Bovine Anatomy
An Illustrated Text
First Edition

Scientific Illustration
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BOVINE ANATOMY

An Illustrated Text
COLLABORATION ON THE ATLAS OF BOVINE ANATOMY

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NOTES ON THIS ATLAS

*Bovine Anatomy, a translation and revision of Atlas der Anatomie des Rindes, is volume III of a series of atlas-textbooks on the topographic anatomy of domestic mammals for veterinary students and practitioners. Volume I, Atlas of the Anatomy of the Dog, in addition to specific canine anatomy, provides the fundamental concepts of general anatomy required for the study of all mammals. The dog is small and inexpensive enough that a specimen can be allotted to each dissection team, with advantages in ease of dissection, review, and preservation. Volume II, Atlas of the Anatomy of the Horse, is an introduction to the many specialized systems of a large herbivore, with an extensive chapter on equine functional and clinical anatomy.

In all three volumes the illustrations were drawn from dissections especially made for that purpose. The boxed information at the top of some text pages is intended to be a dissection guide for students and to give information on the methods used to make the preparations illustrated. Species characteristics of the ox, in contrast to the dog and horse, are printed in italics. Important terms are printed in bold-face type, and when a number is attached to the name, it corresponds to a number in the adjacent illustration. Less important anatomical features are not mentioned in the text, but are listed in the legends of the illustrations. The descriptions are based on normal anatomy. Individual variations are mentioned only when they have clinical importance. The gaps in the numbering of items in the legends of the skeletal system (pp. 3, 15, 31, 33) are caused by omission of features that do not occur in the ox, therefore are not illustrated, but were listed in the German edition for comparison with the dog and horse. The remarks on examination of lymph nodes in meat inspection (pp. 113–118) are translations of German rules and do not necessarily reflect current practice in the United States. The word ox is used in this book to mean “a domestic bovine mammal (Bos taurus),”* Ox is the singular of the collective term, cattle, and is the accepted English translation of Ger. Rind. The other meaning: “an adult castrated male domestic ox”** can be understood from the context, as in “a span of oxen.” The abbreviations used are those of the Nomina Anatomica Veterinaria. Additional abbreviations are explained in the text, the headings, the legends, and in the SPECIAL ANATOMY, TABULAR PART (pp. 98–125). They are listed here for convenience:

The cranial nerves are indicated by Roman numerals I–XII. Vertebral and spinal nerves are indicated by Arabic numerals.

<table>
<thead>
<tr>
<th>Spinal Nerves</th>
<th>Vertebræ and Spinal Nerves</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>C — Cervical (e.g. C1—first cervical vertebra or nerve)</td>
</tr>
<tr>
<td>nd</td>
<td>Cd — Caudal (Coccygeal)</td>
</tr>
<tr>
<td>ndl</td>
<td>L — Lumbar</td>
</tr>
<tr>
<td>ndm</td>
<td>S — Sacral</td>
</tr>
<tr>
<td>nv</td>
<td>T — Thoracic</td>
</tr>
<tr>
<td>nvl</td>
<td>cut. br. — Cutaneous br.</td>
</tr>
<tr>
<td>nvm</td>
<td>— Medial br. of ventral br.</td>
</tr>
</tbody>
</table>

PREFACE TO THE FIRST ENGLISH EDITION

This combination of topographic color atlas and concise textbook of *Bovine Anatomy* is the third volume of a series on the anatomy of domestic mammals. The first edition of the Atlas and Textbook of the Anatomy of the Dog appeared 20 years ago. It was followed 12 years ago by the second volume, the Anatomy of the Horse. In several German and foreign language editions they aroused world-wide interest. Therefore our next project was an Atlas and Textbook of Bovine Anatomy following the proven model and thereby closing a previously existing gap: no comparable work on bovine anatomy was available. The special features of the ox are presented to students in a well-grounded survey of topographic anatomy. Special anatomy is summarized as brief data in tables of muscles, lymph nodes, and nerves, with references to the corresponding pages in the text. Comparative anatomy is addressed through references to the horse and dog. In addition the text-atlas is intended to provide a valuable introduction to the Anatomy of the Living Animal. The authors were concerned with the preparation of a clear and graphic reference book of important anatomical facts for veterinarians in practice and research as well as anyone interested in morphology. This book can also serve as a dictionary of English anatomical nomenclature illustrated in color. An appendix on Applied Anatomy, included in the first and second volumes of the series, was omitted from this edition. Because of its extraordinary relevance for the practical instruction of students it will be provided in the next edition.

Our work on the ox has an unexpected urgency for three reasons: 1. Specialized textbooks for each individual species are required for curriculum revision with the trend to premature specialization and the accompanying formation of species-specific clinics. 2. In the present time of economic and social change, new diseases like bovine spongiform encephalopathy (BSE) attain enormous importance through their catastrophic effects. To determine the neuronal pathways of infection, including the autonomic nervous system, and the lymphatic system, and to judge the risk of noxious substances in the nervous system and in many organs of the body cavities, a graphic survey of bovine anatomy is necessary. 3. A licensed veterinarian is legally qualified to serve in a wide variety of positions: in private practice with small mammals, birds, horses, ruminants, and swine; in public health work to prevent transmission of diseases of animals to man; in governmental control of diseases of livestock; and in teaching and research with many species of experimental animals. To maintain public confidence in the profession, students should be required to master the basic as well as clinical sciences for food animals. This places high demands on teachers and students because a very broad and important body of information must be transmitted even though our teaching time has undergone an ill-advised reduction. Nevertheless, we are forced to accept the challenge, even with our compressed text-atlas, to reach the intended goal – to cover a huge amount of subject matter in the short time available.

This English edition is the responsibility of Professor Habel. His translation and scientific engagement in the production of this atlas and the writing and revision of many chapters are his personal service. His collaboration in the community of authors is a great enrichment.

Our thanks are due also to Prof. Dr. Dr. h.c. Simoens (Ghent) for his contributions of text and illustrations on the eye of the ox, to Prof. Dr. Dr. h.c. König (Vienna) for his article on the mammary glands, and to Prof. Dr. Dr. h.c. mult. Liebisch (Munich) for his collaboration on the article, “Female genital organs.” Coauthors Dr. Wünsche, Dr. Buda, PD Dr. Bragulla, and Dr. Mülling also had their part in the completion of the book. We had additional professional support from Professors Dr. Berg (St. Kitts, West Indies), Dr. Böhme (Berlin) and Dr. Hashimoto (Sapporo). The many suggestions and the completion of many separate tasks on this atlas by the scientific, student, and technical coworkers of our Berlin Institute (see the list of coworkers) were a great help.

Finally, without the prodigious effort of our excellent artists, Renate Richter, Gisela Jahrmärker, and Diemut Starke, the Atlas in its present form would be inconceivable. Mrs. Poersch deserves thankful recognition for her careful computer composition, and the coworkers Mrs. Claudia Nöller and Mr. Thilo Voges for the preparation of subjects to be illustrated, together with computer processing, and for making the Index. Our thanks are also due to the Schlütersche Verlag, Publisher and Printer, Hannover, and especially to Dr. Oslage for always providing support and understanding cooperation in the development of this book.

The provisional completion of our common effort offers the originator and editor, after 30 years of persistent work, the opportunity for a brief reflection. The enormous expense for the production of a book, together with the revision and improvement of many new editions, and the necessity of intensive anatomical preparation of subjects for illustration, were at first greatly underestimated. After overcoming many challenges, the dominant emotion is the joy of an unexpected success that came about through fruitful collaboration with the closest coworkers of our Berlin Institute, with the student body, with the readers, and with German and foreign colleagues across national and continental borders. The experience gained thereby is of inestimable value. The editor feels richly rewarded by the achievement of a professional life-work.

Berlin/Ithaca, May, 2003

The authors
TOPOGRAPHIC ANATOMY
CHAPTER 1: THORACIC LIMB

1. SKELETON OF THE THORACIC LIMB

The thoracic and pelvic limb of the ox, a heavy herbivore, are quite similar in basic structure to those of the horse.

a) On the SCAPULA is a large, half-moon-shaped scapular cartilage (14). The supraspinous fossa (6) is remarkably narrow. It is cranial to the scapular spine (5). On the distal end of the spine is a prominent sharp-edged acromion (8), as in the dog.

b) On the proximal end of the compact HUMERUS the lateral major tubercle (25) and the medial minor tubercle (29) are divided into cranial and caudal parts, as in the horse. Distal to the cran. part of the major tubercle is the crest of the major tubercle (26), and distal to the caudal part lies the round surface for the infraspinatus (26') where the superficial part of the tendon terminates. The intertubercular groove (28) is covered craniolaterally by the major tubercle, so that it is not visible in lateral view. The intermediate tubercle is insignificant, unlike that of the horse. On the medial surface of the body of the humerus (31) is the raised tuberosity of the teres major (32'). Laterally the hooked teres minor tuberosity (27') and the crest-like deltoid tuberosity (32) stand out. On the distal end of the humerus, the articular surface is the humeral condyle (35). The lateral epicondyle (38) and the medial epicondyle (39) include areas for attachment of the collateral liggs. and caudal projections for the origins of flexor mm. The caudally located olecranon fossa (40) and the cranial radial fossa (41) are like those of the horse.

c) The two BONES OF THE FOREARM (ANTEBRACHIUM) remain complete, and, except for a proximal (62') and a distal (62) interosseous space, are joined by syndesmosis in youth and by a synostosis in later life. The radius is flattened and relatively short. The articular circumference of carnivores is reduced to two small caudal articular facets (44) in ungulates. The slightly elevated radial tuberosity (46) lies farther distally than in the dog and horse. On the distal end the radius bears the radial trochlea (48), with tendon grooves on the cranial surface, and the medial styloid process (50) medially. The proximal end of the ulna, the olecranon tuber (52), is a crest with two tubercles, projecting above the radius. The distal end, the pointed lateral styloid process (61), extends distally beyond the radius, with which it is fused, and articulates with the ulnar carpal bone.

d) The proximal row of CARPAL BONES consists of the radial (63), intermediate (63'), ulnar (64), and the thick, bulbous accessory (65), carpal bones. Of the bones of the distal row, C I is always missing, C II and C III (66) are fused, and C IV (66) is a relatively larger, separate bone.

e) Of the METACARPAL BONES, Mc I and Mc II are absent, and Mc V is a much reduced, rod-like bone articulating with Mc IV. The weight-bearing main metacarpal bones (Mc III and Mc IV) are not completely fused, as shown by the dorsal and palmar longitudinal grooves with the perforating proximal and distal metacarpal canals, and by the intercapital notch (69') between the two separate distal heads (capita, 69). Internally there is an incomplete bony septum between the marrow cavities. On the proximal base (67) the flat articular surface is partially divided by a palmar notch into a larger medial part and a smaller lateral part.

f) The PHALANGES form two main digits (III and IV) and two dewclaws (paradigiti II and V). The sides of the digits are designated axial and abaxial with reference to the long axis of the limb, and the joints are called, for the sake of brevity, the fetlock, pastern, and coffin joints, as in the horse. Only on digits III and IV are three phalanges present: the proximal (70), middle (71), and distal (76) phalanges. They are somewhat prismatic, being flattened on the interdigital surface. The prominent abaxial palmar eminence (see text figure) of the prox. phalanx is a landmark for the fetlock joint. The dorsal border of the distal phalanx extends from the extensor proc. (78) to the apex. The dewclaws, which do not reach the ground, except on soft footing, lack the proximal phalanx, and sometimes also the middle phalanx, and are attached to the main digits by fascial ligaments only.

g) The SESAMOID BONES. The four proximal sesamoid bones (83) are in the palmar part of the fetlock joints, and the distal sesamoid (navicular) bone (84) is in the palmar part of each coffin joint. They are not present in the dewclaws.

In small ruminants, the dewclaws often lack phalanges; they are then purely cutaneous structures.

Superficial details of the phalanges of the main digits are similar to those of the horse.

Digital Bones of the Manus
Bones

Scapula

Costal surface (1)
Serrated surface (2)
Subscapular fossa (3)
Lateral surface (4)
Scapular spine (5)
Tubercle of scap. spine (5') + -
Supraspinous fossa (6)
Infraspinous fossa (7)
Acromion (8)
Caudal border (10)
Cranial border (11)
Scapular notch (12)
Dorsal border (13)
Scapular cartilage (14)
Caudal angle (15)
Cranial angle (16)
Vertebral angle (17)
Glenoid cavity (18)
Neck of scapula (19)
Supraxiphoid process (21) + -
Coracoid process (22)

Humerus

Head of humerus (23)
Neck of humerus (24)
Major tubercle (25)
Cranial part (25')
Caudal part (25'')
Crest of major tubercle (26) + -
Infraspinatus surface (26')
Triceps line (27)
Teres minor tuberosity (27)
Intertubercular groove (28)
Minor tubercle (29)
Cranial part (29')
Caudal part (29'')
Body of humerus (31)
Deltoid tuberosity (32)
Teres major tuberosity (32')
Crest of humerus (33)
Brachial groove (34)
Coracoid process (35)
Articular surface (35')
Lateral epicondyle (38)
Lateral supracondylar crest (38"
Medial epicondyle (39)
Olecranon fossa (40)
Radial fossa (41)

Radius

Head of radius (43)
Articular facets (44)
Neck of radius (45)
Radial tuberosity (46)
Body of radius (47)
Tubercle of radius (48)
Medial stylized process (50)

Ulna

Olecranon (51)
Olecranon tuber (52)
Anconeal process (53)
Trochlear notch (54)
Medial coronoid process (55)
Lateral coronoid process (56)
Radial notch (57)
Body of ulna (58)
Head of ulna (59)
Lateral stylized process (61)
Prox. interosseous space (62')
Dist. interosseous space (62"

Carpal bones

Radial carpal bone (63)
Intermediate carpal bone (63')
Ulnar carpal bone (64)
Accessory carpal bone (65)
Carpal bones II and III fused (66)
Carpal bone IV (66)

Metacarpal bones III and IV, V

Base (67)
Tuberosity of Mc III (67')
Body (68)
Heads (capita, 69)
Intercapital notch (69')

Digital bones

Proximal phalanx (70)
Middle phalanx (71)
Base (72)
Body (73)
Heads (74)
Flexor tuberosity (75)
Distal phalanx (coffin bone 76)
Abaxial foramen (76')
Axial foramen (76"
Partial groove (76'')
Articular surface (77)
Extensor process (78)
Finger tubercle (79)
Proximal sesamoid bones (83)
Distal sesamoid (navicular) bone (84)

(See also p. 2 text figure)
2. MUSCLES AND NERVES OF THE SHOULDER, ARM, AND FOREARM

The thoracic limb is skinned down to the hoofs as carefully as possible to preserve the cutaneous nn. and superficial vessels. At the carpus the precarpal subcutaneous bursa should be examined. The skin is carefully cut around the dewclaws to leave them on the limb. In the following nerve and muscle dissection, the pectoral mm. are removed with attention to the cranial and caudal pectoral nn. The blood vessels are spared for their subsequent demonstration. The scarpal part of the deltoideus is removed, except for a small stump on the scapula, sparing the cutaneous branch of the axillary n. The tendon fasciae antebrachii is transected at its attachment to the fascia, and the lateral head of the triceps is transected on the superficial branch of the radial n. and reflected distally.

a) The NERVES AND MUSCLES OF THE SHOULDER AND ARM. The nerves are supplied by the brachial plexus. The roots of the plexus (5) come from the ventral branches of C6–T2. The number of nerves that arise from the plexus is the same in all species of domestic mammals.

