische Universität Wien
PD Dr. Hermann Bragulla, Dept. of Biological Sciences, Lousiana State Universiy, Baton Rouge
Dr. Silke Buda, Institut für Veterinär-Anatomie, Freie Universität Berlin
Prof. Dr. Hartmut Gerhards, Klinik für Pferde, Ludwig-Maximilians-Universität München
Prof. Dr. Peter S. Glatzel, Tierklinik für Fortpflanzung, Freie Universität Berlin
Prof. Dr. Arthur Grabner, Klinik für Pferde, Freie Universität Berlin
Prof. Dr. Ekkehard Henschel †, Institut für Veterinär-Anatomie, Freie Universität Berlin
Dr. Ruth Hirschberg, Institut für Veterinär-Anatomie, Freie Universität Berlin
Prof. Dr. Dr. h.c. Horst E. König, Institut für Veterinär-Anatomie, Veterinärmedizinische Universität Wien
Prof. Dr. Dr. h.c. Hans-Georg Liebich, Institut für Tieranatomie, Ludwig-Maximilians-Universität München
Prof. Dr. Christoph K. W. Mülling, Dept. of Comparative Biology and Experimental Medicine, Faculty of Veterinary Medicine, University of Calgary, Canada
Dr. Claudia Schlüter, Klinik für Kleintiere, Universität Leipzig
Dr. Bianca Patan, Klinik für Orthopädie bei Huf- und Klauentieren, Veterinärmedizinische Universität Wien
Ass. Prof. Astrid B. M. Rijkenhuizen, Department of Equine Sciences. Surgery Faculteit Diergenesskunde Universiteit Utrecht
Prof. Dr. Harald Sieme, Reproduktionsmedizinische Einheit der Kliniken, Stiftung Tierärztliche Hochschule Hannover
Prof. Dr. Paul Simoens, Faculteit Diergeneeskunde, Universiteit Gent
PD Dr. Bettina Wollanke, Klinik für Pferde, Ludwig-Maximilians-Universität München

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Contents

How to use this book

> The framed introductions at the beginning of the text-pages dealing with topographical anatomy give information with respect to the dissection of the areas shown in the figures. At the same time, they can be used as abbreviated dissection instructions.

Bold

Boldface terms of anatomical structures serve for emphasis and, insofar as they are identified by numbers, they are represented on the neighboring illustration-page where they are identified by the same number.

Italics

The comparative anatomical aspects respecting the species-specific features of the horse are accentuated by using *italics*. However, if horse-specific details are continuously discussed in the text (for example, the stay apparatus of the horse), then the descriptions are written in normal lettering. The weighting of each of the anatomical details according to their significance is shown by the use of different character styles, figure captions and cross references to the section “Contributions to Clinical-Functional Anatomy”. Bold face type is used in the text for emphasis and the associated numbers refer to the figures. Less important details are not presented in the text, only in the figure legends. If a minus sign is present in the figure legends of the skeletal system (see Figs. 5, 17, 33, 35 and 74), this means that the structure is not found in the horse, but may be present in other domestic mammals.

Abbreviations

The anatomical/medical terms and expressions occurring in the text are explained and interpreted in “Anatomical Terms”. Abbreviations of anatomical terms follow the abbreviations as employed in the Nomina Anatomica Veterinaria (2005). Other abbreviations are explained in the appertaining text, and in the titles and legends for the illustrations. A few abbreviations that are not generally employed are listed here:

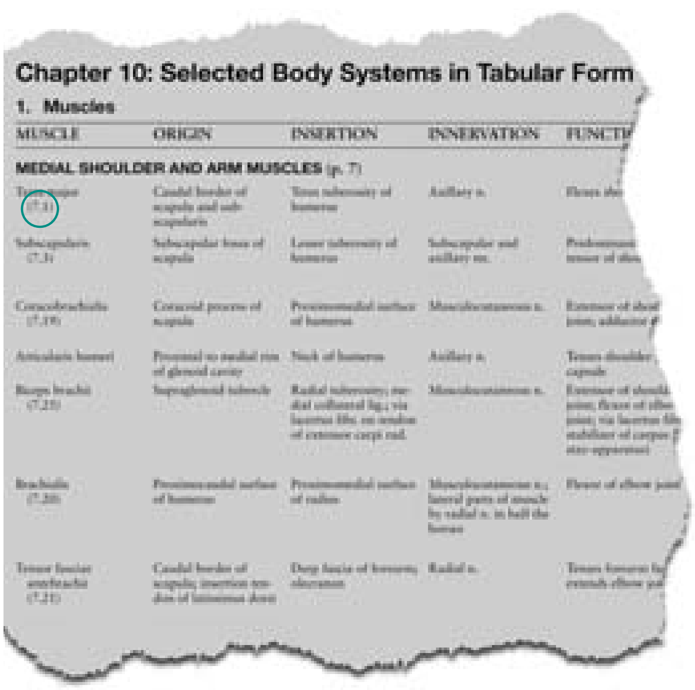
The **cranial nerves** *(Nervi craniales)* are designated with roman numerals I–XII.

Spinal nerves *(Nervi spinales):*
n – Nervus spinalis
nd – Ramus dorsalis n. spinalis
ndl – Ramus dorsolateralis
ndm – Ramus dorsomedialis
nv – Ramus ventralis
nvl – Ramus ventrolateralis
nvm – Ramus ventromedialis
nC – Nervus cervicalis (*e. g.,* nC1 – first cervical nerve)
nCy – Nervus coccygeus s. caudalis
nL – Nervus lumbalis
nS – Nervus sacralis
nT – Nervus thoracicus

Vertebrae:
vC – Vertebra cervicalis (*e. g.,* vC_3 – third cervical vertrebra)
vL – Vertebra lumbalis
vS – Vertebra sacralis
vT – Vertebra thoracica

Numbers on the margin

Numbers on the margin of the text-pages refer to the “Clinical and Functional Anatomy”. The numbers in the clinical anatomy part refer to the corresponding page in the topographical anatomy; e. b., “8.2” refers to the part numered „2“ on page 8.


Chapter 10: Selected Body Systems in Tabular Form
1. Muscles
MUSCLE | ORIGIN | INSERTION | INNERVATION | FUNCTI…
MEDIAL SHOULDER AND ARM MUSCLES (p. 7)

Cross-references

The captions of the anatomical figures in the section **“Contributions to Clinical-Functional Anatomy”** have been deliberately kept to a minimum because the identification of anatomical details with the aid of the figure tables in the front of the book is straightforward. This effectively fulfils the goal of providing an easily memorable exercise for students. The cross-reference numbers refer to both the plate number in the topographical part of the book and the respective structure (Example: Teres major, 7.1 = Plate 7, No. 1 in the legends).

The same principle is also used in the **special anatomy tables.**

Preface

With our three-volume work on the Anatomy of the Dog (1), of the Horse (2), and of the Bovine (3), we pursue the goal to show the structure of the body by illustrations that are true to nature accompanied by a brief accompanying text. We do this in such a way that practical matters are emphasized and irrelevant clinical and functional details are only mentioned. Generally valid principles, which hold for all species with only slight species-specific differences, as for example the general anatomy of the autonomic nervous system, can be found in the *Anatomy of the Dog* (Vol. 1).

With the ever increasing importance of the horse as partner, helper, and sporting companion, we wanted with this submission of the second volume to emphasize the esthetics, grace and genial functionality of the structure of the body but also to emphasize in our book the susceptibility to diseases in all its naturalness. At the same time, we wanted to create an attractive basic contribution to animal health and a practice-related curriculum concept. In the newest edition presented here, the comprehensive and thorough revision of both the text and the figures was continued. A main objective was to join more closely the three areas, namely the topographical-anatomical main part with the clinical-functional contributions and the special anatomy in the form of tables into a uniform total concept, doing this by copious illustration and descriptive references. The well-tried didactic concept of the nexus between descriptive and illustrative elements on respective opposite pages of the book was understandably retained and further developed. In the topographical main part, additions and improvements are concentrated in the important, clinically significant, subjects such as the skin, the hoof and its suspensory apparatus with links to founder, head with pharynx and guttural pouch as well as the larynx, and arteries, veins and nerves of the pelvic cavity as also the perineal region in regards to obstetrics.

Corresponding to their increasing significance in study and practice, the contributions to clinical-functional anatomy were most intensively revised and most extensively completed. The close association between anatomy and orthopedics and their importance for equine medicine were taken into consideration by the expansion and the completion of the chapters on the limbs. Clinically relevant subjects of the head and abdominal and pelvic cavities including the genital organs were more intensively illuminated with a view to colic and parturition. That concerns also the examination of the eye and rectal exploration of the abdominal and pelvic cavities in preparation for sonographic examination of the sex organs with attention to the sexual cycle, artificial insemination and examination for pregnancy. The clinical-functional part was enriched by excellent illustrations from our anatomical archive. By their publication in a suitable manner, the high scientific and esthetic value of the figures may be appreciated and be of use for veterinarians, students and especially for equine medical science. In the clinical-functional portion, corrections, changes, additions and the addition of color were undertaken on the archive figures. The labeling is but scarce and justified, since an identification of anatomical structures by the aid of figure tables in the main part of our book is easily possible. In this way, we attain the aim of an easily remembered exercise for the student. We thank our generous colleagues for providing valuable viewing material from sources of modern imaging methods. These sources are mentioned in the key to the figures. We are thankful for the cooperation of the following mentioned colleagues in our community of authors: Prof. Dr. Rolf Berg, Prof. Dr. Aaron Horowitz, Dr. Bianca Patan, Proff. Christine and Jörg Aurich, Prof. Dr. Astrid Rijkenhuizen, Prof. Dr. Harald Sieme, Dr. Claudia Nöller, Prof. Dr. Peter S. Glatzel, Prof. Dr. Hartmut Gerhards and Privat Dozentin Dr. Bettina Wollanke. The valuable and constructive ideas from our circle of readers, especially the students, were taken into consideration as far as possible. They are also very welcome in the future. We suffered an extremely sad loss from the passing away of our co-editor and friend, Prof. Dr. Wolfgang Sack, who masterfully shaped our former English editions. The common revision was wonderful and extremely beneficial for the improvement of our book.

Berlin, in the summer of 2008

For the authors,
Klaus-D. Budras

Chapter 1: Skin

1. The external Skin (common integument)

On the horse, the colors and markings of the skin are definite. Present markings, pigment-free and haired areas are detected. With dissection of the animal body, notice has to be taken of the variable thickness of the skin, hair coat, direction of the hairs and characteristics of the subcutaneous fat. The later dissection of the head can be used for the study of the vibrissae.

a) Generally, the **SKIN** is subdivided into 3 layers. 1. The epidermis, which is the layer of contact as well as the protective surface, 2. The corium or dermis, which assures the nutritive and sensory supply of the epidermis, and 3. The subcutis or hypodermis, which serves as a displaceable layer and fat layer (*panniculus adiposus externus*).

1. The **epidermis** (**1**) consists of a stratified, keratinized squamous epithelium. Where the common integument bears hairs, the epidermis is relatively thin in comparison to the different skin modifications as, for example, the hoof, where the epidermis is much thicker. The vital, living, part of the epidermis consists of a basal layer, which rests directly on the basal membrane, a spinous layer and a granular layer. The avital, non-living, part consists of the stratum lucidum, which is rarely present, and the stratum corneum, which make up the so-called cutaneous layer. Besides the cells of the epidermis, the keratinocytes, other cells of the basal layer are melanocytes (protection against ultraviolet radiation) and LANGERHANS cells in the basal and spinous layers (antigen presentation). A semipermeable epidermal barrier protects the body against the entrance of water and loss of fluid and regulates the absorption of medicaments in ointment application.