The suprascapular n. (8), from C6–C7; motor, passes laterally between the cranial border of the subscapularis and the supraspinatus (1) and innervates the latter as well as the strongly tendinous infraspinatus (11). The 1–4 subscapular nn. (4), from C7–C8; motor, are the main nerves of the tripartite subscapularis (4). Small caudal parts of it are innervated by the axillary n. (13), from C7–C8; mixed. This nerve passes laterally across the cranial border of the tendon of the teres major (2), which it innervates, to the three parts of the deltoideus: scapular (6), acromial (7), and clavicular (23) [cleidobrachialis]. The axillary n. also innervates the teres minor (12), emerges through the scapular part of the deltoideus, runs distally on the extensor carpi radialis as the cranial cutaneous antebrachial n. (30), and ends in the proximal half of the forearm. The thoracodorsal n. (3), from C7–C8; motor, ends in the latissimus dorsi (3), the distal stumps of which have been retained. The median n. (14) C8–T2, forms the axillary loop under the axillary a. with the musculocutaneous n., as in the horse. The median n. is also bound by connective tissue to the ulnar n. in the upper arm, and runs at first undivided craniodinally to the level of the elbow joint. The musculocutaneous n. (9), from C6–C8; mixed, gives off the proximal muscular br. (b), which passes between the parts of the coracobrachialis (16), innervating them and the biceps brachii (26). The nerve separates from the median n. in the vicinity of the arm (b) and continues distally as the muscular br. (d), which passes deep to the biceps and innervates the brachialis (21). The musculocutaneous n. is continued as the medial cutaneous antebrachial n. (31), which becomes subcutaneous over the lacertus fibrosus (thin, unlike that of the horse), and runs distally medial to the cephalic v. The radial n. (15), from C7–T1; mixed, passes laterally between the medial (19) and long (18) heads of the triceps brachii and gives off branches to the pronator teres (17), tensor fasciae antebrachii (22), and anconeus (25). The anconeus is difficult to separate from the lateral head of the triceps, and an accessory head is incompletely separable from the medial head. The radial n. follows the spiral course of the brachialis around the humerus from caudal to lateral, and occasionally it supplies the distal part of the brachialis, as in the horse. While still under the lateral head of the triceps, the nerve divides into deep (20) and superficial (32) branches.

At the carpal joint the tendon sheaths of the digital extensors, ext. carpi obliquis, and flexor carpi radialis should be examined. The med. and lat. cutaneous antebrachial nerves must be preserved. To demonstrate the nerves and vessels, the pronator teres is transected. The flexor carpi ulnaris and -radialis are transected in the middle of the forearm.

b) NERVES AND MUSCLES ON THE CRANIOLATERAL SURFACE OF THE FOREARM. The muscles are innervated by the deep branch (20) of the radial n. Its superficial branch (32) becomes the occasionally double lateral cutaneous antebrachial n. (33), which runs distally on the extensor carpi radialis, lateral to the cephalic v., with the medial cutaneous antebrachial n. on the medi al side of the vein, and gives off several branches to the lateral side of the forearm and carpus. On the metacarpus it divides into dor sal common digital nn. II and III.

The origins of the digital and carpal extensors are predominantly on the lateral epicondyle of the humerus. The common digital extensor (40) has two bellies and two tendons, which cross the carpus in the same synovial sheath. The larger, more cranial one is the medial digital extensor (proper extensor of digit III). Its flat tendon ends mainly on the extensor process and dorsal surface of the middle phalanx, but a thin abaxial branch descends vertically to a termination below the articular margin of the distal phalanx. At the fetlock joint, abaxial band of the tendon goes to the proximal end of the proximal phalanx of the other main digit.

The median n. is also bound by connective tissue to the ulnar n. in the upper arm, and runs at first undivided craniodinally to the level of the elbow joint. The musculocutaneous n. (9), from C6–C8; mixed, gives off the proximal muscular br. (b), which passes between the parts of the coracobrachialis (16), innervating them and the biceps brachii (26). The nerve separates from the median n. in the vicinity of the arm (b) and continues distally as the muscular br. (d), which passes deep to the biceps and innervates the brachialis (21). The musculocutaneous n. is continued as the medial cutaneous antebrachial n. (31), which becomes subcutaneous over the lacertus fibrosus (thin, unlike that of the horse), and runs distally medial to the cephalic v. The radial n. (15), from C7–T1; mixed, passes laterally between the medial (19) and long (18) heads of the triceps brachii and gives off branches to the pronator teres (17), tensor fasciae antebrachii (22), and anconeus (25). The anconeus is difficult to separate from the lateral head of the triceps, and an accessory head is incompletely separable from the medial head. The radial n. follows the spiral course of the brachialis around the humerus from caudal to lateral, and occasionally it supplies the distal part of the brachialis, as in the horse. While still under the lateral head of the triceps, the nerve divides into deep (20) and superficial (32) branches.

The tendon of the extensor carpi obliquus (39) [aductor pollicis longus], enclosed in a synovial sheath, runs across the tendon of the extensor carpi radialis and ends on Mc III. The supinator is absent.

c) NERVES AND MUSCLES OF THE CAUDOMEDIAL SURFACE OF THE FOREARM. The nerves are innervated by the ulnar n. and median n. (14) from C8–T2; mixed. The latter courses, accompanied by the brachial a. and v., deep to the pronator teres (27) and flexor carpi radialis (28), giving off muscular branches to them and to the humeral and radial heads of the deep digital flexor (34). The pronator quadratus is absent. The nerve continues in the forearm, accompanied by the median a. and v. It supplies the skin on the medial surface of the carpus and the proximal third of the metacarpus, and, without division, unlike that of the horse, passes through the carpus on the medial border of the deep tendon of the supf. dig. flexor. In the metacarpus it divides into palmar common digital nn. II and III and the communicating br. to the supf. palmar br. of the ulnar n. Palmar common dig. n. III divides into the radial, and gives off the double cuta neous antebrachial n. (24) to the caudomedial and caudolateral surfaces of the forearm and carpus. The ulnar n., accompanied by the collateral ulnaris a. and v., passes through the ulna and ulnaris lateralis as the ulnaris radialis (10), from C8–T2; mixed, while still in the upper arm, gives off the double cutaneous antebrachial n. (24) to the caudomedial and caudolateral surfaces of the forearm and carpus. The ulnar n., accompanied by the collateral ulnaris a. and v., passes to the ulnar side of the elbow joint. It gives branches to the extensor carpi ulnaris (29) and supf. digital flexor (36; 37), as well as to the ulnar and humeral heads of the deep dig. flexor (34). Between the flexor carpi ulnaris and ulnaris lateralis it divides into the dorsal branch (43), which in the metacarpus becomes dorsal common dig. n. IV, and the palmar branch (42), which passes through the carpal canal and runs distally to the tendons of the supf. dig. flexor. It divides into a deep branch for the interossei, and a superficial branch, which runs distally in the lateral groove between the deep flexor tendon and interosseous IV to form, with the communicating br. of the median n., palmar common digital n. IV. The supf. dig. flexor is composed of two parts. The tendon of the supf. part passes between the two layers of the flexor retinaculum (k). The tendon of the deep part passes through the carpal canal with the tendon of the deep flexor. The two tendons of the supf. flexor join in the distal part of the metacarpus.

Habermehl, 1961
3. CUTANEOUS NERVES, BLOOD VESSELS, AND LYMPH NODES OF THE THORACIC LIMB

a) The CUTANEOUS INNERVATION of the dorsal part of the scapular region is supplied by the dorsal branches of C8 and T1, which cross over the dorsal border of the scapular cartilage. The supraclavicular nn. innervate the cranialrolateral surface of the shoulder and arm, and the intercostobrachial nn. supplies the caudolateral surface to the level of the olecranon (see text figure).

The small cranial cut. antebraehial n. (25, axillary) supplies the arm and extends down to the middle of the forearm. The skin of the forearm is also innervated by the large lateral cut. antebrachial n. (27, supf. br. of radial), running on the cranial surface of the extensor carpi radialis lateral to the cephalic v. and accompanied medial to the vein by the median cut. antebrachial n. (30, musculocutaneous). The caudal cut. antebrachial n. (7, ulnar) ends at the accessory carpal bone.

The skin of the carpus and metacarpus is innervated on the dorsal surface by the cut. antebrachial n. and its branches: dorsal common digital nn. II (34) and III (35), from the supf. br. of the radial n. The lat. cut. antebrachial n. communicates above the carpus with the medial cut. antebrachial n., which supplies the dorsomedial surface. The dorsolateral surface is innervated by the dorsal br. of the ulnar n. and its continuation, dorsal common digital n. IV (33).

On the palmar surface the skin is innervated by the median n. and its branches, palmar common digital nn. II (18) and III (17), and by the supf. palmar br. of the ulnar n. (p. 9, 8) which receives the communicating br. (f) from the median n. and continues as the short palmar common digital n. IV.

The digits are supplied by the dorsal and palmar proper digital nn. from the corresponding common digital nn. (See p. 8).

Nerves of the thoracic limb

![Diagram of nerves](image)

b) The BLOOD VESSELS of the thoracic limb come from the subclavian a. and v. and the external jugular v., from which the cephalic v. (23) originates. The latter, as in the horse, but unlike the dog, has no anastomosis with the axillary v. Distal to the cranial border of the first rib, where the subclavian vessels become the axillary a. and v. (20), the latter vessels give off the external thoracic a. and v. (21), as well as the suprascapular a. and v. (19) for the lateral muscles of the shoulder and for the shoulder joint, and the large subscapular a. and v. (1), which run along the caudal border of the scapula and supply most of the muscles of the shoulder joint, and the long head of the triceps. One branch of the axillary a. is the caudal circumflex humeral a. (3), which gives off the collateral radial a. (4), from which arises the cranial supf. antebrachial a. (p. 9, 1). This ends in the small dorsal common digital aa. II and III (p. 9, 12). The caudal circumflex humeral v. ends in the region of the shoulder joint. Distal to the origin of the cranial circumflex humeral a. (22) – the vein comes from the subscapular v. – the axillary vessels become the brachial vessels. The latter give off the deep brachial a. and v. (6) to the caudal muscles of the elbow joint. The next branches are the collateral ulnar a. and v. (8), of which the artery continues indirectly to the small dorsal common digital a. IV, while the vein ends at the elbow joint, mostly in the caudomedial muscles of the forearm. Distal to the collateral ulnar vessels, the bicipital a. and v. (24) arise and supply the biceps. They may originate from the more distal vessels, the transverse cut. a. and v. (26). The last branches of the brachial vessels are the common interosseus a. and v. (9), arising distal to the elbow joint. These divide into the large cranial interosseus a. and v. (10) and the insignificant caudal interosseus a. and v. (11), which usually do not reach the carpus. The cranial interosseous a. and v. pass laterally through the proximal interosseous space and run on the lateral surface of the radius and ulna to the distal interosseous space, where they are continued by the brachial a., passing medially through the space to become the palmar br. These divide into deep and superficial br. (p. 9, 8). The ulnar a. and v. are absent, as in the horse. The cephalic v. (23), on the surface of the cleidobrachial, gives off the median cubital v. (28), a long oblique anastomosis to the brachial v. at its point of transition to the median v. The cephalic v. continues distally on the extensor carpi radialis to the deep and superficial br. of the brachial aa., which gives off the cephalic v. (32). This continues the direction of the cephalic v. to the dorsal surface of the metacarpus and becomes dorsal common digital v. III (35). Inconstant dorsal common digital vv. II (34) and IV (33) are given off the main trunk and end in the distal deep palmar arch. The cephalic v. turns medially and joins the radial v. above the carpus. The brachial a. and v. are continued medially in the forearm by the median a. and v. (29), which give off in their course the following branches: the deep antebrachial aa. and vv. (12) to the caudal muscles of the forearm, and the radial a. and v. (31) in the middle of the forearm. The sometimes double radial vein receives the cephalic v. proximal to the carpus. At the carpus the radial a. and v. join their respective dorsal carpal networks, which also receive the cranial interosseous a. and v. and the dorsal carpal br. of the collateral ulnar a. (without the corresponding v.). Dorsal metacarpal a. III comes from the arterial dorsal carpal network. It is accompanied by the dorsal groove of the metacarpal bone by dorsal metacarpal v. III from the venous dorsal carpal network. On the palmar surface of the metacarpal bone the radial a. and v. and the deep palmar branches of the cranial interosseus a. and v. form the deep palmar arches (15), which give off the deep palmar metacarpal aa. and vv. II–IV. Palmar metacarpal v. II is the direct continuation of the radial v. and accompanying median a. and v. pass through the palmaromeral surface of the deep flexor tendon and the tendon of the deep part of the supf. flexor, to the metacarpus. Here the median a., the supf. palmar br. of the cranial interosseus a., and the supf. palmar br. of the radial a. are connected across the surface of the flexor tendons by the zigzag superficial palmar arch, which gives off palmar common digital aa. II (18) and IV. Palmar common digital a. III (17) is the direct continuation of the median a. distal to the arch, and it is the main blood supply to the large digits. It courses to the interdigital space, crossing the medial branch of the supf. flexor tendon, where the pulsation is palpable. It is accompanied by palmar common digital v. III (17). The interdigital a. and v. (p. 11, 5) connect the palmar with the dorsal digital vessels. The palmar common digital veins II and IV originate from the distal deep palmar venous arch. (See also pp. 8–11.)

c) LYMPHATIC STRUCTURES. The large proper axillary ln. (p. 5, 9) lies caudal to the shoulder joint at the level of the second intercostal space between the thoracic wall and the medial surface of the teres major. Small axillary ln. of the first rib are associated with the axillary vessels on the lateral surface of the rib. Both groups of ln. are examined in meat inspection in special cases. In the hanging split carcass the proper axillary node is drawn cranially by the weight of the limb, and may be conveniently found by an incision from the inside of the thoracic wall in the middle of the first intercostal space. The afferent lymphatics come from the bones, joints, and muscles of the shoulder, and from the arm and forearm. The efferent lymphatics go to the ln. of the first rib, proper axillary ln., and caudal deep cervical ln., which are drained on the left side by the thoracic duct and on the right by the right tracheal duct. The lymphatic drainage of the manus goes to the supf. cervical ln.
Arteries, Veins, and Nerves of thoracic limb

1 Subscapular a. and v.
2 Thoracodorsal a., v., and n.
3 Caud. circumfl. humeral a. and v.
4 Collateral radial a.
5 Brachial a. and v.
6 Deep brachial a. and v.
7 Caud. cut. antebrachial n. (ulnar)
8 Collat. ulnar a. and v. and ulnar n.
9 Common interosseous a. and v.
10 Cran. interosseous a. and v.
11 Caud. interosseous a. and v.
12 Deep antebrachial a. and v.
13 Dorsal br. of ulnar n.
14 Palmar br. of ulnar n.
15 Deep palmar arch.
16 Supf. palmar arch.
17 Palmar common digital a., v., and n. III
18 Palmar common digital a., v., and n. II
19 Suprascapular a., v., and n.
20 Axillary a. and v.
21 Ext. thoracic a. and v. and Cran. pectoral nn.
22 Cran. circumfl. humeral a. and v. and Prox. musc. br. of musculocut. n.
23 Cephalic v.
24 Bicipital a. and v. and Dist. musc. br. of musculocut. n.
25 Cran. cut. antebrachial n. (axillary)
26 Transverse cubital a. and v.
27 Lat. cut. antebrachial n. (radial)
28 Median cubital v.
29 Median a., v., and n.
30 Medial cut. antebrachial n. (musculocut.)
31 Radial a. and v.
32 Accessory cephalic v. and Supf. br. of radial n.
33 Dorsal common digital v. IV
34 Dorsal common digital v. and n. II
35 Dorsal common digital v. and n. III

Legend:
a. Circumfl. scapular a. and v.
b. Lat. thoracic n.
c. Caud. pectoral nn.
d. Axillary loop (median and musculocut. nn.)
e. Supf. thoracic v.
f. Communicating br. (median n. and supf. palmar br. of ulnar n.)