2. The **dermis** is subdivided into a **papillary layer** (**2**), which is found directly under the epidermis, and a **reticular layer** (**2'**). It consists of connective tissue, which in the papillary layer contains finer and in the reticular layer, coarser, net-like connected collagen fiber bundles. In the dermis, there are blood vessels and nerves. Besides supplying the tissues with nutrients and oxygen, the blood vessels have a thermoregulatory function, which is not inconsiderable. *The equine dermis is thinner than the bovine dermis.* The thickness varies between the different regions of the body and among the different breeds of horses.

3. The **subcutis** (**3**) consists of loose connective tissue with fixed and freely movable cells, adipose tissue, which *in the horse is of yellowish color and oily consistency*, and larger blood vessels. The subcutis is fixed by taut retinacula to fascia or the periosteum of underlying bone and is *distinctly more weakly developed in the horse than in the dog*. In some body regions (lips, cheeks, eyelids) the subcutis is absent.

The **nerve supply** is realized by sensory and sympathetic fibers. The sympathetic innervation of the blood vessels and sweat glands is related to thermoregulation, but is also a reflection of different states of excitement (*e.g.*, sweating with high sympathetic tonus). Owing to the sensory innervation of the skin, it becomes the largest sense organ of the body. Besides free nerve endings, which serve as pain receptors and thermoreceptors, special receptor cells (**MERKEL cells**) and specially structured **nerve end-corpuscles** (**RUFFINI corpuscles, lamellar corpuscles** -**4**) are located in the skin. These function as pressure and tension receptors and receptors for movement.

The haired skin is characterized by the triad: hair sebaceous gland and apocrine sweat gland.

b) The **HAIRS** (***pili***) are differentiated into long hairs, ordinary hairs and wool hairs. Leading hairs are only very few in number and irregularly distributed. *The* **long hairs** *occur in the horse on the head as the* **forelock** (***cirrus capitis* —5**), on the neck as the **mane** (***juba* —6**) *and at the root of the tail as the* ***cirrus caudae*** (**7**). *In many equine breeds a distinct tuft of hairs is present at the flexion surface of the fetlock of the thoracic or pelvic limb (cirrus pedis).* The other parts of the skin are covered with ordinary hairs and **wool hairs** (**8**), which are of variable character depending on the season. The roots of these hairs lie usually oblique to the surface in the dermis. **Hair tracts** are formed by this alignment. The hairs can be erected by the contraction of the smooth muscle cells (*mm. arrectores pilorum*), which are innervated by sympathetic nerves. In different regions of the body, the hair tracts form diverging (flank) or converging (forehead) hair whorls, hair sheaths (in extension of the flank fold) and hair crests. The density of the hair coat varies with the region of the body. It is most dense in the region of the head, less dense in the abdominal and inguinal regions.

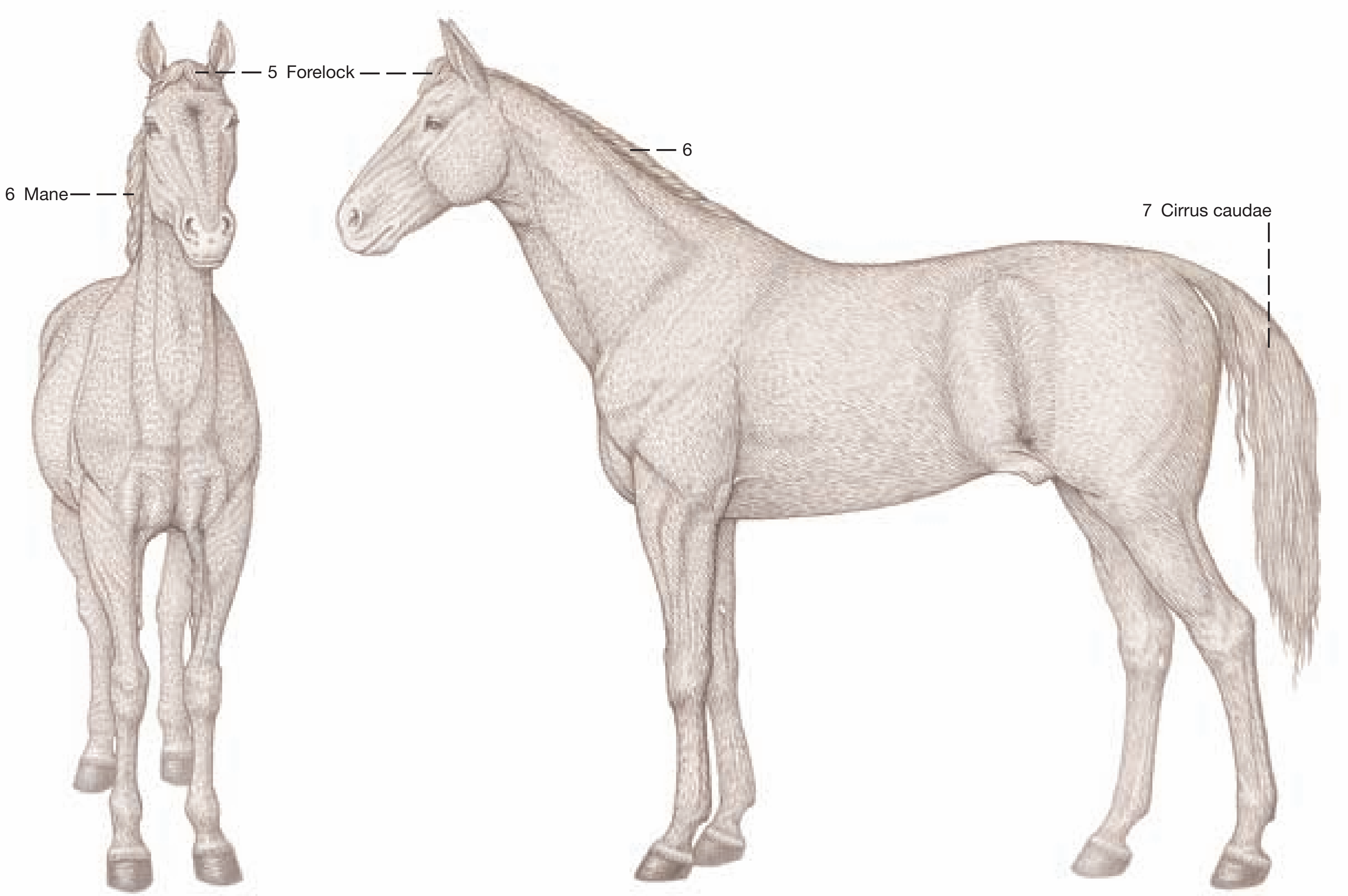
The **SEBACEOUS GLANDS** (**9**) are holocrine secretory cutaneous glands, which release their product, the entire non-living, fat-containing cells into the hair follicle. The sebum thus secreted forms a thin fat film on the skin and hairs and ensures a sleek, glistening coat. At the body openings such as the mouth (lips), the perineal region, the udder, the vulva and prepuce relatively large, "free" sebaceous glands occur. These open onto the surface of the skin and not into a hair follicle.

APOCRINE SWEAT GLANDS (**10**) are associated with the presence of hairs. Their excretory ducts likewise open into the hair follicle. The secretion of the sweat glands consists of 97–99 % water, other constitutents are electrolytes and proteins. Since in cases of stress up to 10 ml secretion per kg body weight per hour is given off (500 kg horse = 5 liters per hour), considerable losses of water can occur due to sweating. *Owing to the protein content of the secretion, with exercise of the animal, a very visible foamy sweat is formed.* The apocrine sweat glands are enlaced by cholinergic sympathetic nerve fibers. However, the innervation is probably limited to the blood vessels running there and to the myoepithelial cells of the glandular end-pieces.

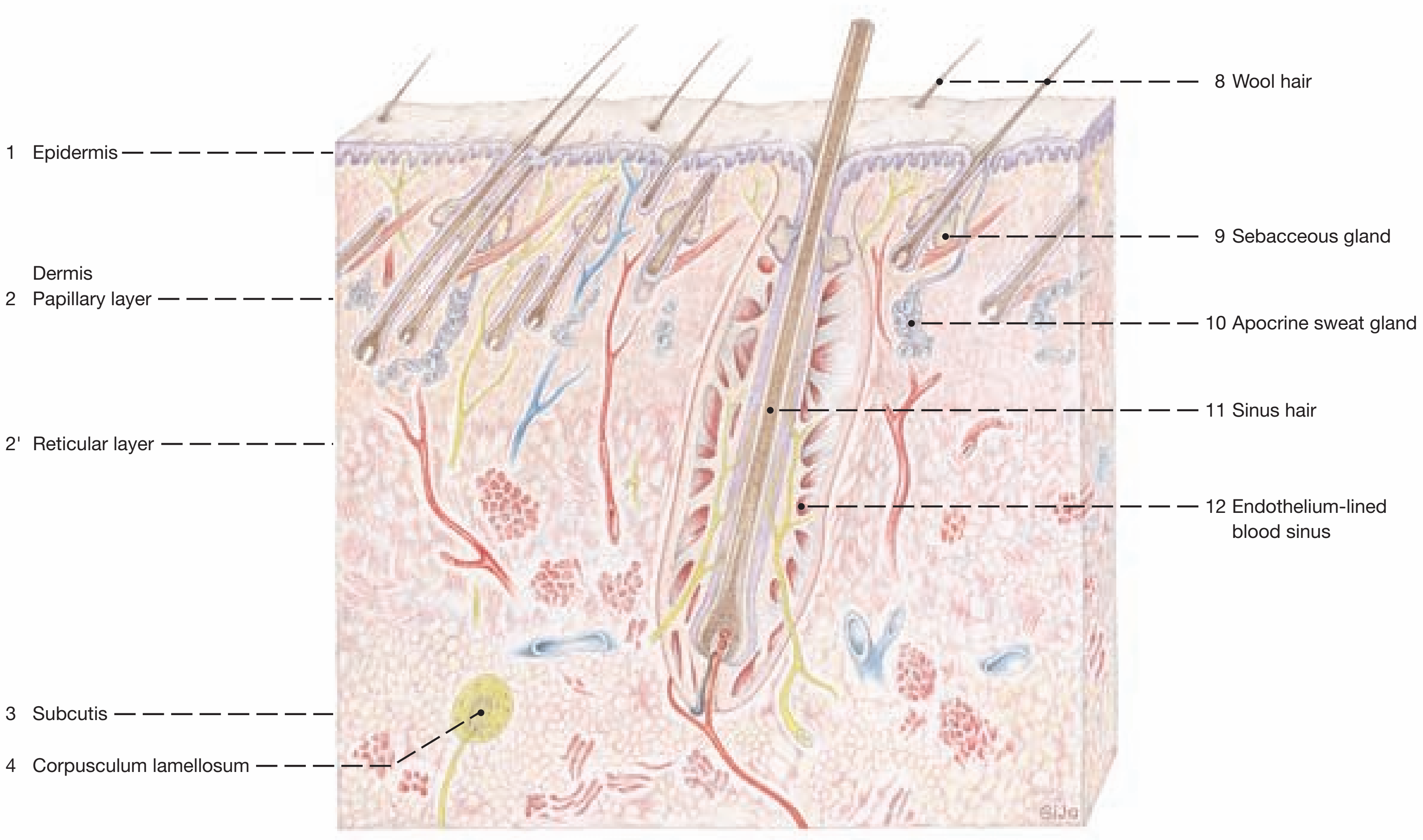
ECCRINE SWEAT GLANDS occur independent of the hairs and open freely, but they are very rare (*e.g.*, heel (ball) segment of the hoof).