(See pp. 5, 9)
The dissection is done on the embalmed limbs provided and on fresh specimens of the metacarpus and digits. The skin is carefully removed down to the hoofs, preserving the nerves and vessels.

4. VESSELS AND NERVES OF THE MANUS

a) The **PALMAR NERVES** come predominantly from the median n., but also from the palmar br. of the ulnar n. (For vessels, see p. 6.)

The median n. (4), accompanied by the median a. and v., passes through the flexor carpi unaris, about 2 cm proximal to the accessory carpal bone. It divides near the middle of the forearm into dorsal and palmar branches. (The accessory carpal bone and vessels are understood to be “proper”, and this adjective may be omitted.) The median n., the supf. br. of the palmar a., and n. of digit II (18, dewclaw) and the continuing abaxial palmar digital a., v., and n. III (19) for deep digital structures and the dermis of the bulb and wall as far as the apex of the hoof. (Axial and abaxial digital nerves and vessels are understood to be “proper”, and this adjective may be omitted.) Palmar common digital n. III (15) is usually double. The branches are accompanied on each side by the branches of the also double palmar common digital v. III, and between them by palmar common digital a. III, proceeding in the direction of the interdigital space (see p. 10).

The ulnar n. divides near the middle of the forearm into dorsal and palmar branches. The palmar br. (p. 7, 14) crosses deep to the tendon of the flexor carpi ulnaris and runs between the deep part of the superficial digital flexor and the accessory carpal bone. Just distal to the carpus it gives off the deep br. to the intersossei and continues as the supf. br. (8), which runs in the lateral groove between interosseous IV and the digital flexor tendons, accompanied by the supf. palmar br. of the cranial interosseous a. (8). Distal to the communicating br. (10) from the median n., the supf. br. of the palmar br. of the ulnar becomes the short palmar common digital n. IV, accompanied by the corresponding a. and v. Proximal to the fetlock joint the fourth digit they divide into the axial palmar digital a., v., and n. of digit II (18, dewclaw) and the abaxial palmar digital a., v., and n. IV (24), with distribution like that of the corresponding structures of digits II and III. Deep palmar metacarpal nn. like those of the dog and horse do not exist. Deep palmar metacarpal aa. and vv. II - IV from the deep palmar arches run distally on the metacarpal bone and anastomose proximal to the fetlock joint with the supf. palmar vessels (see p. 6).

b) The **DORSAL NERVES** come mainly from the supf. br. of the radial n. (lat. cut. antebrachial n.) and also from the dorsal br. of the ulnar. (Vessels, see p. 6.)

The dorsal br. of the ulnar n. (5) emerges between the ulnaris lateralis and the flexor carpi ulnaris, about 2 cm proximal to the accessory carpal bone and runs distally across the bone. It continues on the lateral surface of the carpus to the groove between the metacarpal bone and interosseus IV, where it becomes dorsal common digital n. IV (7). On the dorsolateral surface of the fetlock joint it gives off the small axial dorsal digital n. V (23). (The dewclaws have migrated to the palmar surface from their original lateral and medial positions.) Common digital n. IV is continued by abaxial dorsal digital n. IV (25) to the dorsolateral coronary region of the fourth digit.

The supf. br. of the radial n. (3, lat. cut. antebrachial n.), accompanied medially by the accessory cephalic v. (2) and the often double cranial supf. antebrachial a. (1) passes across the dorsomedial surface of the carpus. Just distal to the middle of the metacarpus the nerve can be palpated on the bone medial to the three digital extensor tendons. Here it divides into dorsal common digital nn. III (12) and II (9). The latter is small. It crosses under dorsal common digital v. II (11) if that is present, reaches the medial surface of the fetlock joint with the small dorsal common digital a. II (9), and divides into axial dorsal digital n. II to the dewclaw (16), and abaxial dorsal digital n. III (17) to the dorsomedial coronary region of the third digit. As they cross the fetlock joints the abaxial dorsal and palmar digital nn. course on opposite borders of the abaxial palmar digital v.

They may be connected by a communicating br. at the level of the proximal phalanx.

The continuing dorsal common digital a., v., and n. III (12) cross the tendon of the medial digital extensor (p. 5, 40) and the medial branch of the tendon of the common extensor of digits III and IV (p. 5, 41) to reach the interdigital space where they divide into the axial dorsal aa., vv., and nn. of digits III and IV.

There are no deep dorsal metacarpal nn., unlike the system in the metatarsus. Deep dorsal vessels are reduced to the dorsal metacarpal a. III and (inconstant) v. III (p. 11, 4), running in the dorsal longitudinal groove of the bone to the interdigital space, where they anastomose with the superficial dorsal common digital vessels.

Arteries and Veins of the Manus (palmar)

(See pp. 5–11)
Arteries, Veins, and Nerves of the Manus

(mediopalmar) (dorsolateral)

1 Cran. supf. antebrachial a.
2 Accessory cephalic v.
3 Supf. br. of radial n.
4 Median a., v., and n.
5 Dors. br. of ulnar n.
6 Supf. br. of radial a. and v.
7 Dors. com. digital n. IV
8 Supf. palm. br. of ulnar n.
(Palm. common dig. n. IV) and
Supf. palmar br. of cran. interosseous a.
9 Dors. com. digital a. and n. II
10 Communicating br.
11 Dors. com. digital vv. II and IV
12 Dors. com. digital a., v., and n. III
13 Palm. com. digital a., v., and n. II
14 Palm. com. digital a., v., and n. IV
15 Palm. com. digital a., v., and n. III
16 Axial dors. digital n. II
17 Abaxial dors. digital n. III
18 Axial palm. digital a., v., and n. II
19 Abaxial palm. digital a., v., and n. III
20 Axial palm. digital nn. III and IV
21 Axial dors. digital aa., vv., and nn. III and IV
22 Axial palm. digital a., v., and n. V
23 Axial dors. digital n. V
24 Abaxial palm. digital a., v., and n. IV
25 Abaxial dors. digital n. IV

Legend:

16 Axial dors. digital n. II
17 Abaxial dors. digital n. III
18 Axial palm. digital a., v., and n. II
19 Abaxial palm. digital a., v., and n. III
20 Axial palm. digital nn. III and IV
21 Axial dors. digital aa., vv., and nn. III and IV
22 Axial palm. digital a., v., and n. V
23 Axial dors. digital n. V
24 Abaxial palm. digital a., v., and n. IV
25 Abaxial dors. digital n. IV

a Flexor carpi ulnaris
b Supf. digital flexor
c Flexor carpi radialis (resected)
d Extensor carpi radialis

e Extensor carpi obliquus
f Common digital extensor
Medial digital extensor
Common extensor of digits III and IV

g Lat. digital extensor
h Ulnaris lateralis
i Abaxial extensor branches
Interosseous III and IV
j Med. cut. antebrachial n.
(musculocutaneous)
5. INTERDIGITAL NERVES AND VESSELS, INTEROSSEI, AND FASCIAE OF THE MANUS

a) The INTERDIGITAL NERVES AND VESSELS of the manus come primarily from the palmar common digital a., v., and n. III (5), whose branches communicate with the corresponding dorsal nerves and vessels (see p. 8).

On the pes the main blood supply of the digits is the dorsal metatarsal a. III (11 and p. 21, 12). This difference is important surgically. The digital vessels and nn. of the pes have the same connections as on the manus. Usually the branches of the double palmar common digital n. III unite for a short distance at the beginning of the interdigital space, and divide again into axial palmar digital nn. III (6) and IV (7). If there is no common trunk, the branches are continued by the axial palmar digital nn., which give off communicating branches to the axial dorsal digital nn. III and IV. Palmar common digital a. III (8) gives off branches to the proximal phalanges. These branches pass between the deep flexor tendon and the bone and anastomose with the abaxial palmar digital aa. A dorsal branch, the interdigital a. (5”), anastomoses with the dorsal metacarpal a. III (4) and the small dorsal common digital a. III (1) and supplies the axial dorsal digital aa. III (3) and IV (2). Distal to the interdigital a., palmar common digital a. III divides into axial palmar digital aa. III (6) and IV (7). Palmar common digital v. III (5), often double, unites at the middle of the proximal phalanx, where it receives the anastomotic branches of the abaxial palmar digital vv. and gives off the interdigital v. (5’) and the axial palmar digital vv. III (6) and IV (7). The interdigital v. has connections with dorsal digital vv. corresponding to the arteries. The axial dorsal digital aa., vv., and nn. supply the dorsal coronary and interdigital regions of the third and fourth digits. The axial palmar (plantar) aa., vv., and nn. supply the interdigital deep structures and dermis of the bulb and hoof of the third and fourth digits. (For the supply of the abaxial surface of the digits, see p. 8.) The axial palmar (plantar) a. and v. enter the axial foramen in the distal phalanx and anastomose in the bone with the abaxial palmar a. and v., which enter through the abaxial foramen, to form the terminal arches.

b) The INTEROSSEI III AND IV (see p. 18) provide support for the fetlock joints of the ox comparable to that of interosseus III (medius) in the horse. These muscles originate from the proximal end of the metacarpal (metatarsal) bone and the deep palmar (plantar) carpal lig. In young animals they are relatively fleshy, and in older animals, predominantly tendinous. Interossei III and IV are fused along their axial borders in the metacarpus (metatarsus), but they separate and terminate on the corresponding digits. In the middle of the metacarpus (metatarsus) the interossei give off the accessory lig., which bifurcates and joins the branches of the supf. digital flexor tendon at the level of the fetlock joints in the formation of the sleeves (manicae flexoriae) through which the branches of the deep flexor tendon pass. Proximal to the fetlock joints each interosseus divides into two tendons (h), each with two extensor branches (p. 5, I, p. 9, i). The two tendons are attached to the sesamoid bones (i) of the corresponding digit. A flat abaxial extensor branch (g) passes across the surface of the sesamoid bone, to which it is attached, and joins the tendon of the proper digital extensor. The axial extensor branches (I) remain fused together until they pass through the intercapital notch in the end of the metacarpal (metatarsal) bone. Then they separate and join the tendons of their respective proper digital extensors. The interosseus, sesamoid bones, and sesamoid lig. of each digit form a synovial sheath which aids the digital flexor tendons in the support of the fetlock joint. In addition, the extensor branches opposed the tension of the deep flexor tendon on the distal phalanx when the weight is on the foot.

c) On the carpus the FASCIA OF THE MANUS is thickened dorsally to form the extensor retinaculum (p. 5, s) and especially on the palmar surface to form the flexor retinaculum (p. 5, k).

On the dorsal surface of the metacarpus (metatarsus) the fascia is thin, but on the palmar surface, in continuation of the flexor retinaculum, it is thick, forming the proximal ligg. of the dewclaws. These come from the borders of the metacarpal (metatarsal) bone and have been cut to expose the palmar (plantar) nerves and vessels. At the level of the fetlock joints, the transverse lig. connects the dewclaws, and a palpable distal lig. runs from each dewclaw to the fascia on the abaxial surface of the coffin joint, resembling in its course the lig. of the ergot in the horse. It also blends with the abaxial end of the distal interdigital lig. (see below). The whole system of ligaments of both dewclaws forms a letter H.

On the fetlock joints the fascia around the digital flexor tendons of each digit is thickened to form the palmar annular lig. (12), which joins the collateral sesamoid lig. and the proximal scutum – the fibrocartilaginous bearing surface for the flexor tendons, formed on the sesamoid bones and the palmar (plantar) lig. between them, and extending proximal to the sesamoid bones.

Distal to the fetlock joint the fascia is reinforced in the proximal (13) and distal (15) digital annular liggs., attached to the proximal phalanx. The main digits are connected by the proximal and distal interdigital ligg. The proximal interdigital lig. (14) is short and thick; it is attached on the axial surfaces of the proximal halves of the proximal phalanges, and is supplemented by the crossed interdigital phalangesesamoid ligg. These extend from the sesamoid bones of one digit to the axial tubercle of the proximal phalanx of the other digit. The distal interdigital lig. (16) has greater mechanical advantage in resisting the spread of the digits. It consists of superficial and deep parts. The superficial part is palpable. Its crossed fibers extend from the abaxial eminence of the flexor tuberosity of the middle phalanx (see p. 3, 71), around the palmar surface of the deep flexor tendon to the navicular bone of the other digit. It serves to hold the deep flexor tendon in place. The crossed fibers of the deep part pass from the axial surface of the distal end of the middle phalanx of one digit to the distal phalanx and navicular bone of the other digit. The attachment to the navicular bone is by means of the distal scutum – a plate of fibrocartilage that covers the flexor surface of the bone and extends proximal to it. The terminal branches of the deep and supf. flexor tendons have common digital synovial sheaths, which begin between the middle and distal thirds of the metacarpus and end just above the coffin joint.

They form six pouches for each main digit: two abaxial pouches and one palmar (plantar) pouch proximal to the palmar (plantar) annular lig., two between the two digital annular liggs., and one distal to the superficial part of the distal interdigital lig.

Of the three pouches proximal to the palmar (plantar) annular lig., (I) is between the interosseus and the accessory lig.; (II) lies along the accessory lig., partially surrounding the deep flexor tendon; and III is on the palmar (plantar) surface of the supf. flexor tendon. Abaxial (IV) and axial (V) pouches bulge between the two digital annular ligg. The sixth pouch (VI) is distal to the supf. part of the distal digital annular lig. The sheaths of both digits may communicate with each other where they are in contact.
Legend:

1 Dors. com. digital a., v., and n. III
2 Axial dors. digital a., v., and n. IV
3 Axial dors. digital a., v., and n. III
4 Dors. metacarpal a. and v. III
5 Palm. (plant.) com. dig. a., v., and n. III
5' Interdigital a. and v.
6 Axial palm. (plant.) digital a., v., and n. III
6' Communicating br. (nerve)
7 Axial palm. (plant.) digital a., v., and n. IV
8 Dors. com. digital a., v., and n. III
9 Axial dors. digital a., v., and n. IV
10 Axial dors. digital a., v., and n. III
11 Dors. metatarsal a., v., and n. III
11' Communicating br. (nerve)

Legend:

Tendons:
a. Lateral digital extensor
b. Common digital extensor or Long digital extensor (Med. dig. ext., and common (long) ext. of digits III and IV)
c. Common digital extensor or Long digital extensor (Med. dig. ext., and common (long) ext. of digits III and IV)
d. Supf. digital flexor
e. Deep digital flexors
f. Interossei III and IV.
g. Abax. extensor branches
h. Tendon to sesamoid bone
i. Prox. sesamoid bone of dig. IV
j. Dorsal lig.
k. Axial common collat. lig.
l. Axial collat. ligg.
m. Axial palm. (plant.) lig. of pastern joint
n. Axial collat. sesamoid lig.