SINUS HAIRS (***pili tactiles* —11**) are present on the upper and lower lip as well as on the eyelids. These tactile hairs are considerably larger than the normal hairs. The root of the hair reaches deeply, far into the reticular layer of the dermis, and is in contact with muscle fibers of the striated cutaneous musculature. The connective tissue root sheath is subdivided by an irregularly chambered **endothelium-lined blood sinus** (**12**) into an external and internal lamina. A distinct basal membrane and the external epithelial root sheath are associated with the internal lamina. Many **MERKEL cells,** which are in contact with (myelinated) neve fibers, lie in the basal layer of the external epithelial root sheath. The **MERKEL cell**-axon complexes and free nerve-endings of unmyelinated nerve fibers are excited by deviation of the sinus hair. The movement of the hair and, by this, the pressure on the receptors is reinforced still more by compression of the blood sinus in the region of the hair follicle, by which a very sensitive mechanoreceptor-complex is formed. The importance of the sinus hairs for mechanoreception becomes also clear by the great number of sensory myelinated nerve fibers, which approach regularly the root of a sinus hair and are visible in the histological slide.

External Skin (common integument)



Lips



Chapter 2: Thoracic Limb

1. The Skeleton of the Thoracic Limb

1 The limbs of the horse are adapted for the well-developed ability to run fast. Compared to the plantigrade stance (newborn dog) and the digitigrade stance (adult dog), the overextended angulation at the canine carpus has been lost in the horse. The horse is an unguligrade animal and as a result of the straightening and lengthening of its limbs is capable of a long stride. The loss of rays 1 and 5, the reduction of 2 and 4, and the very well-developed digit 3 as the only one that supports the body are part of the same adaptation. The thoracic limbs in the standing horse carry about 55–60 % of the body weight. The rider, by using the reins to flex the atlanto-occipital and nearby cervical joints, "shortens" the neck and thus causes the center of gravity to move toward the hindlimbs. In horses of good conformation, the forelimbs appear straight and parallel to one another when viewed from the front. In lateral view, they should appear straight and vertical. A plumb line from the palpable **tuber** (5') on the scapular spine passes through the center of the fetlock joint and touches the caudal aspect of the hoof.

The shoulder girdle (scapula, coracoid, clavicle of other animals) is greatly reduced; the clavicle has disappeared and only a fibrous strip (clavicular intersection) is left in the brachiocephalicus.

2 a) The equine **SCAPULA** is characterized by the wide, semilunar **scapular cartilage** (14) that enlarges its dorsal border. The spine presents a palpable tuber and subsides distally opposite the neck of the bone without forming an acromion. An **infraglenoid tubercle** (20) is sometimes present.

3 b) **HUMERUS**. The **greater** (25) and **lesser** (29) **tubercles** on the lateral and medial sides, respectively, of the proximal extremity are nearly equally well developed. Both tubercles are separated by a sagittal **intertubercular groove** (28) which is wide and carries an **intermediate tubercle** (28'). The latter fits into a depression on the deep surface of the wide biceps tendon and seems to impede movement of the tendon relative to the humerus in the standing horse. The body of the bone presents the **teres major tuberosity** (32') on its medial surface about opposite the much more salient **deltoid tuberosity** (32) on the lateral surface. The distal end forms a cylindrical **condyle** (35) that transfers the weight onto the radius. The condyle presents laterally a slight sagittal ridge flanked by grooves that fit into corresponding features on radius and ulna. The **epicondyles, lateral** (38) and **medial** (39), as well as the **lateral supracondylar crest** (38') are palpable. The shallow **radial fossa** (41) is just proximal to the condyle on the cranial surface of the bone. The very much deeper **olecranon fossa** (40) between the two epicondyles lies opposite the radial fossa on the caudal surface. (There is no perforation in the form of a supratrochlear foramen between the two fossae.)

4; 6 c) Of the two bones, **RADIUS** and **ULNA**, that form the antebrachial skeleton, only the radius supports the humerus in the elbow joint. The **radius** on its proximomedial aspect presents the large **radial tuberosity** (46) that serves as the insertion of the biceps tendon. At the distal end of the bone, unobtrusive **medial** (50) and **lateral** (61) **styloid processes** form the ends of the articular surface; the lateral process contains a distal remnant of the ulna.

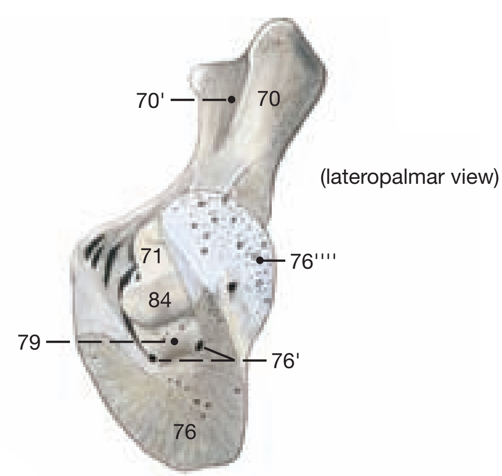
The **ulna** is fused to the radius and with its olecranon limits exten-
5 sion of the elbow joint. Its proximal extremity (**olecranon tuber, 52**) reaches to the fifth rib. The shaft of the bone is greatly reduced and tapers to end in midforearm. The fusion of the two bones is interrupted at an **interosseous space** (62) that is situated in the proximal third of the forearm.

d) **CARPAL BONES.** The bones of the proximal row from medial to
7; 8 lateral are the **radial** (63), the **intermediate** (63'), the **ulnar** (64), and
9 the **accessory** (65) **carpal bones**. The bones of the distal row are
numbered, **first to fourth carpal bones** (66), of which the first is 10
small and inconstant.

e) **METACARPAL BONES**. Only Mc2, 3, and 4 are present. Mc1 and 5 have disappeared and Mc2 and 4 are greatly reduced in accordance with the streamlining and lengthening of the limb for speed.
Mc3, also known as **cannon bone**, is well developed and carries the 11
entire weight assigned to the limb; it is a very robust bone with a lateromedially oriented oval cross section. The caput at the distal end of the bone presents a sagittal ridge that engages a groove in the
proximal phalanx. Mc2 and 4, known also as **splint bones**, are slen- 12
der and about a third shorter than the cannon bone. The **proximal bases** (67) of the metacarpal bones articulate with the carpal bones (Mc2 with C2; Mc3 with C2 and 3; and Mc4 with C4). The splint bones are connected to Mc3 by fibrous tissue, their rounded distal end is an important palpable landmark.

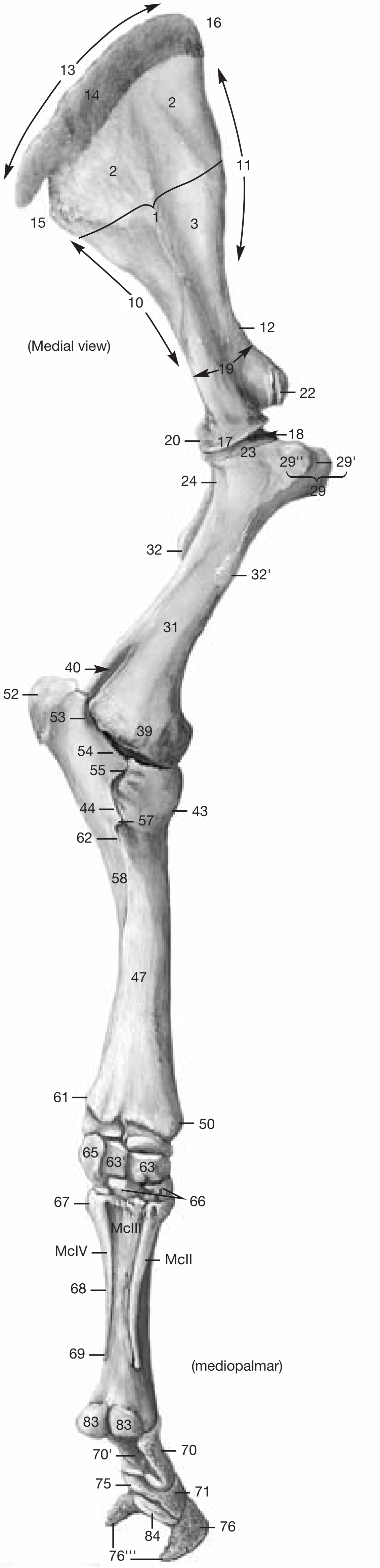
f) The proximal, middle, and distal **PHALANGES** (70, 71, 76) form
the supporting skeleton of the single third digit. The **proximal pha-** 13
lanx, also known as Phalanx I (PI), is the longest of the three; it presents a **triangular rough area** (70') on its palmar surface. The
middle phalanx (PII) is half as long as the preceding bone and pres- 14
ents a **flexor tuberosity** (75) on its proximopalmar aspect that, in the fresh state, is enlarged proximally by a stout **complementary fibrocartilage** for the attachment of ligaments and the tendon of the
supf. digital flexor. The **distal phalanx** (PIII) is also known as the 15
coffin bone. It consists of spongy bone throughout and presents **sole foramina** (76') and **parietal grooves** (76'') as conduits for blood ves-
sels. The medial and lateral **hoof cartilages** (76'''') surmount respec- 16
tive **palmar processes** (76''') of the bone; they are slightly curved to conform to the curvature of the hoof. Their proximal border projects above the hoof where they can be palpated. The **articular surface** (77) of the distal phalanx makes contact principally with the middle phalanx, but has a small facet for articulation with the distal sesamoid bone. The **flexor surface** (79) of the coffin bone provides insertion for the deep flexor tendon.

Phalanges, Navicular Bone, and Hoof Cartilages with some of their Ligaments



g) The proximal and distal **SESAMOID BONES** are of considerable 17
clinical importance in the horse. The (paired) **proximal bones** (83)
articulate with Mc3, while the single distal bone, known as the **na-** 18
vicular bone (84), lies within the hoof and contacts both middle and distal phalanges.