Digital fascia, Fibrous and synovial digital sheaths of manus and pes

Subtendinous bursae
Dist. tendon sheaths of com. ext. of digits tendons

(See pp. 5, 7, 9)
6. SYNOVIAL STRUCTURES OF THE THORACIC LIMB

a) JOINTS OF THE THORACIC LIMB

<table>
<thead>
<tr>
<th>NAME</th>
<th>BONES involved</th>
<th>TYPE OF JOINT</th>
<th>FUNCTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Shoulder joint</td>
<td>Glenoid cavity of scapula and head of humerus</td>
<td>Simple spheroidal</td>
<td>Restricted to flexion and extension</td>
<td>Infraspinatus and subscapularis act as contractile ligaments</td>
</tr>
<tr>
<td>II. Elbow joint</td>
<td>a) Humeroulnar joint</td>
<td>Humeral condyle and ulna</td>
<td>Composite joint</td>
<td>a–b) Flexion and extension, snap joint</td>
</tr>
<tr>
<td></td>
<td>b) Humeroradial joint</td>
<td>Humeral condyle and head of radius</td>
<td>Simple hinge</td>
<td>Because the collateral liggs. are attached to the humerus prox. to axis of rotation of the condyle they are stretched in the neutral position of joint and tend to snap it into extension or flexion Pronator teres is feebly muscular.</td>
</tr>
<tr>
<td></td>
<td>c) Proximal radiohumeral joint</td>
<td>Articular circumference of radius and radial notch of ulna</td>
<td>Simple rotating</td>
<td>c) No movement</td>
</tr>
<tr>
<td>III. Distal radioulnar joint:</td>
<td>Absent</td>
<td></td>
<td></td>
<td>Synostosis</td>
</tr>
</tbody>
</table>

JOINTS OF THE MANUS

IV. Carpal joint

<table>
<thead>
<tr>
<th>NAME</th>
<th>BONES involved</th>
<th>TYPE OF JOINT</th>
<th>FUNCTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Antebrachiocarpal joint</td>
<td>Radial trochlea and ulnar styloid process with carpal bones</td>
<td>Composite joint</td>
<td>Flexion and extension to 95°</td>
<td>Collateral liggs. have long supf. parts and prox., middle, and distal short deep parts. Med. collar. lig. is stronger. Synovial sac of a) rarely communicates with b); b) and c) always communicate*</td>
</tr>
<tr>
<td>b) Midcarpal joint</td>
<td>Prox. and dist. rows of carpal bones</td>
<td>Composite condylar</td>
<td>Flexion and extension to 45°</td>
<td></td>
</tr>
<tr>
<td>c) Carpometacarpal joint</td>
<td>Carpal II–IV and metacarpal bones III and IV</td>
<td>Composite plane joint</td>
<td>Little movement</td>
<td></td>
</tr>
<tr>
<td>d) Intercarpal joints</td>
<td>Carpal bones of same row</td>
<td>Composite plane joints</td>
<td>Little movement</td>
<td></td>
</tr>
</tbody>
</table>

V. Fetlock (metacarpophalangeal) joints

<table>
<thead>
<tr>
<th>NAME</th>
<th>BONES involved</th>
<th>TYPE OF JOINT</th>
<th>FUNCTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prox. and middle phalanges</td>
<td>Metacarpal III and IV, prox. phalanges, and prox. sesamoid bones</td>
<td>Composite hinge joint</td>
<td>Flexion and extension</td>
<td>The ox has two fetlock joints, whose capsules communicate. In their dorsal walls are fibrocartilago-ginous sesamoid bodies.</td>
</tr>
</tbody>
</table>

VI. Pastern (prox. interphalangeal) joints

<table>
<thead>
<tr>
<th>NAME</th>
<th>BONES involved</th>
<th>TYPE OF JOINT</th>
<th>FUNCTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prox. and middle phalanges</td>
<td>Simple saddle joint</td>
<td>Flexion, extension, and small lateral and rotational movements</td>
<td>There is no communication between pastern joints. Their dorsal pouches extend to the coffin joint pouches.</td>
<td></td>
</tr>
</tbody>
</table>

VII. Coffin (dist. Interphalangeal) joints

<table>
<thead>
<tr>
<th>NAME</th>
<th>BONES involved</th>
<th>TYPE OF JOINT</th>
<th>FUNCTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle and dist. phalanges and navicular (dist. sesamoid) bones</td>
<td>Composite saddle joint</td>
<td>Flexion, extension, and small lateral and rotational movements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) SYNOVIAL BURSAE

The large (up to 8 cm in diameter, Schmidtchen**) infraspinatus bursa lies deep to the flat superficial part of the tendon, which terminates on the distinct infraspinatus surface (p. 3, 26') distal to the major tubercle. (The deep part of the tendon ends on the proximal border of the tubercle). The voluminous intertubercular bursa on the medial surface of the major tubercle lies deep to the tendon of origin of the biceps and on both sides of it. At the level of the transverse humeral retinaculum the bursa surrounds the tendon. As in the horse, the bursa is separate from the joint capsule. The bursa of the triceps brachii lies under the terminal tendon on the olecranon tuber. The inconstant subcutaneous olecranon bursa lies on the caudal surface of the olecranon in old cattle.

The subcutaneous precard bursa develops in adults and enlarges with age. It may reach the size of an apple. It extends on the dorsal surface from the midcarpal joint to a point just below the metacarpal tuberosity, covering the termination of the extensor carpi radialis. It usually does not communicate with underlying synovial structures and can be surgically removed when enlarged (hygroma). The subteniduous bursae of the ext. carpi obliquis, ext. carpi radialis, ulnaris lateralis, and the supf. and deep digital flexors lie under the respective tendons on the medial, dorsal, lateral, and palmar surfaces of the carpal joint.

The subteniduous bursae of the medial and lateral proper digital extensorslie dorsally on the fetlock joints. The navicular bursae are between the terminal branches of the deep flexor tendon and the navicular bones. Inflammations of the bursae have the same clinical signs as in the horse.

c) TENDON SHEATHS (VAGINAE SYNOVIALES)

On the dorsal and lateral surfaces of the carpus the extensor carpi obliquis and the digital extensors have synovial sheaths; the tendons of the ext. carpi radialis and ulnaris lat. do not. On the medial surface, only the flexor carpi radialis has a synovial sheath.

On the dorsal surface of the phalanges the terminal branches of the tendon of the common extensor of digits III and IV have synovial sheaths. On the palmar surface is the common synovial sheath of the supf. and deep digital flexor tendons. They are held in position at the fetlock joint and on the proximal phalanx by annular ligg., and in the region of the pastern joint by the supf. part of the distal interdigital lig.

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* Desrochers et al., 1997
** Schmidtchen, 1906
Joints, Bursae, and Synovial Sheaths

Legend:

1 Supraspinatus
2 Infraspinatus
3 Deltoides
4 Biceps brachii
5 Triceps brachii
5' Long head
5" Lat. head
5''' Med. head
6 Brachialis
7 Ext. carpi radialis
8 Com. digital extensor
9 Lat. digital extensor
10 Ulnaris lat.
11 Deep dig. flexor
12 Coracobrachialis
13 Subscapularis

Legend:

14 Pronator teres
15 Ext. carpi obliquus
16 Flexor carpi ulnaris
17 Flexor carpi radialis
18 Supf. dig. flexor
18' Supf. part
18'' Deep part
19 Interosseus IV

Legend:

A Abax. collat. ligg.
B Abax. collateral sesamoid ligg.
C Abax. palm. ligg. of pastern joint
D Abax. distal sesamoid ligg.
E Palmar annular ligg.
F Prox. digital ann. ligg.
F' Dist. digital ann. ligg.
G Dist. interdigital ligg. (Supf. part)
CHAPTER 2: PELVIC LIMB
1. SKELETON OF THE PELVIC LIMB

The skeleton of the pelvic limb includes the bones of the pelvic girdle, described with the pelvis (pp. 78–79).

a) The FEMUR has a proximal head (1), the articular surface of which presents a condylar lateral extension on the upper surface of the neck (3). The fovea (2) is small and almost centrally located. The major trochanter (4) is, in contrast to that of the horse, undivided, and borders a deep trochanteric fossa (5). The rounded cunomedially directed minor trochanter (6) is connected to the major trochanter by a distinct intertrochanteric crest (4'). The small rounded tuberosity for the deep gluteal m. is distal to the major trochanter. The third trochanter is absent in the ox. The body of the femur (8) is rounded and relatively slender and straight, compared to that of the horse. Distolaterally, as in the horse, there is a supracondylar fossa (13), but it is shallow in the ox. On the distal end of the femur are the nearly parallel medial (14) and lateral (17) condyles, separated by a deep intercondylar fossa (20). Cranial to the lateral condyle is the extensor fossa. On the cranial surface of the distal end of the femur is the trochlea (21), the medial ridge of which is larger and extends farther proximally, where it is thickened to form a tubercle (21').

The patella (69) is a sesamoid bone in the terminal tendon of the quadriceps femoris. The broad proximal base (69') has blunt, rough borders, and a cartilaginous process (69'') for attachment of the med. parapatellar fibrocartilage (69''), as in the horse. The distal apex (69'') is more acutely pointed than in the horse.

b) The BONES OF THE CRUS (LEG, SHANK) are the strong tibia and the vestigial fibula, reduced to its proximal and distal extremities.

I. The tibia with its medial condyle (23) and its laterally extended lateral condyle (25) presents proximal articular surfaces almost on the same level, between which the intercondylar eminence (24) rises. On the body of the tibia (28) is the broad proximocranial tibial tuberosity (29) with the laterally adjacent extensor groove (27). On the distal tibial coxhead (30) the articular ridge and grooves are almost sagittal like those of the dog, but unlike those of the horse. Distolaterally, as in the horse, there is a supratrochlear fossa (39), which is larger and extends farther proximally, where it is thickened to form a crest. In the ox, the tibia articulates with the central and fourth tarsal bone. The single bone of the middle row, the central tarsal, is fused with the fourth tarsal of the distal row to form one bone, the central and fourth tarsal (45'), characteristic of Ruminantia. It occupies the full width of the tarsus, and jogs upward proximomedially. The remaining tarsal bones of the distal row occupy the distomedial part of the tarsus. The rounded T I is mediolateral. T II and T III are always fused to form one flat bone, also characteristic of Ruminantia. The tarsal canal passes between the two large distal tarsal bones and the metatarsus. It connects with the proximal mt. canal, which, unlike the proximal mc. canal, opens on the proximal surface of the base of the mt. bone. The tarsus, metatarsus, and digits are homologous to the human foot (pes) and correspond to the manus of the thoracic limb.

II. The fibula is more or less reduced, depending on the individual. The head of the fibula (32) fuses with the lateral condyle of the tibia as a distally directed process. Rarely is it an isolated bone as in the horse. A body of the fibula can be present as an exception, but it is usually replaced by a fibrous strand; therefore there is usually no interosseous space in the crus.

The distal end of the fibula persists as an independent bone, the lateral malleolus (35), and articulates proximally with the tibia, medially with the talus, and distally with the calcaneus.

c) The TARSAL BONES make up, in proximal, middle, and distal rows, a total of only five bones. The talus (37) in the proximal row is longer and more slender than in the horse. The ridges of the proximal trochlea (39) are sagittal, unlike those of the horse, and articulate with the tibial coxhead medially and with the lateral malleolus. The proximal trochlea is joined by the roughened neck (40) to the distal trochlea (41'), which articulates with the central and fourth tarsal bone. A distal trochlea of the talus is characteristic of the order Artiodactyla, the even-toed ungulates. The calcaneus (42) is also longer and more slender than in its proximal tuber calcanci (43) is roughened dorsocranially, divided by a transverse crest, and hollowed out in a plantar groove. The compact sustentaculum tali (44) is hollowed to form a tendon groove on the plantar surface.

Legends:

A Artic. surface for T C and T IV
B Artic. surfaces for talus
C Coracoid process
D Artic. surface for malleolus
E Tarsal sinus
F Artic. surfaces for calcaneus

The manus. Metatarsal bone III and IV is longer and more slender, and square in cross section; metacarpal bone III and IV is transversely oval. A small, discoid metatarsal sesamoid (70) is located proximoplantar to Mt. III in the fused tendons of origin of the interossei.
Femur
Head of the femur (1)
Fovea capitis (2)
Neck of the femur (3)
Major trochanter (4)
Intertrochanteric crest (4')
Trochanteric fossa (5)
Minor trochanter (6)
Body of femur (8)
Rough surface (9)
Popliteal surface (12)
Fossa suprapatellaris (13)
Medial condyle (14)
Medial epicondyle (16)
Lateral condyle (17)
Lateral epicondyle (19)
Intertrochanteric fossa (20)
Femoral trochlea (21)
Tubercle of femoral trochlea (21')

Tibia
Prox. articular surface (22)
Medial condyle (23)
Intercondylar eminence (24)
Lateral condyle (25)
Extensor groove (27)
Body of tibia (28)
Popliteal line (28')
Tibial tuberosity (29)
Crural border (29')
Tibial condyle (30)
Medial malleolus (31)

Fibula
Head of the fibula (32)
Lateral malleolus (35)

Tarsal bones
Talus (37)
Body of talus (38)
Prox. trochlea (39)
Neck (40)
Head (41)
Distal trochlea (41')
Calcaneus (42)
Tuber calcanei (43)
Sustentaculum tali (44)
Central + 4th tarsal bone (45)
T II + T III, dorsal view, and T I, in plantar view (46)

Metatarsal bones III and IV
Base (47)
Body (48)
Head (49)

Digital bones (see text fig. p. 2)
Proximal phalanx (50)
Middle phalanx (51)
Base (52)
Distal phalanx (coffin bone – 56)
Extensor process (58)

Sesamoid bones
Proximal sesamoid bones (66)
Distal sesamoid bone (67)
Patella (69)
Base (69')
Apex (69'')
Cartilaginous process (69''')
Medial parapatellar fibro-cartilage (69'''')
Articular surface (69''''')
Metatarsal sesamoid bone (70)
a) LATERALLY ON THE THIGH and on the rump the cranial gluteal n. (2) supplies the especially large and fleshy tensor fasciae latae (5) (which includes the cranial part of the gluteus supr.), the thin glutus medius (1), which causes the characteristic bowed flattening of the rump, the glutus accessorius (3), (see above, considered a part of the gluteus medius), and the fleshy glutus profundus (4). Each terminal tendon of the deep, middle, and accessory gluteal muscles has a synovial bursa on the major trochanter.