Thoracic Limb



Scapula

Costal surface (1)
  Serrated surface (2)
  Subscapular fossa (3)
Lateral surface (4)
  Scapular spine (5)
  Tuber of scapular spine (5')
  Supraspinous fossa (6)
  Infraspinous fossa (7)
Caudal border (10)
Cranial border (11)
  Scapular notch (12)
Dorsal border (13)
Scapular cartilage (14)
Caudal angle (15)
Cranial angle (16)
Ventral [articular] angle (17)
  Glenoid cavity (18)
Neck of scapula (19)
Infraglenoid tubercle (20)
Supraglenoid tubercle (21)
Coracoid process (22)

Humerus

Head of humerus (23)
Neck of humerus (24)
Greater tubercle (25)
  Cranial part (25')
  Caudal part (25'')
  Crest of greater tubercle (26)
  Triceps line (27)
Intertubercular groove (28)
Intermediate tubercle (28')
Lesser tubercle (29)
  Cranial part (29')
  Caudal part (29'')
Body of humerus (31)
  Deltoid tuberosity (32)
  Teres tuberosity (32')
  Crest of humerus (33)
  Brachialis groove (34)
Condyle of humerus (35)
  Lateral epicondyle (38)
  Lateral supracondylar crest (38')
  Medial epicondyle (39)
  Olecranon fossa (40)
  Radial fossa (41)

Radius

Head of radius (43)
  Circumferential facet (44)
Neck of radius (45)
  Radial tuberosity (46)
Body of radius (47)
Trochlea of radius (48)
  Medial styloid process (50)

Ulna

  Olecranon (51)
  Olecranon tuber (52)
  Anconeal process (53)
Trochlear [semilunar] notch (54)
Medial coronoid process (55)
Lateral coronoid process (56)
Radial notch (57)
Body of ulna (58)
Lateral styloid process (61)
Interosseus space (62)

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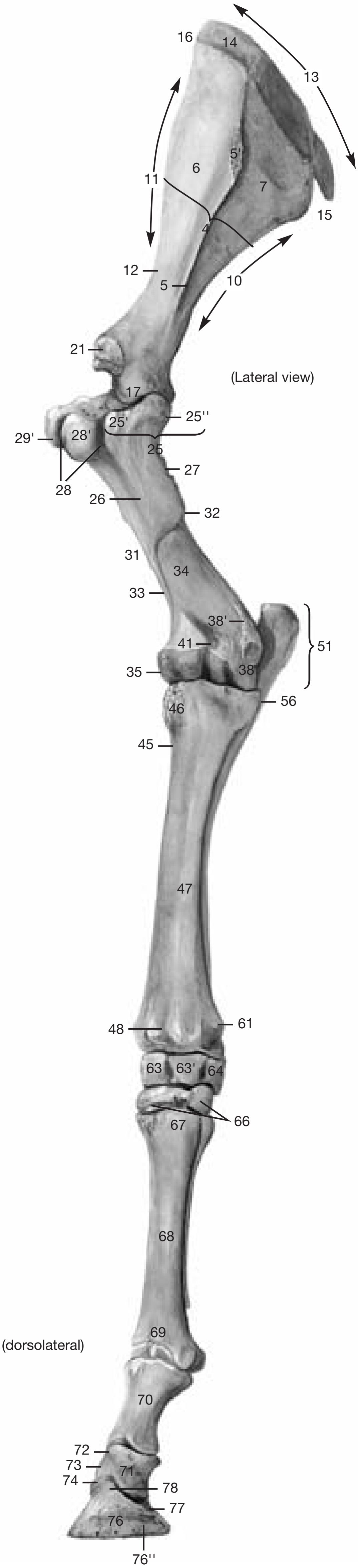
Radial carpal bone (63)
Intermediate carpal bone (63')
Ulnar carpal bone (64)
Accessory carpal bone (65)
First, second, third, fourth carpal bones (66)

Metacarpal bones II–IV

Base (67)
Body (68)
Head (69)

Digital bones

Proximal phalanx (70)
  Triangular rough area (70')
Middle phalanx (71)
  Base (72)
  Body (73)
  Caput (74)
  Flexor tuberosity (75)
Distal phalanx (76)
  Sole foramen (76')
  Parietal groove (76'')
  Palmar process (76''')
  Hoof cartilage (76'''')
  Articular suraface (77)
  Extensor process (78)
  Flexor tuberosity (79)
Proximal sesamoid bone (83)
  Distal (navicular) sesamoid bone (84)



The two Figures on the opposite page show the structures mentioned in the account below to best advantage. The following steps would reproduce the dissection upon which the two Figures were based:

Skin the limb to the hoof (note the chestnut, the homologue of the carpal pad, proximomedial to the carpus; the ergot, homologue of the metacarpal pad, caudal to the proximal phalanx is often hidden in long hair). Remove the **pectoral muscles** and the **subclavius** (innervated by the cranial and caudal pectoral nerves, respectively). Preserve the blood vessels throughout. Transect the **deltoideus** at the level of the shoulder joint. The tensor fasciae antebrachii and the lateral head of the triceps are transected at their middle. In midforearm, the flexor carpi radialis and flexor carpi ulnaris are transected.

In addition, transect the tendon of origin of the **biceps brachii** to expose the intertubercular bursa; the supf. and deep digital flexor tendons are lifted from the carpal canal after transection of the flexor retinaculum.

a) Shoulder and Arms

1 A) The roots of the **brachial plexus** (4) arise from the ventral branches of C6 through T2.

B) The **axillary nerve** (14) innervates the **teres major** (1), the caudal
2 segment of the **subscapularis** (3), and, on the lateral side, the **deltoideus** (6) and the relatively tendinous **teres minor** (13). The axillary nerve ends by furnishing the **cranial cutaneous antebrachial nerve** (26) which supplies the skin on the cranial aspect of the forearm. The **subscapular nerves** (3) innervate most of the subscapularis. The **suprascapular nerve** (9) crosses the cranial border of the scapula and ends in the **supra-** (5) and **infraspinatus** (10) muscles. The sharp scapular border and the absence of an acromion are thought to expose the nerve to mechanical trauma. The **thoracodorsal nerve** (2) passes caudally to innervate the **latissimus dorsi** (2). **Median** (8) and **musculocutaneous** (7) **nerves** join to form a loop (ansa axillaris) which supports the axillary artery as it passes into the limb. The musculocutaneous nerve, with its proximal and distal muscular branches, supplies the **coracobrachialis** (19) and **biceps** (25), and the **brachialis** (20), respectively. It ends as the **medial cutaneous antebrachial nerve** (30). The proximal musclar branch passes deep (lateral) to the coracobrachialis to reach the biceps. The
3 **radial nerve** (11) releases a branch to the **tensor fasciae antebrachii** (21) before changing over to the lateral aspect of the arm. Proximal muscular branches are given off to the **anconeus** (24) and the **long** (15), **medial** (17), and **lateral** (16) **heads** of the triceps that lacks an accessory head in the horse. The nerve then crosses the lateral supracondylar crest of the humerus and splits into **supf.** (27) and **deep** (18) **branches**.

b) Nerves an Muscles on the craniolateral Surface of the Forearm

The supf. branch of the radial nerve gives rise to the **lateral cutaneous antebrachial nerves** (29); none of these reach the carpus—the dorsum of metacarpus and digit is supplied by the median and ulnar nerves. The deep branch of the radial nerve goes to the craniolateral muscles of the forearm.

The carpal and digital extensors arise from the craniolateral aspect of the distal end of the humerus and from the nearby lateral collateral ligament of the elbow joint. The **common digital extensor**, in addition to its large **humeral head** (33), has a small **radial head** (34) known formerly as Phillip's muscle, whose thin tendon joints that of the lateral digital extensor to end on the proximal phalanx. (A tiny deeply placed ulnar head, formerly Thierness' muscle, is also present.) The tendon of the common digital extensor, before ending on the extensor process of the distal phalanx, attaches also on the middle phalanx and receives the extensor branches of the largely tendinous interosseus (see p. 13).

The **lateral digital extensor** (36) presents a bursa at its insertion on the proximolateral surface of the proximal phalanx.

The **extensor carpi radialis** (31) receives the lacertus fibrosus (see p. 13) and terminates on the proximodorsal tuberosity of the large metacarpal bone.

The **ulnaris lateralis** (38; m. extensor carpi ulnaris) ends on the accessory carpal bone, and with a second, longer tendon on the lateral splint bone. Only the long tendon has a tendon sheath.

The **extensor carpi obliquus** (42; m. abductor pollicis longus) ends on the proximal end of the medial splint bone; its tendon is protected by a synovial sheath and a subtendinous bursa.

c) Nerves and Muscles on the caudomedial Surface of the Forearm

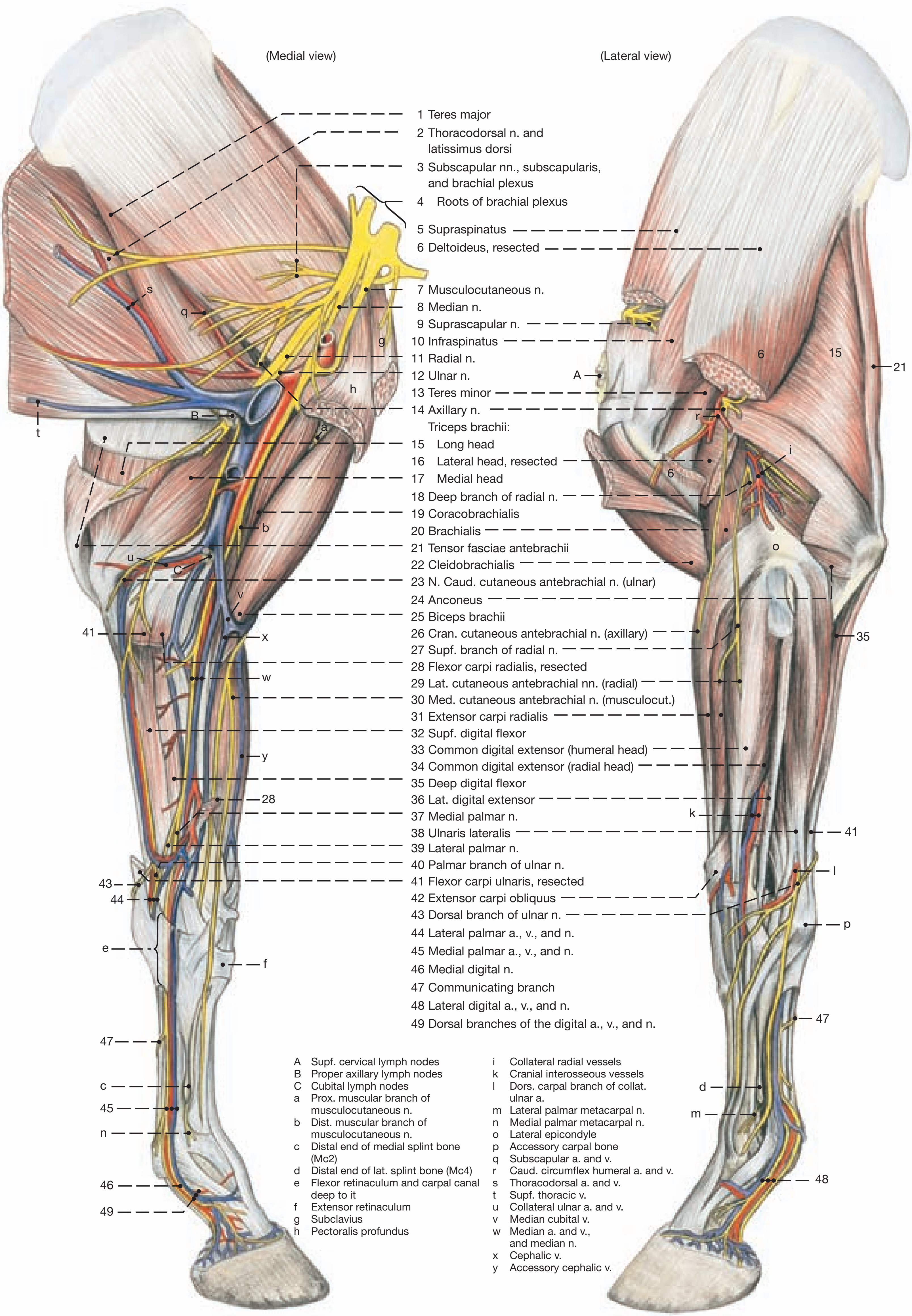
The median nerve accompanies the brachial artery and vein over the 4
elbow joint where it releases muscular branches to the **flexor carpi radialis** (28) and to the radial and humeral heads of the **deep digital flexor** (35; see p. 13). (The pronator teres of other species has become the long part of the medial collateral ligament of the elbow joint; the pronatur quadratus is absent.)

The median nerve ends in the distal half of the forearm by dividing into **medial** (37) and **lateral** (39) **palmar nerves**. The medial palmar nerve passes through the carpal canal along the medial border of the deep flexor tendon. The lateral palmar nerve crosses the musculotendinous junction of the supf. digital flexor, receives the palmar branch of the ulnar nerve, and follows the lateral border of the deep flexor tendon through the carpal canal. (The two nerves, after passing the carpal canal, may also be termed the common digital nerves II and III.)