The caudal gluteal n. (16) supplies the vertebral head of the biceps femoris [gluteobiceps, 7], which includes the caudal part of the gluteus supf. The ischial head is innervated by the ribial n. The vertebral heads of the semitendinosus and semimembranosus, seen in the horse, are absent in the ox.

The wide sciatic n. (17) passes over the gluteus profundus, and, at the hip joint, gives off muscular brr. to the gemelli and quadratus femoris. (The internal obturator is absent in the ox.) Here the sciatic n. divides into the common peroneal [fibular] n. cranially and the ribial n. caudally.

The ribial n. (19) gives off proximal muscular brr. to the ischial head of the biceps femoris and to the semitendinosus and semimembranosus, which originate from the tuber ischiadicum only, as in the dog.

In the course of the nerve toward the gastrocnemius the caudal cutaneous sural nerve (19') is given off in the middle of the thigh and runs with the lateral saphenous v. to the middle of the latero-plantar surface of the metatarsus.

The biceps femoris [gluteobiceps, 7] has a large trochanteric bursa on the trochanter major, over which the muscle passes. The bursa is clinically important as a cause of lameness when inflamed. Distal to the trochanter the biceps is divided into two parts as in the dog, but unlike the three parts in the horse. It ends with the fascia cruris on the patella, lateral patellar lig., and the cranial border of the tibia, and has another synovial bursa under its tendon at the level of the femoral condyle (see p. 29). Its tarsal tendon (34) ends on the tuber calcanei.

The semitendinosus (20) passes over the medial head of the gastrocnemius and ends, with a synovial bursa, on the cranial border of the tibia and by its tarsal tendon (see p. 19) on the tuber calcanei. Characteristic of the muscle is a transverse tendinous intersection at the beginning of its middle third.

The semimembranosus (18) is indistinctly divided near the end into a larger part ending on the medial femoral condyle, and a smaller part ending on the medial condyle of the tibia.

b) ON THE CRUS the common peroneal [fibular] n. (6) sometimes gives off in the middle of the crus a lateral cutaneous sural n. (21) toward the hock. The common peroneal n. runs over the lateral head of the gastrocnemius, passes under the peroneus [fibularis] longus, and runs between the latseral and the lateral digital extensor to divide in the middle of the tibia into superficial (14) and deep (9) peroneal [fibular] n. They innervate the flexors of the tarsus and extensors of the digits.

The fleshy peroneus [fibularis] tertius (10), absent in the dog and entirely tendinous in the horse, originates in the extensor fossa of the femur with the long digital extensor, which it largely covers proximomedially. Its terminal tendon is perforated by that of the cranial tibial and ends on Mt III and Mt IV and under the medial collateral lig. on T II and T III.

The cranial tibial muscle (8) is smaller than in the horse and is covered by the peroneus tertius and long digital extensor. It is fused with the vestibial long extensor of digit I. It is sometimes possible to separate the two tendons, which end on T I and medially on Mt III and Mt IV.

The peroneus [fibularis] longus (11), which also occurs in the dog, but not in the horse, is narrow, forms its tendon in the middle of the crus, crosses the tendon of the lateral extensor, passes under the lateral collateral lig., runs across the plantar surface of the tarsus and ends on T I.

The long digital extensor (13) (See also the cranial tibial m.) has a superficial lateral belly (extensor of digits III and IV) and a deep medial belly (medial digital extensor, extensor of digit III).

Both tendons pass under the crural retinaculum with the tendons of the cranial tibil and peroneus tertius; whereas only the long digital extensor tendons pass under the metatarsal retinaculum. They are arranged in the pes like the corresponding tendons of the common digital extensor in the manus. The tarsal extensor retinaculum of the horse is absent in the ox.

The lateral digital extensor (extensor of digit IV, 12) originates from the lateral collateral lig. of the stifle and the lateral condyle of the tibia. It is a relatively large muscle that passes under the tendon of the peroneus longus and laterally over the tarsus to digit IV. Its tendon is arranged here like that of the muscle of the same name in the manus. The extensor digitalis brevis (15) is small; a peroneus brevis is absent as in the horse.
Medially on the thigh the gracilis is detached from the symphysial tendon and removed, except for a short distal stump. At the tarsus the two retinacula, the tendon sheaths, and the bursae are examined. After demonstration of the tarsal tendons of the biceps and semitendinosus, the medial head of the gastrocnemius is severed near its origin to expose the superficial digital flexor.

a) **MEDially ON THE THIGH** the muscles are innervated by the obturator n. only, or by the saphenous and obturator nn., or by the saphenous and obturator nn.

The obturator n. (6) **RUnS WITH THE obturator v.** medially on the body of the ilium, passes through the obturator foramen, and innervates the following muscles:

The **external obturator in the ox has an additional intrapelvic part (7)** that originates inside around the obturator foramen, but is not homologous to the internal obturator of other domestic animals.

The adductor magnus (et brevis, 9) originates from the ventral surface of the pelvis and from the symphysial tendon as in the horse, but is more closely bound to the semimembranosus by connective tissue. It terminates on the caudal surface of the femur, but does not extend to the epicondyle.

The pectineus (et adductor longus, 8) is more robust than in the horse. Its adductor part is innervated by the obturator n.; its pectineus part by the saphenous n. The tendons of origin come from the iliopubic eminence and pecten pubis, cross the median plane, and form with the tendons of the contralateral pectineus, the bulk of the prepubic tendon. Each pectineus terminates on the caudomedial surface of the body of the opposite femur. The gracilis (10) is innervated by the obturator n. supplemented by the saphenous n. It takes origin from the pelvic symphysis and the prepubic tendon. Its tendon forms, with that of the other side, the distinctive symphysial tendon, which is bean-shaped in the cow and equatorially triangular in the bull, indicating the sex of a split carcass.

At the level of the pelvis the femoral n. gives off the saphenous n. (4) (skin innervation, see p. 20), which not only supplies the last two muscles, but also is the sole innervation of the sartorius (3). This muscle originates by two heads: the cranial one from the tendon of the psosas minor and the iliac fascia, and the caudal one from the body of the ilium dorsocaudal to the tubercle for the psosas minor. The cran. head of the sartorius, the iliopsoas, and the femoral n. pass through the muscular lacuna. The caud. head passes through the vascular lacuna (p. 78).* The femoral n. enters the quadriceps femoris, whose four clearly separate heads it innervates. The rectus femoris (1) and the vastus lateralis—medialis (2), and—intermedius conform in origin and termination to the relationship in the horse. (See p. 17.) The femoral a. and v. and saphenous n. pass between the two origins of the sartorius on their way to the femoral triangle. The sartorius forms the medial wall of the triangle, the proximal border of which is formed by the pelvic tendon of the external oblique, the caudal border by the gracilis and pectineus, and the cranial border by the rectus femoris.

b) **O*N THE CRUS** the tibial nerve (12) gives off its distal muscular br. to the extensors of the tarsus and flexors of the digits, passes between the heads of the gastrocnemius, and reaches the medial side of the crus, at the distal end of which it divides into the lateral (13) and medial (14) plantar nn.

The peroneus (special flexor of the stifle) lies caudal to the stifle joint (see p. 29.4). The gastrocnemius (11) originates by two heads from the sides of the supracondylar fossa of the femur and terminates on the calcaneum tuber. It is very tendinous, and an intermediate fleshy tract connects the origin of the lateral head to the terminal tendon of the medial head, which is therefore bipartite. The tendon of the lateral head takes a deeper course and passes through a sheath formed by the tarsal tendons of the biceps and semitendinosus.** The gastrocnemius tendons (24) are separate until shortly before their attachment to the tuber calcanei. The robust soleus (see p. 17) fuses with the lateral head of the gastrocnemius and forms with the two heads the triceps surae. The superficial digital flexor lies between the heads of the gastrocnemius and is fused with the lateral head at its origin from the supracondylar fossa. Its thick terminal tendon (22) passes from the deep surface of the gastrocnemius tendon around the medial side to expand superficially over the tuber calcanei, to which it is attached. The spiral groove between the tendons is palpable in the live animal. The tendons of the gastrocnemius and supf. flexor, and tarsal tendons of the biceps and semitendinosus make up the common calcanean tendon—the hamstring of quadrupeds. On the pes the superficial flexor tendon is arranged as in the thoracic limb. The deep digital flexors include three muscles as in the horse: the caudal tibial (see p. 17) is the smallest; its belly is short and flat and its long narrow tendon lies on the caudal surface of the largest muscle—the lateral digital flexor (see p. 17). The tendons of these two muscles pass together over the sustentaculum tali; whereas the tendon of the medial digital flexor, as in the horse, passes over the medial surface of the tarsus (p. 29) and joins the other two in the proximal metatarsus to form the common deep flexor tendon, which is arranged as in the thoracic limb.

c) The **INTEROSSEI III AND IV** (see text figure) have the same supportive function for the main digits of the ox as the interosseus medius (III) in the horse. When the weight is on the foot and the fetlock joints are overextended, the interossei, through the sesamoid bones and distal sesamoid ligaments, aid the digital flexor tendons in support of the fetlock joints. Through their extensor branches attached to the med. and lat. (proper) digital extensor tendons they oppose the action of the deep flexor tendons on the coffin joints and ensure that the hoofs are planted on the solar surface. They have the same structure as on the thoracic limb (see p. 10, b). These muscles originate from the long plantar tarsal ligament and the proximal part of the metatarsal bone. In young animals they are relatively fleshy and in older animals predominantly tendinous. Interossei III and IV are fused along their axial borders in the metatarsus, but they separate and terminate on the corresponding digits. In the middle of the metatarsus the interossei give off the accessory lig., which bifurcates and joins the branches of the supf. digital flexor tendon at the level of the fetlock joints in the formation of the sleeves (manicae flexoriae) through which the branches of the deep flexor tendon pass.

Proximal to the fetlock joints each interosseus divides into two tendons, each with two extensor branches. The two tendons are attached to the sesamoid bones. A flat abaxial extensor branch passes across the surface of the sesamoid bone, to which it is attached, and joins the tendon of the proper digital extensor. The axial extensor branches remain fused together until they pass through the intercapital notch in the metatarsal bone. Then they separate and join the tendons of their respective proper digital extensors.

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* Traeder, 1968
** Pavaux, Lignereux, and Sautet, 1983
Pelvic Limb

Legend:

15 Internal abdominal oblique
16 External abdominal oblique
17 Sacrocaudalis [-coccygeus] ventralis medialis
18 Coccygeus
19 Levator ani
20 Semimembranosus
21 Semitendinosus
22 Superficial flexor tendon
23 Tarsal tendon of semitendinosus
24 Gastrocnemius tendon
25 Peroneus [fibularis] tertius
26 Cranial tibial n.

A Iliofemoral lymph node
B Tuberal lymph node

(See pp. 17, 21, 23, 29)
4. CUTANEOUS NERVES, BLOOD VESSELS AND LYMPH NODES OF THE PELVIC LIMB

a) The CUTANEOUS INNERVATION of the lateral rump and thigh regions is supplied, in craniocaudal order, by the cranial clunial nn. (dorsolat. cut. br. of L4 to L6), middle clunial nn. (dorso-solat. cut. br. of S1 to S3), and in the region of the tuber ischiadicum and major trochanter by caudal clunial nn. (cut. br. of the pudendal n., k) and the caudal cutaneous femoral n. (i), the cutaneous br. of which may be absent. In addition, the region of the biceps groove is supplied by cutaneous br. of the tibial n. (p) and the common peroneal [fibular] n. (o). A large area of skin in the craniolateral thigh region is supplied by the lateral cutaneous femoral n. (3). On the medial surface of the thigh the nerves are the iliohypogastric (1), ilioinguinal (2), and genitofemoral (4) (see also p. 91).

The innervation of the crus down to the hock is provided mainly medially, but also caudolaterally, by the saphenous n. (11); mainly caudolaterally by the caudal cutaneous sural n. (24) from the tibial n., and laterally also by the lateral cutaneous sural n. (25) from the common peroneal [fibular] n. The pes (see p. 23) is innervated dor-sally by dorsal common digital nn. II–IV from the superficial peroneal (o°), and in the interdigital region by dorsal metatarsal n. III (from the deep peroneal (o°), see p.11) and plantar common digital n. III (see p. 11). Plantar common digital nn. II–IV are branches of the medial (29) and lateral (28) plantar nn.

### Nerves of the pelvic limb

- **Saphenous n.**
- **Common peroneal n.**
- **Cutaneous br. of the pudendal n.**
- **Tibial n.**
- **Cran. clunial nn.**
- **Middle clunial nn.**
- **Lat. cut. femoral n.**
- **Caud. cut. femoral n.**
- **Caudal [coccygeal] nn.**

b) The BLOOD VESSELS of the pelvic limb come primarily from the external iliac a. and v., and to a lesser extent from the internal iliac a. and v. (14). The latter give off, caudal to the body of the ilium, the cranial gluteal a. and v. (15) for the gluteal muscles and the gluteobiceps. The internal iliac a. and v. terminate in the region of the lesser sciatic foramen by dividing into the caudal gluteal a. and v. (16) and the internal pudendal a. and v. The obturator n. (17) originates from the internal iliac immediately after the cranial gluteal v. An obturator a. is absent as in the dog. The external iliac a. and v. (13) leave the abdominal cavity through the umbilical a. and v. (10). The latter give off cranial branches without giving off cranial branches in the ox, unlike the dog and horse. On the dorsolateral surface of the tarsal joint the arterial and venous branches divide into the medial (29) and lateral (28) plantar nn.

Distal to the femoral triangle the femoral a. and v. give off the descending genicular a. and v. (7) to the stifle, and caudally the origins of the caudal femoral a. and v. (22) mark the transition between the femoral vessels and the popliteal a. and v. (23). The latter vessels pass between the heads of the gastrocnemius and give off the small caudal tibial a. and v. (8) cranial to the popliteus. Distal to that muscle they are continued as the large cranial tibial a. and v. (10). Before these pass distal to the tibiofibular synostosis to the craniolateral surface of the tibia, they give off the crural interosseous a. and v. (9) to the deep digital flexors. These vessels are absent in the dog and horse. On the dorsolateral surface of the tarsal joint the cranial tibial a. and v. become the large dorsal pedal a. and the small dorsal pedal v. (12), which, together with the deep peroneal [fibular] n., pass deep to the extensor retinaculum to the metatarsus (see p. 23).

c) The LYMPH NODES of the rump and pelvic limb belong to various lymphocenters. The deep popliteal ln., 3–4 cm long (see p. 17) in the popliteal space between the gluteobiceps and the semitendinosus collects the lymph from the pes and a large part of the crus. The supf. popliteal ln. is absent.

The sciatic ln., 2–3 cm in diameter (see p. 17) lies on the lateral surface of the sacrosciatic ligament at the lesser sciatic foramen and receives lymph from the caudal femoral muscles.

The conspicuous iliofemoral (deep inguinal) ln. (see p. 19) drains the femur, thigh, crus, and the large lateral gluteal artery and vein. The subscapular ln. (p. 67, 5) may reach a length of 10 cm. It drains the skin of the rump, thigh, stifle, and crus. In meat inspection all of these lymph nodes are examined in retained carcasses. In addition, the coxal ln. (not shown) lies medial to the tensor fasciae latae, and the following ln. are present in the ox, but not in the dog and horse: gluteal ln. (see p. 17) at the greater sciatic notch, and the tuberal ln. (see p. 19) on the medial surface of the tuber ischiadicum. The lymph is drained through the sacral, sciatic, iliofemoral, medial and lateral iliac, ln. and through the lumbar trunks to the cisterna chyli.
Arteries, Veins, and Nerves of the pelvic limb

Legend:
a  Caudal vena cava
b  Aorta
c  Ovarian a. and v.
d  Umbilical a.
e  Deep circumflex iliac a. and v.
f  Femoral n.
g  Median sacral a. and v.
h  Caudal gluteal n.
i  Caudal cut. femoral n.
j  Pudendal n.
k  Vaginal a. and v.
l  Accessory vaginal v.
m  Common peroneal [fibular] n.
o  Deep peroneal [fibular] n.
o'  Supf. peroneal [fibular] n.
p  Tibial n.
q  Deep brr. of the medial plantar a. and v.

(See pp. 17, 19, 23)
a) The PLANTAR NERVES of the tarsus and metatarsus come from the tibial nerve alone. (See the palmar nerves, p. 8. For blood vessels, see p. 20.)

The tibial n. divides into the medial and lateral plantar nn at the distal end of the crus, as in the dog and horse. The medial plantar n. (5) passes over the medial side of the tarsus to the metatarsus, covered by fascia and accompanied by the medial plantar a. and v. In the metatarsus it runs in the palpebral medial groove between the interosseus and the deep flexor tendon, accompanied by the superficial branches of the medial plantar a. and v., to the distal third of the metatarsus, where it divides with the vessels into plantar common digital aa., vv., and nn. II (9) and III (8).

Plantar common digital n. II (9) and the vessels of the same name give off proximal to the fetlock joint the small axial plantar digital a., v., and n. II (11) to the medial dewclaw, and the continuing abaxial plantar digital a., v., and n. III (17). This nerve and the artery on its plantar side cross deep to the distal ligament of the dewclaw, while the more dorsal vein crosses superficially, to the abaxial bulb and hoof regions of the third digit to the apex.

The large plantar common digital n. III (8) turns across the plantar surface of the medial branch of the supf. dig. flexor tendon, crosses the artery of the same name, and runs between this and the mediially located vein to the interdigital space. The nerve may occasionally be double, or it may divide over a short distance and reunite. At the middle of the proximal phalanx, it and the accompanying vessels divide into the axial plantar digital aa., vv., and nn. III (20) and IV (19). These supply the abaxial bulb and hoof regions of the third and fourth digits, as the corresponding abaxial structures do (see also p. 11, upper right fig.).

Before their distribution the nerves each receive a communicating branch from the junction of the superficial and deep dorsal nn., and the plantar common digital a. and v. III (8) anastomose at their bifurcation with dorsal mt. a. and v. III via the interdigital a. and v. (Compare the corresponding vessels of the manus, p. 10.)

The lateral plantar n. accompanied by the lateral plantar a. and v., if present, cross distolaterally deep to the long plantar tarsal lig. and reach the metatarsus (see p. 21). The nerve, after reaching the lateral border of the deep flexor tendon just distal to the tarsus, gives off its deep branch to the interossei III and IV and becomes plantar common digital n. IV (5). The latter, accompanied by plantar common digital a. IV (5), takes a course like that of plantar common dig. n. II, and divides with the vessels into axial plantar digital a., v., and n. V (10) and abaxial plantar digital a., v., and n. IV (18), which are distributed as the corresponding structures of digits II and III are. Plantar common digital v. IV comes from the distal deep plantar arch, and is very short.

A communicating branch between the lateral and medial plantar mn., present in the horse, is absent in the ox. Deep plantar mt. mn., present in the dog and horse, are absent in the ox, as are corresponding mn. in the thoracic limb. The deep plantar vessels, plantar mt. aa. and vv. II–IV, vary in size. They are similar to the deep palmar vessels on the manus.

b) The DORSAL NERVES of the pes come from the superficial and deep peroneal [fibular] nn. (For blood vessels see p. 20.)

The superficial peroneal n. (2) is distributed as in the dog, but unlike that of the horse, it supplies superficial digital nn. In the crus it gives off dorsal common digital n. IV (6). This crosses distolaterally, deep to the large cranial br. of the lat. saphenous v. (2) and the insigificant supf. br. of the dorsal pedal a., runs lateral to the tendon of the lat. dig. extensor in the proximal half of the metatarsus, and in the distal half crosses deep to the large dorsal common dig. v. IV (6). The nerve then runs on the dorsal side of plantar common dig. v. IV to the level of the fetlock joint, where it divides into the small axial dorsal dig. n. V (14) to the lateral dewclaw, and the continuous abaxial dorsal dig. n. IV (15) to the dorsolateral coronary and bulbar regions of the fourth digit.

The remaining trunk of the supf. peroneal n. courses medial to the cranial br. of the lat. saphenous v. to the dorsal surface of the metatarsus. Separated by the vein from the parallel dorsal common dig. n. IV, it divides at the end of the proximal third of the mt. into the large dorsal common dig. n. III and the small dorsal common dig. n. II (4). This crosses obliquely mediolaterally over mt. III, without accompanying vessels, to the dorsomedial side of the fetlock joint and divides into axial dorsal dig. n. II (12) and abaxial dorsal dig. n. III (13). These nerves are distributed like the corresponding nerves of the fifth and fourth digits. The continuing dorsal common dig. n. III (7), accompanied laterally by dorsal common dig. v. III (7), runs on the tendon of the lateral belly (common extensor of digits III and IV, see p. 16) of the long digital extensor to the interdigital space. Distal to the fetlock joint it divides into axial dorsal dig. nn. III (21) and IV (22). Just before the division it sends a communicating br. to the (deep) dorsal mt. n. III (to be described).

The deep peroneal n., accompanied by the large dorsal pedal a. and the small dorsal pedal v., runs on the flexion surface of the tarsus deep to the long and lat. dig. ext. tendons and the crural and metatarsal extensor retinacula to the metatarsus. Here the nerve and vessels become dorsal mt. a., v., and n. III (1). They run along the dorsal longitudinal groove on the metatarsal bone to the interdigital space.

Dorsal mt. n. III receives the communicating br. from the dorsal common dig. n. III, and the resulting short common trunk divides into communicating brr. to the axial plantar dig. nn.

The dorsal vessels are distributed like the corresponding vessels of the manus. (See p. 11, upper right fig.)

The dorsal and plantar abaxial dig. nn. may be connected by a communicating br. as in the thoracic limb.

Arteries and Veins of the Pes (plantar)

<table>
<thead>
<tr>
<th>(lateral)</th>
<th>(medial)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caud. br. of lat. saphenous v.</td>
<td>Caud. br. of med. saphenous a. and v.</td>
</tr>
<tr>
<td>Prox. deep plantar arch</td>
<td>Anastomotic br. to med. saphenous v.</td>
</tr>
<tr>
<td>Med. plantar a. and v.</td>
<td>Rete calcaneum</td>
</tr>
<tr>
<td>Supr. brr.</td>
<td></td>
</tr>
<tr>
<td>Plantar metatarsal aa. and vv.</td>
<td></td>
</tr>
<tr>
<td>Plantar common digital aa., vv., and nn.</td>
<td>Dist. deep plantar arch</td>
</tr>
<tr>
<td>Dist. perforating brr.</td>
<td>Dist. perforating brr.</td>
</tr>
<tr>
<td>Br. to digit V</td>
<td>Deep brr.</td>
</tr>
<tr>
<td>Interdigital a. and v.</td>
<td>Supr. brr.</td>
</tr>
<tr>
<td>Abaxial plantar digital a. and v. of digit IV</td>
<td>Plantar common digital aa., vv., and nn.</td>
</tr>
<tr>
<td>Axial plantar digital aa. and vv. of digits IV and III</td>
<td></td>
</tr>
</tbody>
</table>

(See pp. 11, 21, and 23)
Arteries, Veins, and Nerves of the Pes

Legend:

Tendons:
a Supf. dig. flexor
b Deep dig. flexors and Interossei III and IV:
c Abax. extensor brr.
d Tendon of interosseus III
e Long dig. extensor
f Medial extensor of dig. III
g Extensor digitalis brevis
h Accessory lig. of interossei
i Plantar annular lig.
j Prox. dig. annular lig.
k Dist. dig. annular lig.
l Supf. part of dist. interdig. lig.
m Dist. lig. of dewclaw
n Collateral lig.
o Abax. plant. lig. of pastern joint

(See pp. 11, 17, 19, 21)
6. DERMIS OF THE HOOF

a) THE HOOFS are fully developed on both main digits (3 and 4). They are composed of modified skin with a thick, strongly cornified epidermis. The hoof surrounds the skeletal and soft structures of the distal part of the digit. The main hooves have an elongated half-round form, and together they serve the same function as the equine hoof, giving rise to the false concept of the “clown hoof.”

The terms of direction used on the equine hoof—dorsal and palmar or plantar, as well as proximal and distal—apply to the bovine hoof, but medial and lateral are replaced by axial and abaxial with reference to the long axis of the limb, which passes between the main digits.

The Dextoeclaus are reduced digits II and V that are attached, without synovial joints, by fascial ligaments at the level of the fetlock joint (see p. 10). They do not reach the ground, except in soft footing. The short conical dextoeclaus are, in principle, composed of the same modified skin layers as the main hoofs. They usually have only two phalanges, sometimes only the distal one.

The hairless skin covering the end of the digit is distinctly modified in its three layers—subcutis, dermis, and epidermis—compared to the haired skin (common integument). These three layers are modified in different parts of the hoof to form five segments: periople, corona, wall, sole, and bulb (see also p. 27).

The Subcutis is absent in two segments (wall and sole), but in the other segments forms relatively firm immovable cushions that consist of a three-dimensional network of transverse, longitudinal, and oblique robust connective tissue fibers with enclosed fat lobules. In the bulb there is an especially thick cushion that absorbs the shock when the foot is planted.

The Dermis consists of a deep reticular layer and a more superficial papillary layer. The papillary layer, with the exception of the wall segment, bears dermal papillae. These papillae arise either from a smooth surface or from parallel dermal ridges. The wall segment presents parallel dermal lamellae directed from proximal to distal. In some places (proximally and distally) the lamellae bear a row of cap papillae on their free edge.

The deep layers of the Epidermis conform to the dermal papillae and lamellae, producing tubular horn in all segments except the wall, and lamellar horn in the wall segment. (See p. 25, middle and lower figures.)

b) THE SEGMENTS OF THE HOOF can be clearly distinguished on the dermal surface when the horn capsule is removed after maceration in warm water. The perioplic segment is next to the haired skin. The coronary and wall segments follow distally. The horn formed in these segments moves from proximal to distal and makes up the horn wall (paries corneus). This turns from the abaxial surface to the axial surface at the dorsal border (Margo dorsalis) of the hoof. The horn formed in the sole and bulbar segments makes up the ground surface of the hoof. In clinical practice the entire ground surface is often called the sole.

I. The perioplic segment (Limbus, 1) is about 1 cm wide. Dorsally and abaxially the subcutis forms a slightly convex perioplic cushion, absent on the axial surface. On the palmar/plantar surface it expands and is continuous with the digital cushion in the bulb. The perioplic dermis (6) covers the subcutis and bears fine distally directed perioplic papillae about 2 mm long and relatively sparse. Abaxially it is separated by a shallow groove from the dermis of the haired skin. The perioplic (Epidermis limbi, 1) covers the dermis and forms horn tubules (12) on the dermal papillae. The soft periplic horn grows distally as the external layer of the wall. It usually does not reach the distal border because it flakes off easily. When moist it is markedly swollen.

II. Coronary segment (Corona): The coronary segment is distal to the perioplic segment and extends to a level about halfway down the hoof, unlike that of the horse. The subcutis forms the coronary cushion, which is wide and only slightly convex. Its width and thickness decrease on both sides of the hoof in the palmar/plantar direction. The coronary dermis (7) bears fine conical coronary papillae, rounded off at the ends. At their base they are thicker and project horizontally, whereas the apical portion is inclined distally in the direction of growth. The inflection of the coronary segment that forms part of the bar in the horse is slightly indicated at the abaxial end of the lamellar dermis. The coronary epidermis (2) forms horn tubules (13) which correspond to the dermal papillae and make up the middle layer of the wall. The thickest, mostly unpigmented, tubules are in the middle layer of the coronary horn, whereas thinner tubules in the outer layer and indistinct or distally absent tubules in the inner layer are typical.

III. The Wall segment (Paries) is distal to the coronary segment and of about equal width. The inflection of the wall that forms part of the bar in the horse is only slightly indicated. The subcutis is absent from the wall segment. The lamellar (parietal) dermis (8) bears proximodorsally oriented dermal lamellae. These are smooth; unlike those of the horse, no secondary lamellae are present. The wall epidermis (11) bears epidermal lamellae (14) between the dermal lamellae. The epidermal lamellae are cornified in their middle layers to form the horny lamellae. Unfortunately two different meanings of the word wall complicate the description of the hoof. The horny wall (lamina, hoof plate, Paries corneus) is the more common, broader concept. Homologous to the human fingernail, it is the part of the hoof capsule that includes three layers formed by the perioplic, coronal, and wall segments. The wall segment might better be called the lamellar segment, keeping in mind the distinction between the lamina and its lamellae.

IV. Sole segment (Solea): In artiodactyls this is a narrow crescent inside the white zone (5). It is divided into a dorsal body and axial and abaxial crura (see text fig. p. 26). The subcutis is absent. The solcar dermis (9) bears low transverse ridges topped by dermal papillae, with the result that the papillae are arranged in rows. The solcar epidermis (3) contains horn tubules (15).

V. Bulbar segment (Torus unguae): The bulbar segment lies palmar/plantar to the sole and between its crura. It extends back to the haired skin. The subcutis forms the digital cushion, which distinguishes the bulb from the sole. In the apical part of the bulb the cushion is 5 mm thick; in the basal part it is up to 20 mm thick. These two parts may be demarcated by an imaginary line connecting the ends of the white zone (see text fig. p. 26). The digital cushion is covered by the bulbar dermis (10), which bears dermal papillae. These arise in part from discontinuous low, wavelike ridges. Upon the dermis lies the bulbar epidermis (4), containing horn tubules (16). The harder bulbar horn between the crura of the sole presents a flat ground surface. This apical portion is more prominent and more obviously part of the bulb in the sheep, goat, and pig. The horn in the base of the bulb is, depending on the state of hoof care, more or less markedly split into scale-like layers of soft, elastic rubbery consistency. (For segments of the hoof, see also p. 27.)
7. THE HOOF (UNGULA)

a) The hoof capsule surrounds: the distal end of the middle phalanx (c), the distal interphalangeal joint (l), and the distal phalanx (coffin bone, D) with the terminations of the common dig., extensor tendon (E) on the extensor process and the deep dig. flexor tendon (K) on the flexor tubercle. Also enclosed is the distal sesamoid (navicular) bone (E), which serves as a trochlea for the deep dig. flexor tendon. The navicular bursa (M) reduces friction between them.