The **ulnar nerve** (12) lies caudal to the brachial vessels and, in the 5
distal third of the arm, releases the **caudal cutaneous antebrachial nerve** (23). After crossing the elbow joint the ulnar nerve releases muscular branches to the **flexor carpi ulnaris** (41), the **supf. digital flexor** (32), and to the ulnar head (see p. 13) and the humeral head of the deep digital flexor. The nerve then passes distally in the caudal border of the forearm. A few cm proximal to the accessory carpal it divides into dorsal and palmar branches. The **dorsal branch** (43), palpable as it becomes subcutaneous at this location, passes around the lateral aspect of the carpus to innervate the skin on the dorsolateral surface of the cannon. The **palmar branch** (40) as already mentioned joins the lateral palmar nerve of the median in the carpal canal.

The bellies of the supf. and deep flexors form a partially fused muscle mass on the caudal surface of the radius. Their tendons distal to the carpus are described on p. 13.

Thoracic Limb



1 Teres major
2 Thoracodorsal n. and latissimus dorsi
3 Subscapular nn., subscapularis, and brachial plexus
4 Roots of brachial plexus
5 Supraspinatus
6 Deltoideus, resected
7 Musculocutaneous n.
8 Median n.
9 Suprascapular n.
10 Infraspinatus
11 Radial n.
12 Ulnar n.
13 Teres minor
14 Axillary n.
Triceps brachii:
15 Long head
16 Lateral head, resected
17 Medial head
18 Deep branch of radial n.
19 Coracobrachialis
20 Brachialis
21 Tensor fasciae antebrachii
22 Cleidobrachialis
23 N. Caud. cutaneous antebrachial n. (ulnar)
24 Anconeus
25 Biceps brachii
26 Cran. cutaneous antebrachial n. (axillary)
27 Supf. branch of radial n.
28 Flexor carpi radialis, resected
29 Lat. cutaneous antebrachial nn. (radial)
30 Med. cutaneous antebrachial n. (musculocut.)
31 Extensor carpi radialis
32 Supf. digital flexor
33 Common digital extensor (humeral head)
34 Common digital extensor (radial head)
35 Deep digital flexor
36 Lat. digital extensor
37 Medial palmar n.
38 Ulnaris lateralis
39 Lateral palmar n.
40 Palmar branch of ulnar n.
41 Flexor carpi ulnaris, resected
42 Extensor carpi obliquus
43 Dorsal branch of ulnar n.
44 Lateral palmar a., v., and n.
45 Medial palmar a., v., and n.
46 Medial digital n.
47 Communicating branch
48 Lateral digital a., v., and n.
49 Dorsal branches of the digital a., v., and n.

A Supf. cervical lymph nodes
B Proper axillary lymph nodes
C Cubital lymph nodes
a Prox. muscular branch of musculocutaneous n.
b Dist. muscular branch of musculocutaneous n.
c Distal end of medial splint bone (Mc2)
d Distal end of lat. splint bone (Mc4)
e Flexor retinaculum and carpal canal deep to it
f Extensor retinaculum
g Subclavius
h Pectoralis profundus
i Collateral radial vessels
k Cranial interosseous vessels
l Dors. carpal branch of collat. ulnar a.
m Lateral palmar metacarpal n.
n Medial palmar metacarpal n.
o Lateral epicondyle
p Accessory carpal bone
q Subscapular a. and v.
r Caud. circumflex humeral a. and v.
s Thoracodorsal a. and v.
t Supf. thoracic v.
u Collateral ulnar a. and v.
v Median cubital v.
w Median a. and v., and median n.
x Cephalic v.
y Accessory cephalic v.

3. Cutaneous Innervation, Blood Vessels, and Lymphatic Structures of the Thoracic Limb

a) Cutaneous Innervation

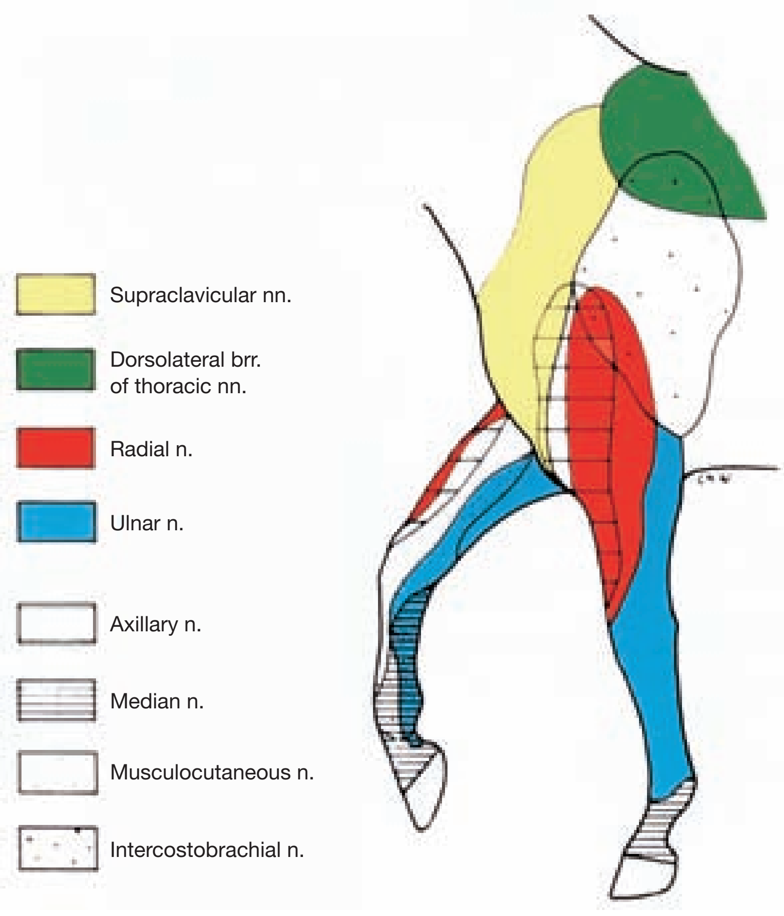
The skin of the forelimb is innervated in the region of the scapular cartilage by the dorsal branches of the thoracic nerves. The small area over the cranial border of the scapula is supplied by the ventral branch of the 6th cervical nerve (n. supraclavicularis). The large region over scapula and triceps receives its innervation from the **intercostobrachial nerve** (**1;** from brachial plexus and the ventral branches of T2 and T3) which carries also motor fibers for the m. cutaneus omobrachialis.

The cranial region of distal arm and forearm receives skin sensation from the **cranial cutaneous antebrachial nerve** (**axillary; 24**). The lateral skin region of distal arm and forearm is supplied by the **lat-**
1 **eral cutaneous antebrachial nerve** (**radial; 27**). The **caudal cutaneous antebrachial nerve** (**ulnar; 9**) innervates the **caudal**, and the **medial cutaneous antebrachial nerve** (**musculocutaneous; 29**) the medial surface of the forearm.

Carpus and metacarpus receive skin innervation from the **medial cutaneous antebrachial nerve** (**29**) for the dorsomedial surface, from the **dorsal branch of the ulnar nerve** (**14**) for the dorsolateral surface, and from the **medial** (**16**) and **lateral** (**15**) **palmar nerves** for the palmar surface.

The medial surface of the digit is innervated by the **medial digital nerve** (**median n.; 17**), while the lateral surface receives a mixed innervation (median and ulnar nn.) from the **lateral digital nerve** (see pp. 7 and 11).

Cutaneous Nerves of the Thoracic Limb (craniolateral view)



b) Blood Vessels

The **subclavian artery** (**19**), before becoming the **axillary artery** (**20**), gives off the supf. cervical artery. The deltoid branch of the lat-
2 ter accompanies the **cephalic vein** (**23**) through the groove between brachiocephalicus and pectoralis descendens. (The cephalic vein arises from the external jugular vein.) The axillary vessels (a. and v.) give rise, either directly or indirectly, to the **external thoracic vessels** (**21**) to the pectoral muscles, the **suprascapular vessels** (**18**) to the lateral scapular muscles, the **subscapular vessels** (**2**) to the caudal border of the like-named muscle, the **thoracodorsal vessels** (**4**) to the latissimus dorsi, and the **caudal circumflex humeral vessels** (**3**) which anastomose with the cranial circumflex humeral vessels, the last branches of the axillary vessels before the stem artery becomes the brachial artery. (The thoracodorsal and caudal circumflex humeral arteries are branches of the large subscapular artery and therefore indirect branches of the axillary.) The **cranial circumflex humeral artery** (**22**) accompanies the proximal muscular branch of the musculocutaneous nerve deep to the coracobrachialis to the biceps, while the often double satellite vein can cross the coracobrachialis on either surface. The **supf. thoracic** (**spur**) **vein** (**5**) arises from the initial segment of the thoracodorsal vein, passes caudally, and drains the ventral part of the trunk.

The **brachial vessels** (**7**) in midarm give off the **deep brachial vessels** (**6**) to the triceps, and more distally the **bicipital vessels** (**25**) to the biceps. The **transverse cubital vessels** (**26**), the next branches, pass deep to the biceps. From the caudal surface of the brachial vessels arise the **collateral ulnar vessels** (**8**) which follow the ulnar nerve. The last branches are the **common interosseous vessels** (**28**) which pass to and through the interosseous space. They often are continued by the cranial interosseous vessels.

At the level of the elbow, the brachial vein gives off the **median cubital vein** (**10**) which provides an anastomosis to the cephalic vein. After leaving the groove between brachiocephalicus and pectoralis descendens, the **cephalic vein** (**23**) descends on the medial surface of the forearm. Already at the elbow joint it releases the **accessory cephalic vein** (**30**) which parallels the cephalic vein, but inclines more cranially to end on the dorsal surface of the carpus.

The **median artery and vein** (**11**) continue the brachial vessels in the forearm in close mediocaudal proximity to the radius. The vein is often double. The median vessels give off one or two **deep antebrachial vessels** (**12**) which supply the caudomedial antebrachial musculature. Proximal to the carpus they give rise to the proximal radial artery and the **radial vessels** (**31**). The radial vein receives the cephalic vein and as the **medial palmar vein** (**16**) passes subfascially over the mediopalmar aspect of the carpus. The **palmar branch** (**13**) of the median vein receives the collateral ulnar vein and as the **lateral palmar vein** (**15**) continues over the lateropalmar surface of the carpus.

The median artery after giving off its palmar branch passes through the carpal canal. After that it is joined by a branch from the radial
artery, and as the **medial palmar artery** (**16**) (the largest artery in 3
this area) passes toward the digit.

The small **lateral palmar artery** (**15**) originates from the union of the palmar branch of the median artery with the collateral ulnar artery proximal to the carpus.