The cornified hoof capsule consists of the lamina (horny wall) with an abaxial part, a dorsal border, and an axial part facing the interdigital space, as well as the horn sole and horn bulb. The capsule has a thickness of about 10 mm in the dorsal part and about 5 mm in the axial part. The growth of the epidermis pushes the cornified masses distally at a rate of about 5 mm per month. After an exungulation the renewal of the entire hoof capsule would require up to 20 months. Horn formation is more intensive in calves than in adults and more active on the pelvic than on the thoracic limb. In the last third of pregnancy and in very high milk production, horn formation is reduced. That is shown on the superficial surface of the hoof by the formation of semicircular grooves.

When cattle are kept on soft footing with little or no possibility of exercise the horn grows faster than it is worn off and therefore the hoofs must be trimmed regularly.

I. The lamina (Paries corneus) consists of external, middle, and internal layers, which are bonded together and formed by the peripheric, coroneal, and wall segments respectively. The external layer is very thin; the middle layer constitutes the bulk of the lamina; and the internal layer bears the horny lamellae that make up the junctional horn.

II. The junctional horn is part of the suspensory apparatus of the coffin bone. This term includes all of the tissues that attach the coffin bone (distal phalanx) to the inside of the lamina. The suspensory apparatus of the coffin bone consists of a connective tissue (dermal) part and an epidermal part. Collagenous fiber bundles anchored in the outer zone of the coffin bone run obliquely proximodorsally in the reticular layer and then in the lamellae of the dermis. The collagen fibers are attached to the basement membrane. The tension is then transmitted through the living epidermal cell layers by desmosomes and bundles of keratin filaments to the junctional horn.

III. The rate of horn formation differs greatly among the individual hoof segments. In the coronary segment horn formation is very intensive. In the proximal half of the wall segment the rate of horn formation is low. In the distal half, on the other hand, horn is formed in measurable amounts and at an increasing rate toward the apex of the hoof. (The term sterile bed, used in older textbooks for the wall segment is therefore incorrect.) Proximally in the wall segment the beginnings of the dermal lamellae bear proximal cap papillae. From the epidermis on these papillae, nontubular proximal cap horn is produced. This is applied to the sides of the proximal parts of the horn lamellae. Distal to the cap horn, as far as the middle of the wall, not much lamellar horn is added. In the distal half of the wall segment the horny lamellae become markedly higher, up to 5 mm, and, beginning with their middle portion, become flanked by amorphous distal cap horn that is applied cap-like over the edges of the dermal lamellae. It is formed on the distal cap papillae by the living epidermis there (see p. 27, right figure).

Distally on the wall-sole border the almost vertically directed dermal lamellae bend into horizontally directed dermal ridges of the sole segment. At the bend the lamellae are split into terminal dermal papillae which have a remarkable diameter of 0.2–0.5 mm. They are covered by living epidermis from which terminal tubular horn is formed. As a part of the white zone the terminal horn fills the spaces between the horny lamellae (see p. 27, right figure).

IV. The white zone (white line) consists only of horn produced by the wall segment, and presents external, middle, and internal parts. The external part (a) appears to the naked eye as a shining white millimeter-wide stripe. It consists of the basal sections of the horny lamellae and the flanking proximal cap horn, and borders the mostly nonpigmented inner coronary horn, which does not belong to the zona alba. The middle part (b) of the white zone is formed by the intermediate sections of the horny lamellae with the distal cap horn that lies between them. The internal part (c) of the white zone consists of the wall parts of the horny lamellae and, between them, the terminal tubular horn. They cornify in the distal half of the wall or at the wall-sole border.

The white zone has abaxial and axial crura (b', b''), which lie between the mostly unpigmented coronary horn and the sole horn. The axial crus ends halfway between the apex of the hoof and the palmar/plantar surface of the bulb.

V. Horn quality is the sum of the characteristics of the biomaterial horn, including hardness or elasticity, resistance to breakage, water absorption, and resistance to chemical and microbial influences. Horn quality is adapted to the biomechanical requirements of the different parts of the hoof. Accordingly, hard horn is found in the lamina; soft elastic horn in the proximal part of the bulb. Horn quality can be determined by morphological criteria in combination with data from physicotechnical material testing.
a) JOINTS OF THE PELVIC LIMB

<table>
<thead>
<tr>
<th>NAME</th>
<th>BONES involved</th>
<th>TYPE OF JOINT</th>
<th>FUNCTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Hip joint</td>
<td>Ilium, ischium, pubis in acetabulum, and head of femur</td>
<td>Composite spheroidal</td>
<td>Restricted to flexion and extension</td>
<td>Ligaments: transverse acetabular, labrum acetabulare, lig. of head of femur. Accessory lig. absent.</td>
</tr>
<tr>
<td>II. Stifle</td>
<td>Tibial condyles and femoral condyles</td>
<td>Simple condylar</td>
<td>Mainly flexion and extension restricted by ligaments</td>
<td>Ligg.: collateral, cruciate, transverse, meniscotibial, menisco-femoral. Injection: Med. sac, same as II b. Lat. sac in extensor groove of tibia on border of tendon of peroneus tertius; does not communicate with any other sac.*</td>
</tr>
<tr>
<td>a) Femorotibial joint</td>
<td>Femoral trochlea and patella</td>
<td>Simple sesamoid</td>
<td>Tendon guide</td>
<td>Ligg.: med., middle, and lat. patellar, and med. and lat. fem.-patel. Injection: 4 cm. prox. to tibial tuberosity, between med. and middle patellar ligg. Communicates with med. fem.-tibial sac.</td>
</tr>
<tr>
<td>b) Femoropatellar joint</td>
<td>Femoral trochlea and patella</td>
<td>Simple sesamoid</td>
<td>Tendon guide</td>
<td>Ligg.: med., middle, and lat. patellar, and med. and lat. fem.-patel. Injection: 4 cm. prox. to tibial tuberosity, between med. and middle patellar ligg. Communicates with med. fem.-tibial sac.</td>
</tr>
<tr>
<td>III. Prox. tibiofibular joint</td>
<td>Tibial cochlea, prox. trochlea of talus, calcaneus, and lat. malleolus</td>
<td>Composite joint</td>
<td>Flexion and extension, snap joint</td>
<td>The collateral ligg. each have long and short parts. Long plantar lig. is divided into medial and lat. branches. Many other ligg. are blended with the fibrous joint capsule. Injection: Into dorsomed. pouch between med. collat. lig. and med. branch of tendon of cran. tibial muscle</td>
</tr>
<tr>
<td>IV. Distal tibiofibular joint</td>
<td>Distal trochlea of talus, calcaneus, and T IV + T C.</td>
<td>Composite joint</td>
<td>Flexion and extension</td>
<td>The collateral ligg. each have long and short parts. Long plantar lig. is divided into medial and lat. branches. Many other ligg. are blended with the fibrous joint capsule. Injection: Into dorsomed. pouch between med. collat. lig. and med. branch of tendon of cran. tibial muscle</td>
</tr>
<tr>
<td>V. Tarsal joint (hock)</td>
<td>Tibial cochlea, prox. trochlea of talus, calcaneus, and lat. malleolus</td>
<td>Composite joint</td>
<td>Flexion and extension, snap joint</td>
<td>The collateral ligg. each have long and short parts. Long plantar lig. is divided into medial and lat. branches. Many other ligg. are blended with the fibrous joint capsule. Injection: Into dorsomed. pouch between med. collat. lig. and med. branch of tendon of cran. tibial muscle</td>
</tr>
<tr>
<td>a) Tarsocrural joint</td>
<td>Distal trochlea of talus, calcaneus, and T IV + T C.</td>
<td>Composite joint</td>
<td>Flexion and extension</td>
<td>The collateral ligg. each have long and short parts. Long plantar lig. is divided into medial and lat. branches. Many other ligg. are blended with the fibrous joint capsule. Injection: Into dorsomed. pouch between med. collat. lig. and med. branch of tendon of cran. tibial muscle</td>
</tr>
<tr>
<td>b) Prox. intertarsal joint</td>
<td>Distal trochlea of talus, calcaneus, and T IV + T C.</td>
<td>Composite joint</td>
<td>Flexion and extension</td>
<td>The collateral ligg. each have long and short parts. Long plantar lig. is divided into medial and lat. branches. Many other ligg. are blended with the fibrous joint capsule. Injection: Into dorsomed. pouch between med. collat. lig. and med. branch of tendon of cran. tibial muscle</td>
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<tr>
<td>c) Dist. intertarsal joint</td>
<td>Distal trochlea of talus, calcaneus, and T IV + T C.</td>
<td>Composite joint</td>
<td>Flexion and extension</td>
<td>The collateral ligg. each have long and short parts. Long plantar lig. is divided into medial and lat. branches. Many other ligu. are blended with the fibrous joint capsule. Injection: Into dorsomed. pouch between med. collat. lig. and med. branch of tendon of cran. tibial muscle</td>
</tr>
<tr>
<td>d) Tarsometatarsal joint</td>
<td>Distal trochlea of talus, calcaneus, and T IV + T C.</td>
<td>Composite joint</td>
<td>Flexion and extension</td>
<td>The collateral ligg. each have long and short parts. Long plantar lig. is divided into medial and lat. branches. Many other ligu. are blended with the fibrous joint capsule. Injection: Into dorsomed. pouch between med. collat. lig. and med. branch of tendon of cran. tibial muscle</td>
</tr>
<tr>
<td>e) Intertarsal joints. Vertical, slightly moveable joints between tarsal bones in the same row.</td>
<td>Composite joint</td>
<td>Flexion and extension</td>
<td>The collateral ligg. each have long and short parts. Long plantar lig. is divided into medial and lat. branches. Many other ligu. are blended with the fibrous joint capsule. Injection: Into dorsomed. pouch between med. collat. lig. and med. branch of tendon of cran. tibial muscle</td>
<td></td>
</tr>
</tbody>
</table>

b) SYNOVIAL BURSAE

Of the inconstant bursae, the iliac (coxal) subcutaneous bursa, unilaterally or bilaterally over the tuber coxae, and the ischial subcutaneous bursa laterally on the tuber ischiadicum, are clinically important. Of the important bursae related to the major trochanter, the inconstant trochanteric bursa of the gluteus medius is on the summit and mediodistal surface of the trochanter. The constant trochanteric bursa of the gluteus accessorius is on the lateral surface of the femur just distal to the major trochanter. The clinically important, but inconstant trochanteric bursa of the biceps femoris is between the vertebral head of the biceps and the terminal part of the gluteus medius on the major trochanter. This bursa may be the cause of a dislocation of the vertebral head of the biceps behind the major trochanter.

The large, up to 10 cm long, constant distal subcutaneous bursa of the biceps femoris lies between the lat. femoral condyle and the thick terminal tendon of the biceps attached to the patella and the lat. patellar lig. Occasionally it communicates with the lat. femorotibial joint. When inflamed it produces a decubital swelling on the stifle.

The inconstant subcutaneous bursa of the lat. malleolus, when inflamed, produces a decubital swelling on the tarsus.

The multilocular subcutaneous calcanean bursa on the calcaneau expansion of the supf. digital flexor tendon is also inconstant and occurs only in older animals.

The constant, extensive subcutaneous calcanean bursa of the supf. digital flexor lies between that tendon and the termination of the gastrocnemius on the tuber calcanei. The navicular (podotrochlear) bursae (p. 27, M) between the terminal branches of the deep digital flexor tendon and the navicular bones are like those of the thoracic limb.

c) SYNOVIAL SHEATHS

Dorsally on the hock the tendons of the peroneus longus and the digital extensors are surrounded by synovial sheaths. The sheaths of the digital extensors communicate partially with the sheath of the cranial tibial and the sheath-like bursa of the peroneus tertius.

On the plantar aspect of the hock the lat. digital flexor and the caudal tibial m. have a common sheath, and the med. digital flexor has a separate sheath. The tendon sheaths in the digits are like those of the thoracic limb.
Joints, Bursae, and Synovial Sheaths of the Pelvic Limb

Legend:

A Med. collateral lig.
B Lat. collateral lig.
C Med. patellar lig.
D Middle patellar lig.
E Lat. patellar lig.
F Csd. tibial lig. of lat. meniscus
G Csd. tibial lig. of med. meniscus
H Meniscofemoral lig.
I Csd. cruciate lig.
J Cr. cruciate lig.
K Cr. tib. lig. of lat. meniscus
L Cr. tib. lig. of med. meniscus

Legend:

M Lat. long collateral tarsal lig.
M’ Lat. short collateral tarsal lig.
N Long plantar lig.
O Med. long collateral tarsal lig.
O’ Med. short collateral tarsal lig.
P Dorsal tarsal lig.

Legend:

Deep digital flexors
7 Lat. digital flexor
8 Caud. tibial m.
9 Med. digital flexor
10 Tarsal tendon of biceps femoris
11 Gastrocnemius
12 Supf. digital flexor
13 Tarsal tendon of semitendinosus
14 Short digital extensor (in part)
15 Interossei III and IV
16 Extensor retinacula
17 Flexor retinaculum

Legend:

A Med. collateral lig.
B Lat. collateral lig.
C Med. patellar lig.
D Middle patellar lig.
E Lat. patellar lig.
F Csd. tibial lig. of lat. meniscus
G Csd. tibial lig. of med. meniscus
H Meniscofemoral lig.
I Csd. cruciate lig.
J Cr. cruciate lig.
K Cr. tib. lig. of lat. meniscus
L Cr. tib. lig. of med. meniscus

Legend:

M Lat. long collateral tarsal lig.
M’ Lat. short collateral tarsal lig.
N Long plantar lig.
O Med. long collateral tarsal lig.
O’ Med. short collateral tarsal lig.
P Dorsal tarsal lig.