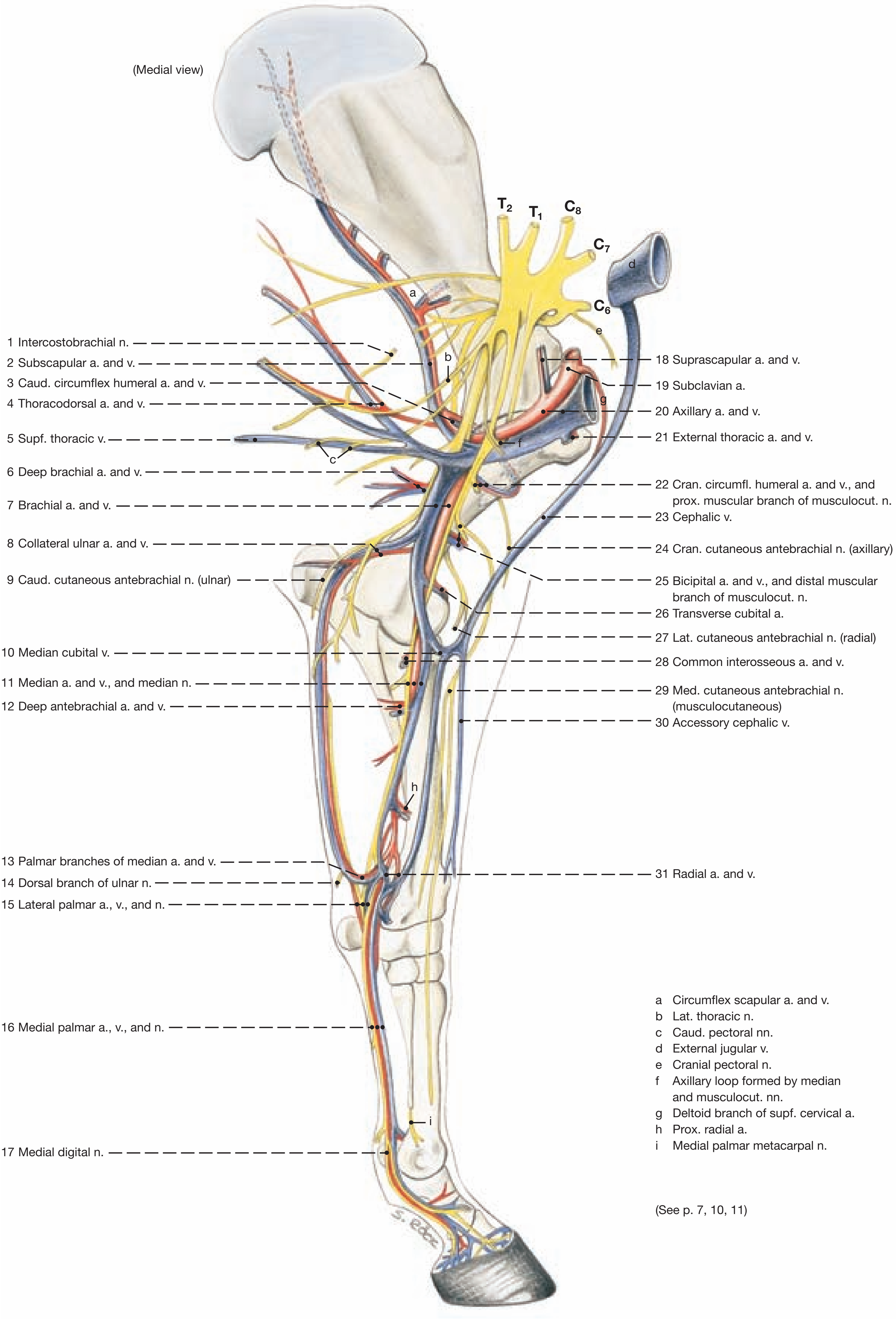
The median and lateral palmar metacarpal arteries descend on the axial surface of the splint bones. They arise distal to the carpus from the deep palmar arch that is formed by branches of the median and radial arteries.

c) Lymphatic Structures

Lymph from the hoof is collected in several vessels that become dissectable proximal to the coronet. At first evenly spaced around the digit, they converge on each side to form one to three vessels. Those on the lateral side change over to the medial side a few cm proximal to the proximal sesamoid bones. They do so either deeply between the interosseus and the deep flexor tendon or subcutaneously. The lymphatics then accompany the medial palmar vessels and nerve and ascend (predominantly through the carpal canal) to the medial aspect of the forearm and thence to the **cubital lymph nodes** (see p. 7.C) that lie just proximal to the elbow joint. From here the lymph passes to the **axillary nodes** (see p. 7.B) on the distal end of the teres major.

From the axillary nodes the lymph passes via the caudal deep cervical nodes to the veins at the thoracic inlet. Lymph, especially from the proximal and lateral areas of the forelimb, is channeled to the **supf. cervical nodes** (see p. 7.A), not to the axillary ones.

Arteries, Veins and Nerves of the Thoracic Limb



a Circumflex scapular a. and v.
b Lat. thoracic n.
c Caud. pectoral nn.
d External jugular v.
e Cranial pectoral n.
f Axillary loop formed by median and musculocut. nn.
g Deltoid branch of supf. cervical a.
h Prox. radial a.
i Medial palmar metacarpal n.

(See p. 7, 10, 11)

 Clinical and Functional Anatomy p. 119–122

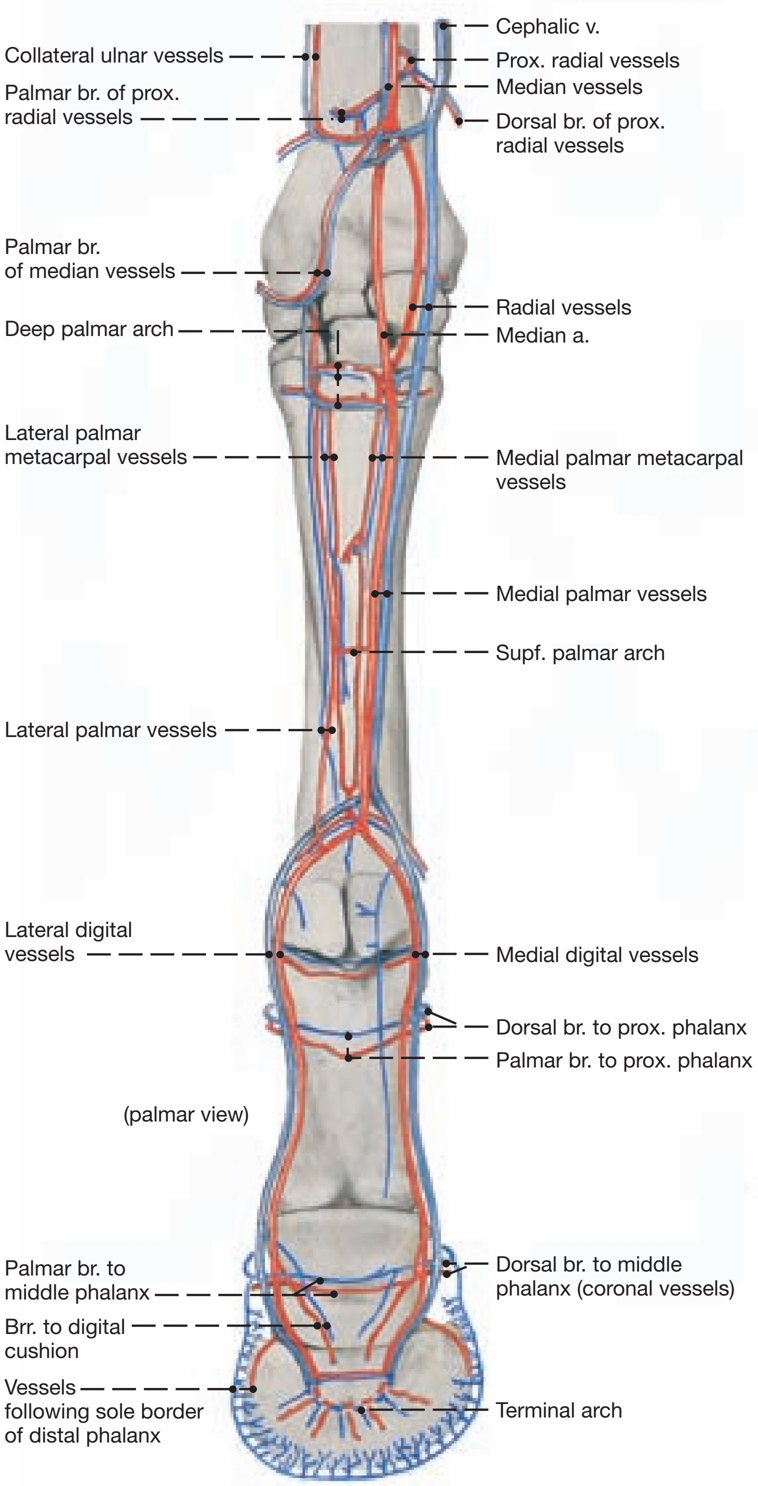
1 a) Just distal to the carpus the **Medial Palmar Artery, Vein and Nerve** (2) lie next to each other in this dorsopalmar sequence (VAN). Artery and nerve have just passed through the carpal canal; the vein crossed the carpus supf. to the flexor retinaculum. In the metacarpus, the three structures, retaining this sequence, lie medial to the interosseus and deep flexor tendon. (There are no corresponding dorsal vessels and nerves.)

At the fetlock joint the medial palmar vessels and nerve become the **medial digital vessels and nerve** (7). These release several **dorsal branches** (9) that serve the dorsal surface of the digit. Opposite the pastern joint they give off a branch to the **digital cushion** (10).

The **lateral palmar artery, vein, and nerve** (3) pass the carpus near the tip of the accessory carpal. They are markedly thinner than their medial counterparts, especially the artery. Vein and nerve lie next to each other, and deep to them lies the small artery. They are suc-
2 ceeded at the fetlock by the **lateral digital vessels and nerve** (8). There are no real differences in distribution from the same structures on the medial side. The prominent **communicating branch** (4) connecting the medial and lateral palmar nerves must be taken into account when nerve blocks are performed.

For the deeper-lying palmar metacarpal nerves we need to return to the carpal level. Here the median nerve (g) splits into medial and lateral palmar nerves (c and b; or 2 and 3 that were followed into the digit just now).The ulnar nerve (a) also splits: its **dorsal branch** (1) supplies the skin over the dorsolateral aspect of carpus and metacarpus, while its **palmar branch** (**d**) joins the lateral palmar nerve. Soon after receiving the branch of the ulnar, the lateral palmar nerve gives off a deep branch that innervates the interosseus and is continued by the **medial and lateral palmar metacarpal nerves (5; 6).** These are deeply placed and run along the axial surfaces of the two splint bones where they are accompanied by equally thin arteries.

Arteries and Veins of the Left Distal Forelimb



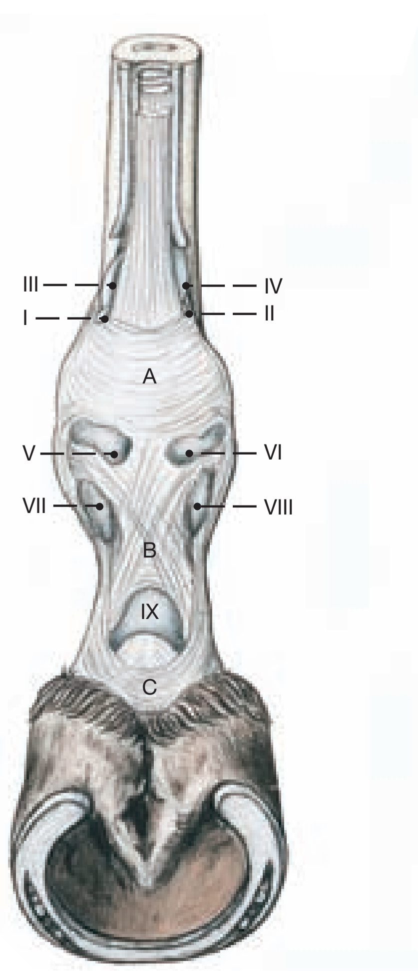
b) The **Deep Fascia** on the dorsal surface of the carpus forms the **extensor retinaculum** (see p. 7.f) that guides the extensor tendons
ober the joint. On the palmar surface it furnishes the **flexor retinaculum** (see p. 7.e) that extends from carpal bones on the medial side 3
to the accessory carpal forming the carpal canal with these bones. At the level of the fetlock joint the deep fascia is again thickened to
form the **annular ligament of the fetlock joint** (**A** in Figure below) 4
that is most prominent at the palmar aspect where it connects the abaxial borders of the proximal sesamoid bones and holds the flexor tendons in place. Distal to this the deep fascia forms the **proximal digital annular ligament** (**B**). This resembles the letter X and holds the flexor tendons against the ligaments on the palmar surface of the proximal phalanx. Its four corners insert on the medial and lateral borders of the bone, the distal two attachments being weaker than the proximal, as the ligament here blends also with the two branches of the supf. flexor tendon. The **distal digital annular ligament** (**C**) arises from the medial and lateral borders of the proximal phalanx and descends to the distal phalanx between the deep flexor tendon and the digital cushion. It is crossed medially and laterally by the ligament of the ergot (not shown), subcutaneously, connects the ergot with the hoof cartilage.

The **digital synovial sheath** surrounds the flexor tendons and facilitates their movements against each other and over the three bearing surfaces on the palmar surface of the digit.

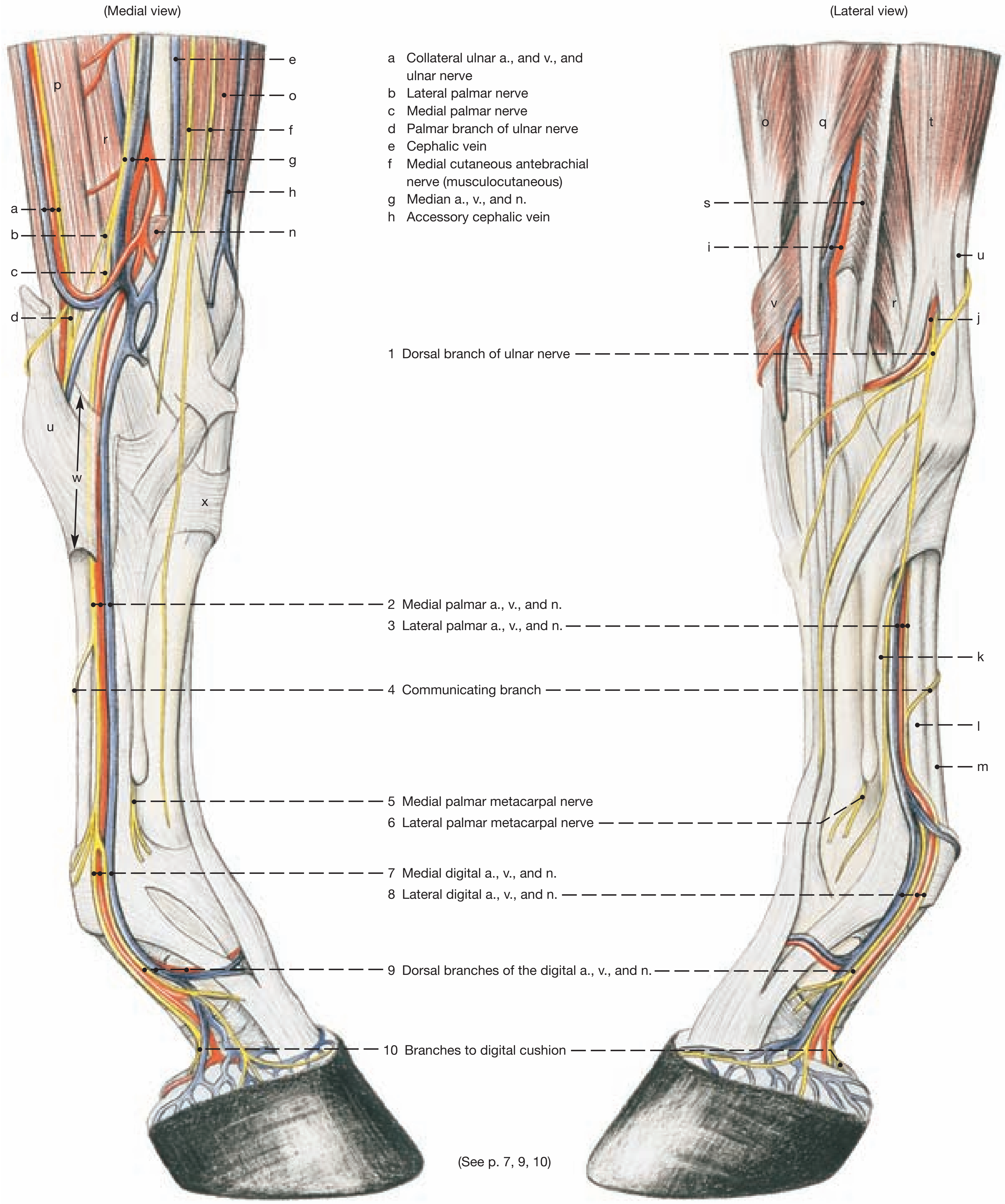
Inflammation may cause the sheath to swell and to pouch out in any of the nine places where it is not bound down by the annular ligaments just described: Four pouches occur proximal to the annular ligament of the fetlock joint; two (I and II) medial and lateral to the supf. flexor tendon and two (III and IV) medial and lateral to the interosseus. The remaining more dicrete single pouches are as shown in the next figure below.

Palmar View of Fetlock and Digit

(For explanation see text above.)



Arteries, Veins, and Nerves of the Distal Forelimb



(See p. 7, 9, 10)

i Cranial interosseous a. and v.
j Dorsal carpal branch of coll. ulnar artery
k Interosseus
l Deep digital flexor tendon
m Supf. digital flexor tendon
n Flexor carpi radialis, resected
o Extensor carpi radialis
p Supf. digital flexor
q Common digital extensor (humeral head)
r Deep digital flexor
s Lat. digital extensor
t Ulnaris lateralis
u Flexor carpi ulnaris, resected
v Extensor carpi obliquus
w Flexor retinaculum and carpal canal deep to it
x Extensor retinaculum

5 The passive Stay-Apparatus of the Thoracic Limb

Clinical and Functional Anatomy p. 112–113; 122–125

The structures making up the **PASSIVE STAY-APPARATUS** are shown on the opposite page schematically and on two dissections. The latter show the actual structures to best advantage and were made by the following steps. The limb is skinned to the hoof, and the pectoral muscles, subclavius, and rests of the trapezius and brachiocephalicus are removed. Blood vessels and nerves can be discarded (and removed) throughout. The extensor carpi radialis is resected at the level of the elbow, preserving the lacertus fibrosus as shown. Then the brachialis is resected. At the level of the fetlock and digit, the palmar annular ligament and the prox. digital annular ligament are transected axially, and the sleeve formed by the supf. digital flexor around the deep digital flexor tendon is opened by a similar but deeper cut. The deep flexor tendon is transected in midmetacarpus and liftet out of the sleeve so it can be reflected distally.

The **PASSIVE STAY-APPARATUS** of both fore- and hindlimbs enables the horse to be on its feet for long periods with a minimum of muscular effort. Older subjects actually doze (perhaps sleep) while standing, although for a refreshing sleep horses lie down, usually at night when they are unobserved. By being on its feet most of the time, the horse, a rather nervous and excitable animal that uses flight as its principal means of defense, appears to be in perpetual readiness to run away from danger.

The four limbs that carry the body of a quadruped are angulated bony columns that would collapse were they not prevented from doing so by the activity of the intrinsic limb muscles. Active muscles soon tire and become painful, which signals the animal to lie down. The effort of the intrinsic limb muscles of horses is greatly reduced by the non-tiring tendons and ligaments of the stay-apparatus, which stabilizes the joints in a position suitable for the support of the body. In most joints stabilization means preventing them from flexing. Pastern and fetlock joints in the standing horse, however, are extended and overextended, respectively; their stabilization requires them not to overextend further so as to prevent the fetlock from sinking to the ground.

1. The fleshy attachment (**synsarcosis**) of the forelimb to the trunk is not part of the stay-apparatus, though the serratus ventralis that serves as the principal **weight-bearing** connection is heavily interlaced with non-tiring tendinous tissue.

2. Though no collateral ligaments are present, the movements in
1 the **shoulder joint** are restricted largely to flexion and extension in the sagittal plane by the subscapularis medially and the infraspinatus and (to a lesser degree) the supraspinatus laterally.

The principal stabilizer of the shoulder joint in the standing horse is the biceps tendon pressing against the cranial (extensor) surface of the joint. The way the tendon caps the intermediate tubercle of the intertubercular groove suggests a partial locking of the joint. The shoulder joint is further prevented from collapsing (flexing) by the internal tendon of the biceps that anchors the muscle to the most proximal part of the radius and, via the lacertus fibrosus and extensor carpi radialis, to a similar point on the large metacarpal bone. Thus the weight of the trunk acting on the proximal end of the scapula, tenses the biceps-lacertus-extensor carpi “rigging” just mentioned. This causes a cranial “pull” on the elbow joint (i. e., an extension of the joint) and “pressure” on the extensor surface of the carpal joint that tends to prevent flexion in that joint.

3. The **elbow joint** is stabilized (i. e., prevented from flexing) principally by tension in a group of carpal and digital flexors that arise on the medial and lateral epicondyles of the humerus and contain much fibrous tissue. Eccentrically placed collateral ligaments inhibit flexion to a lesser degree. The principal extensor of the joint, the triceps, seems inactive by its flabbiness in the quietly standing horse, although some workers believe that its tonus alone would prevent collapse of this key joint. The “pull” on the flexor surface by the biceps insertion that would tend to keep the joint extended has already been mentioned.

4. The **carpal joint** is stabilized (prevented from flexing) by the (dorsal) “pressure” of the extensor carpi radialis tendon already alluded to. The flexor carpi ulnaris and ulnaris lateralis ending on the accessory carpal and being tensed by the weight of the trunk via scapula, fixed shoulder joint, and humerus, “pulls” on the flexor surface of the carpal joint in an attempt to keep the joint extended. The accessory ligaments of the supf. and deep digital flexors attaching on the palmar surface of radius and large metacarpal bone above and below the carpus tend to supply a similar “pull”, again by the weight of the animal, but in the opposite direction—distally. Some workers ascribe a similar potential to the interosseus.

5. The **fetlock joint** needs to be stabilized by being prevented from 2
further overextending, i. e., sinking toward the ground. This is accomplished by three elements: the suspensory apparatus associated with the interosseus, and the supf. and deep digital flexor tendons. These attach to the palmar surface of the limb skeleton proximal and distal to the joint and are tensed when the weight of the horse overextends the joint. Their elastic properties “carry” the joint in a yielding, anticoncussive manner that is best observed in slow-motion films of a horse at speed.

The **suspensory apparatus** consists again of three parts: interosseus, 3
proximal sesamoid bones, and sesamoidean ligaments. The interosseus arises from the carpus and proximal end of the large metacarpal bone and ends on the two sesamoid bones. (Before doing so it sends extensor branches around the proximal phalanx to the common extensor tendon.) The proximal sesamoid bones articulate with the distal end of the large metacarpal bone to reduce friction between the suspensory apparatus and the palmar surface of the fetlock joint. Collateral ligaments tie the sesamoid bones to the cannon bone and proximal phalanx, while a thick palmar ligament unites the sesamoid bones and forms a smooth bearing surface
for the digital flexor tendons. The tension in the interosseus is con- 4
tinued distal to the joint by four sesamoidean ligaments (short, cruciate, oblique, and straight) of which the first three end on the proximal, and the last on the middle phalanx.

The **supf. digital flexor tendon** assists the suspensory apparatus by 5
providing a tendinous support extending (via its accessory [check] ligament) from the radius above the fetlock joint to the proximal and middle phalanges below the joint.

The **deep flexor tendon** and its accessory (check) ligament provide 6
added and similar support; the accessory ligament arises with the interosseus from the caudal aspect of carpus, the tendon itself ends on the distal phalanx.

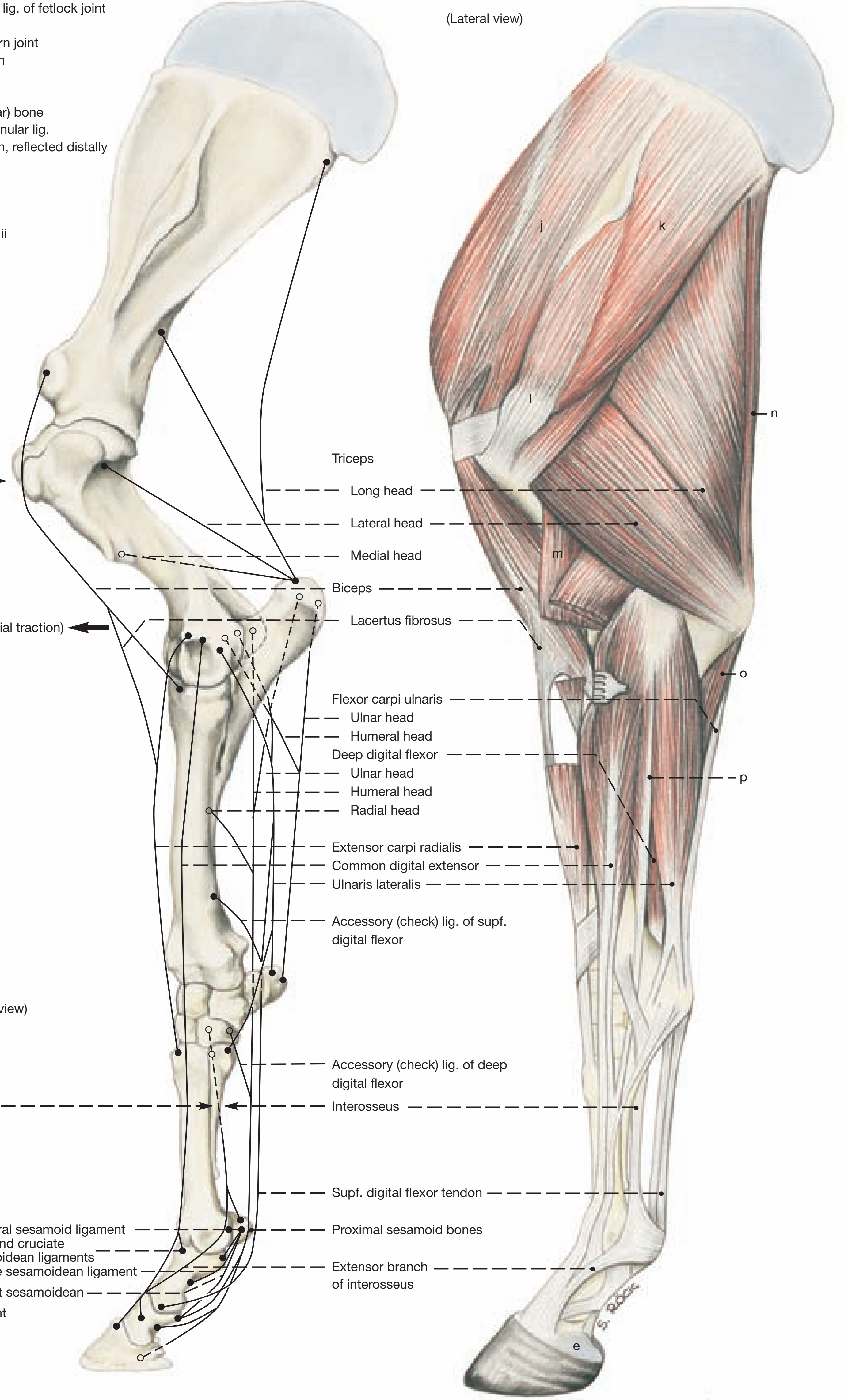
6. The **pastern joint** is prevented from overextension by four pastern ligament that connect the two bones that form the joint on the palmar surface. The straight sesamoidean ligament of the suspensory apparatus and the supf. and deep flexor tendons give additional support.

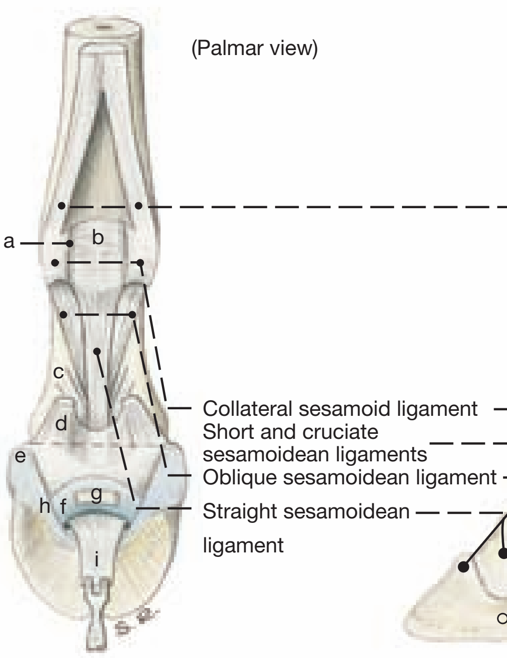
The proximopalmar border of the middle phalanx carries a complementary fibrocartilage into which the supf. flexor tendon and the ligaments reaching the bone from above insert. The cartilage and part of the bone form the second bearing surface over which the deep flexor tendon changes direction.

7. The **coffin joint** actually flexes when the fetlock sinks under 7
weight and can be disregarded in the consideration of the stay-apparatus. On its palmar surface lies the distal (navicular) sesamoid bone suspended by proximal (collateral) and distal ligaments. It provides the third bearing surface for the deep flexor tendon which here is protected from wear by the navicular bursa.

Musculature of the Thoracic Limb

a Stump of palmar annular lig. of fetlock joint
b Palmar ligament
c Axial palmar lig. of pastern joint
d Supf. digital flexor tendon
e Hoof cartilage
f Navicular bursa
g Distal sesamoid (navicular) bone
h Stump of distal digital annular lig.
i Deep digital flexor tendon, reflected distally
j Supraspinatus
k Deltoideus, resected
l Infraspinatus
m Brachialis
h Tensor fasciae antebrachii
o Deep digital flexor
p Lat. digital extensor





6. Synovial Structures of the Thoracic Limb

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1 a) **Joints of the Thoracic Limb**

Name/Fig.	Bones involved	Type of joint	Function	Remarks
2 **I. Shoulder Joint / 1–3**	Glenoid cavity of scapula and head of humerus	Simple spheroidal joint	Restricted to flexion and extension by tendinous components of subscapularis and supra- and infraspinatus muscles	Site of injection Cranial border of palpable infraspinatus tendon, 2 cm proximal to greater tubercle, to a depth of about 5 cm
3 **II. Elbow Joint / 4–6**		Composite joint		
a) Humeroulnar articulation	a) Condyle of humerus and ulna	a) Simple hinge joint	a–b) Flexion and extension	Initial flexion of the joint is impeded by eccentrically placed collateral ligaments. The long part of the medial collateral ligament corresponds to the pronator teres of other animals
b) Humeroulnar articulation	b) Condyle of humerus and head of radius	b) Simple hinge joint		
c) Proximal radioulnar articulation	c) Articular circumference of radius and radial notch of ulna	c) Simple pivot joint	c) No movement	
III. Distal radioulnar joint (absent)				
Carpal and Digital Joints				
4 **IV. Carpal joint / 7, 8**		Composite joint (in the wider sense)		
a) Radiocarpal joint	Trochlea of radius and carpal bones	Composite condylar joint	a) Flexion and extension up to 90°	a) Site of injection: Between lateral digital extensor and ulnaris lateralis into the proximal pouch when the carpus is flexed
b) Midcarpal joint	Proximal and distal rows of carpal bones	Composite condylar joint	b) Flexion and extension up to 45°	
c) Carpometacarpal joint	Carpal bones II–IV and metacarpal bones II–IV	Composite plane joint	c) Little movement	a–d) The fibrous layer of the joint capsule is common to all articulations in the carpus. The synovial layer is divided to enclose the three individual articulations separately. The midcarpal capsule communicates with that of the carpometacarpal articulation.
d) Intercarpal joints	Carpal bones of the same row	Composite plane joint	d) Little movement	
5 **V. Fetlock (metacarpophalangeal) joint / 9, 10**	Metacarpal 3, prox. phalanx, and prox. sesamoid bones	Composite hinge joint	Flexion and extension	Site of injection: Into the prox. palmar pouch between large metacarpal bone and interosseus
6 **VI. Pastern (prox. interphalangeal) joint / 9, 10**	Proximal and middle phalanx	Simple saddle joint	Flexion and extension, also slight side-to-side and rotational movements	Site of injection: Into the prox. dorsal pouch under the lateral border of the common extensor tendon
7 **VII. Coffin (dist. interphalangeal) joint / 10**	Middle phalanx, distal phalanx, with hoof cartilage, and navicular bone	Composite saddle joint	Flexion and extension, also slight side-to-side and rotational movements	Site of injection: Into the prox. dorsal pouch under the lateral border of the common extensor tendon

The three **digital joints** are the fetlock, pastern, and coffin joints. The proximal sesamoid bones and their ligaments are part of the fetlock joint, and the navicular bone and its ligaments are part of the coffin joint (page 12 and 13, and the Figure on page 4, respectively). The sesamoids receive part of the body weight when the limb is bearing weight. The capsules of the three digital joints present dorsal and palmar pouches which extend proximally; some of them are the sites for puncturing the joints.

b) **Important Synovial Bursae**

The **infraspinatus bursa** (1) lies between the tendon of the infraspinatus and the caudal part of the greater tubercle of the humerus.

8 The **intertubercular bursa** (4) underlies the biceps tendon between the greater and lesser tubercles of the humerus. It corresponds to the recess (of the shoulder joint capsule) that surrounds the biceps tendon in most other domestic mammals. Its inflammation can produce shoulder lameness.

9 The **subcutaneous olecranon bursa** (4) over the olecranon tuber is inconstant. Its hygromatous enlargement is known as capped elbow.

10 A **subcutaneous (precarpal) bursa** (7) on the dorsal surface of the carpus can develop after repeated injury in small box or trailer stalls.

The subtendinous bursa of the common and lateral digital extensors (9) lies between the cannon bone and the tendons of these muscles.

The **navicular bursa** (10) provides frictionless movement of the deep 11
flexor tendon over the navicular bone.

c) **Tendon Sheaths**

Synovial tendon sheaths are thin walled, but double-layered, fluid-filled tubes surrounding stretches of tendons; they protect the tendons where they are exposed to wear. Synovial sheaths surround the
tendons passing over the carpus (7), except for the short tendon of 12
the ulnaris lateralis and that of the flexor carpi ulnaris. One of these
is known as the **carpal sheath** (8); it serves both supf. and deep flex- 13
or tendons as they pass the carpus in the carpal canal. A similar sheath for both these tendons is the digital sheath which extends from above the fetlock joint to the middle of the middle phalanx. In both sheaths, the deep flexor tendon is wholly, but the supf. flexor is only partly surrounded. Only at the proximal extremity of the digital sheath is the supf. flexor tendon nearly completely enclosed.
Except for the nine outpouchings illustrated on page 10, the palmar 14
surface of the digital sheath is covered by the annular ligament of the fetlock joint and by the proximal and distal digital annular ligaments.