Legend:

Deep digital flexors
7 Lat. digital flexor
8 Caud. tibial m.
9 Med. digital flexor
10 Tarsal tendon of biceps femoris
11 Gastrocnemius
12 Supf. digital flexor
13 Tarsal tendon of semitendinosus
14 Short digital extensor (in part)
15 Interossei III and IV
16 Extensor retinacula
17 Flexor retinaculum
CHAPTER 3: HEAD

1. SKULL AND HYOID APPARATUS

The bovine skull undergoes marked changes in shape as it grows from the newborn calf to the adult—changes that are caused in part by the development of the horns. In the process, the roof of the cranium, the occipital surface, and the lateral surfaces alter their relative positions significantly.

a) On the CRANIUM, the roof (Calvaria) is formed by the rectangular frontal bones (I). They extend back to the caudal surface of the intercornual protuberance (3), where they are fused with the parietal (II) and interparietal (III) bones. These are united with the occipital (VI) bone, but no sutures are visible here in the adult. The external occipital protuberance (31), the point of attachment of the funicular lig. nuchae, is about 6 cm ventral to the top of the skull. The nuchal line (m), arching laterally from the external occipital protuberance, corresponds to the nuchal crest of the horse and dog. On the caudolateral angle of the frontal bone is the cornual process (36). The infraorbital foramen (59) is the double canal for the hypoglossal n. (35). Dorso- lateral to the petrous temporal bone is the internal opening of the temporal meatus (e). There is a lateral opening (e) in the temporal fossa. The ox does not have a foramen lacerum; it has an oval foramen (45) for the mandibular n., connected by the petro-occipital fissure (a) with the jugular foramen (q), which conducts cranial nerves IX, X, and XI. Before the internal carotid a. is occluded at three months of age, it goes through the fissure. In the caudal part of the orbit are three openings: from dorsal to ventral, the ethmoid for. (2), the optic canals (52), and the for. orbitorotundum (44), (the combined orbital fissure and round for. of the horse and dog). The pointed projection lat. to these is the pterygoid crest (46). On the dorsal surface the frontal bone is pierced medial to the zygomatic process by the supraorbital canal (1), often double, which opens in the orbit. The palpable supraorbital groove (1) runs rostrally and caudally from the canal.


e) The HYOID APPARATUS (Text figure). The body (basihyoid) gives off a stubby median lingual process. The thyrohyoid fuses later with the body and articulates with the rostral horn of the thyroid cartilage of the larynx. The ceratohyoid articulates with the body and with the rod-shaped epihyoid, which in turn articulates with the long, flattened stylohyoid. The last three joints are synovial. The proximal end of the stylohyoid is joined by the fibrocartilaginous tympanohyoid to the stylohyoid process. The angle of the stylohyoid is drawn out in the form of a book.
2. SKULL WITH TEETH

DENTITION.

The formula for the permanent teeth is:
\[ 2 \left( \frac{1}{2} C \frac{1}{2} P \frac{1}{2} M \right) = 32 \]
where I = incisor, C = canine, P = premolar, and M = molar.

The formula for the deciduous teeth (milk teeth) is:
\[ 2 \left( DI \frac{1}{2} DC \frac{1}{2} DP \right) = 20 \]
where Di = deciduous incisor, Dc = deciduous canine, and Dp = deciduous premolar.

In domestic ruminants the missing upper incisors and canines are replaced by the dental pad (p. 45, a) a plate of connective tissue covered by cornified epithelium.

The individual TEETH have a crown, neck, and root. They consist of dentin (ivory), enamel, and cement. The five surfaces of a tooth are: lingual, vestibular (labial or buccal), occlusal, and two contact surfaces. The mesial contact surface of the incisors is toward the median plane; on all other teeth it is directed toward the incisors. The opposite contact surface is distal. Although the upper incisors and canines are absent after birth, the primordia are present in the embryo.

The canine teeth (C) have the shape of incisors (I1, 2, 3) with a definite neck and a shovel-shaped crown; therefore they are commonly counted as the fourth incisors. When these teeth erupt, the crown is covered briefly by a thin pink layer of gingival mucosa, and neighboring teeth overlap, but by the end of the first month they have rotated so that they stand side by side. The permanent incisors erupt at about the following ages: I1, 1½-2 yrs.; I2, 2-2½ yrs.; I3, 3 yrs.; C, 3½-4 yrs. At first the crown is completely covered by enamel; lingual and labial surfaces meet in a sharp edge. The lingual surface is marked by enamel ridges extending from the occlusal border about two thirds of the way to the neck. As the tooth wears, the thin lingual enamel is abraded faster than the thick labial plate, keeping the tooth beveled to a sharp edge (see text fig.). The darker, yellowish dentin is exposed and forms most of the occlusal surface. The dental star appears, filled with secondary dentin. The lingual border of the occlusal surface is notched between the ridges on the lingual surface. When the tooth wears down to the point where the ridges disappear, the lingual border of the occlusal surface is a smooth curve and the tooth is said to be level. This usually occurs in sequence from I1 to C at 6, 7, 8, and 9 years. Deciduous incisors and canines are smaller than permanent teeth and have narrower necks. The first premolar is missing, so that the first cheek tooth is P2. Between the canines and the premolars in the lower jaw there is a space, the diastema (J), with no teeth. The size of the cheek teeth increases greatly from rostral to caudal. The incisors and canines are brachydont teeth; they do not grow longer after they are fully erupted, and they do not have infundibula. The cheek teeth are hypsodont; they continue to grow in length after eruption, but to a lesser extent than in the horse.

The infundibula of the cheek teeth develop by infolding of the enamel organ. (See text fig.) When tooth erupts the central enamel of each infundibulum is continuous with the external enamel in a crest. As the crest wears off the infundibulum is separated from the external enamel and the dentin is exposed between them. In ruminants the sections of the infundibula visible on the occlusal surface are crescentic. The infundibula are partially filled by cement and blackened feed residue. The outside of the newly erupted tooth is also coated with cement.

The upper premolars have one infundibulum and three roots. The upper molars have two infundibula and three roots. The horns of the crescents of all the infundibula of the upper cheek teeth point toward the buccal surface. The lower premolars (P2, 3, 4) are irregular in form. P2 is small and has a simple crown, usually without enamel folds. P3 and P4 have two vertical enamel folds on the lingual surface. On P4 the caudal one may be closed to form an infundibulum. The lower premolars have two roots. The lower molars (M1, 2, 3) have two infundibula and two roots. The horns of the infundibula point toward the lingual surface.

The lower jaw is narrower than the upper jaw, and the occlusal surface of the upper cheek teeth slopes downward and outward to overlap the buccal edge of the lower teeth, but the lateral motion of the mandible in chewing, first on one side and then on the other, wears the occlusal surfaces almost equally.

Directions for the use of figures on p. 31: features marked with an asterisk (◆) — upper fig.; those marked with a square (□) — lower fig.; those marked with a bullet (●) — p. 33 upper figure; those marked with a rhombus (●) — p. 33 lower figure.
3. SKULL WITH PARANASAL SINUSES AND HORN

a) The PARANASAL SINUSES (see also p. 45) may be studied from prepared skulls, but many of the clinically important septa are not solid bone; they are completed by membranes that do not survive maceration. The paranasal sinuses develop by evagination of the nasal mucosa into the spongous bone (diploe, b, p. 33) between the external and internal plates (a, c) of the cranial and facial bones. Therefore each sinus is lined by respiratory epithelium and, except for the lacrimal and palate sinuses, which are diverticula of the maxillary sinus, each has a direct opening to the nasal cavity. Unfortunately, when inflammation occurs, the mucous membrane swells and closes the aperture, blocking normal drainage of the sinus. This condition may require surgical drainage.

The paranasal Sinuses of the Ox

<table>
<thead>
<tr>
<th>Group</th>
<th>Sinus</th>
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<tbody>
<tr>
<td>Group I</td>
<td>Maxillary</td>
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<tr>
<td></td>
<td>Lacrimal</td>
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<tr>
<td></td>
<td>Palatine</td>
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<td>Conchal</td>
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<td>Dorsal</td>
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<td></td>
<td>Ventral</td>
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1. The first group of sinuses open into the middle nasal meatus (p. 45, 6)

1. The maxillary sinus (7) occupies the maxilla and extends back under the orbit into the thin-walled lacrimal bulla (E) and into the zygomatic bone, thereby surrounding the orbit rostrally and ventrally. The nasomaxillary opening is high on the medial wall just ventral to the lacrimal canal (D) and midway between the orbit and the facial tube. It opens into the middle nasal meatus.

   The maxillary sinus communicates with the lacrimal sinus (5) and through the maxillopalatine opening (F) over the infraorbital canal (G) with the palatine sinus (10). See also p. 45, j.

   There is a large opening in the bony wall between the ventral nasal meatus and the palatine sinus, but this is closed in life by the apposition of its mucous membranes.

2. Also opening into the middle nasal meatus is the dorsal conchal sinus (6) in the caudal part of the dorsal concha, and

3. the ventral conchal sinus in the caudal part of the ventral concha (XVI) p. 33. See also p. 45.

II. The second group of sinuses open into ethmoidal meatuses in the caudal end of the nasal cavity.

1. The frontal sinuses are variable in size and number. In the newborn calf, they occupy only the frontal bone rostrodorsal to the brain. In the aged ox the caudal frontal sinus is very extensive, invading also the parietal, interparietal, occipital, and temporal bones. Left and right frontal sinuses are separated by a median septum (B). The caudal frontal sinus (1) is bounded rostrally by an oblique transverse septum (B') that runs from the middle of the orbit caudomedially to join the median septum in the transverse plane of the caudal margin of the orbit. The caudal boundary is the occipital bone and the lateral boundary is the temporal line (k). There is an extension into the zygomatic process. The supraorbital canal (C), conducting the frontal vein, passes through the caudal frontal sinus in a plate of bone that appears to be a septum, but is always perforated. The caudal frontal sinus has three clinically important diverticula: the nuchal (H), cornual (J), and postorbital (K) diverticula. The caudal frontal sinus has only one aperture: at its rostral extremity there is a small outlet to an ethmoid meatus. There is no frontomaxillary opening in any domestic animal except the Equidae. The rostral frontal sinuses (2, 3, 4) lie between the rostral half of the orbit and the median plane. Each has an opening at its rostral end to an ethmoid meatus. A part of the dorsal nasal concha (6) projects caudally between two of the rostral frontal sinuses. The lateral rostral frontal sinus is separated by a thin septum from the lacrimal sinus.

2. The sphenoid sinus (8), when present, opens into an ethmoid meatus.

3. The ethmoid cells (9) in the medial wall of the orbit, and

4. The sinus of the middle concha (p. 45, g) open into ethmoid meatuses.

b) The HORMS (CORNUA) project from the caudolateral angle of the frontal bone in both sexes, (except for hornless breeds, which have only a knob-like thickening of the bone.) Round, and tapering conically to a small apex, their form is not only species and breed specific, but is also quite variable individually. In the cow they are slender and long—in the bull, thick and short, and in the steer also thick, but longer. We recognize a base, a body, and an apex. The osseous core of the horn is the cornual process of the frontal bone (p. 31, 3'), which until shortly before birth is a rounded thickening. This elongates after birth to become a massive bony cone, and beginning at six months is pneumatized from the caudal frontal sinus. This is clinically important in deep wounds of the horns and in dehorning methods.

The bony process, like the distal part of the digit, is covered by greatly modified skin.

I. The subcutis is absent and the periesteum is fused with the dermis.

II. The dermis bears distinct papillae, which become longer on the base and especially toward the body, and lie step-wise over each other parallel to the surface. On the apex they are large free vertical tapering papillae. The dermis forms the positive die on which the living epidermis is molded.

III. The epidermis of the horn produces from its living cells the cornified horn sheath (stratum corneum) as horn tubules corresponding to the dermal papillae. The tubules are bound together by intertubular horn. Longitudinal growth of the horns occurs under the previously formed conical horn sheath through the production of a new cone of horn by the living epidermal cells, pushing the horny substance toward the apex. This can be seen on a longitudinal section. The horn consists of a stack of cones, each produced during a growth period, the horn sheath becoming thicker toward the apex. Radial growth pressure inside the rigid sheath compresses and flattens the tubules so that they are not recognizable in the body. On the apex of the cornual process additional tubular horn is formed over the free papillae. Growth is mainly longitudinal; growth in diameter is of lesser importance.

The formation of horn substance is steady in the bull; therefore the horns appear smooth on the surface. In the cow, growth is periodical and variable in rate, causing superficial rings and grooves. The rings are the product of regular, and the grooves the product of irregular horn formation, which is explained primarily by repeated pregnancies, but also by nutritional deficiencies and possibly diseases.

On the base of the horn at the transition from the skin to the horn sheath there is an epidermal zone called the epikeras that is comparable to the periople of the equine hoof.

The blood supply of the horns comes from the cornual aa. and vv. from the supf. temporal a. and v.

The innervation is supplied by the cornual br. of the zygomaticotemporal br. (see p. 40) and also the supraorbital and infratrochlear nn., all from the ophthalmic n.

The lymph is drained to the parotid ln.
Paranasal Sinuses and Horns

(dorsal)

1 Caudal frontal sinus
2 Med. rostral frontal sinus
3 Intermediate rostral frontal sinus
4 Lat. rostral frontal sinus
5 Lacrimal sinus
6 Dorsal conchal sinus
7 Maxillary sinus

(lateral)

8 Sphenoid sinus
9 Ethmoid cells
10 Palatine sinus

Legend:
A Intrasinual lamellae
B Median septum between frontal sinuses
B' Oblique transverse septum
C Supraorbital canal
D Lacrimal canal
E Lacrimal bulla
F Maxillopalatine opening
G Infraorbital canal
H Nuchal diverticulum
J Cornual diverticulum
K Postorbital diverticulum

(See p. 45)
4. SUPERFICIAL VEINS OF THE HEAD, FACIAL N. (VII), AND FACIAL MUSCLES

To demonstrate the superficial veins and nerves, the head is split in the median plane and the skin is removed, except for a narrow strip of skin around the horn, eye, nose, and mouth, noting the cutaneous faciei (A) and the frontalis, which is spread superficially over the frontal region. The parotidoauricularis and zygomaticoauricularis are transected and reflected to expose the parotid gland. The dorsal part of the gland above the maxillary v. is removed piecemeal, sparing the vessels and nerves in the gland, and the large parotid lymph node ventral to the temporomandibular joint.

a) The SUPERFICIAL VEINS (refer to p. 37) are drained by the external jugular v. (k) whose main branches, the supf. temporal v. (31) and the deep temporal v. (32) pass deep to the masseter to the deep fac. plexus (text fig. b) and to the orbit. The facial vessels continue dorsally, supplying deep and superficial vessels of the upper lip (21). The vein supplies the lat. nasal v. (9) and dorsal nasal v. (7), and is continued by the deep temporal v. (6) of angle of eye (28). The latter passes dorsomedial to the orbit and becomes the frontal v., which courses in the supraorbital groove (p. 31, 1') to the supraorbital foramen.

Caudal to the angle of the mandible, medial to the parotid gl., the maxillary v. (15) gives off the caud. auricular v. (14) and the ventral massteric v. (34). (The occipital v. comes from the int. jugular v.) Before the maxillary v. turns deep to the ramus of the mandible it gives rise to the large supf. temporal v. (31), which gives off the short transverse facial v. (30), the rostral auricular v. (18), and the cornual v. (17), and turns rostrally into the orbit to become the dorsal ext. ophthal. v. (19).

b) The FACIAL N. (VII) as it leaves the stylomastoid foramen, gives off the caud. auricular n. and internal auricular br., which does not give off the cutaneous brr. that go to the base and inner surface of the auricle in the horse and dog; these are supplied exclusively by the auricular branch of the vagus n. Dorsally, the facial n. gives off the auriculopalpebral n. (29), which divides into the ros-tral auricular br. and the zygomatic br. The latter runs forward on the surface of the zygomatic arch to the eyelids and ends in palpebral br. In the parotid gland the facial n. divides into dorsal and ventral buccal br. The dorsal buccal br. (32) emerges at the ventral end of the parotid ln. under the parotid gland. It is joined by a large branch of the sensory auriculotemporal n. (V3, g) and courses toward the upper lip, supplying facial muscles and cutaneous sensation. The ventral buccal br. (33) is more slender than the dorsal br. It follows the caudal and ventral borders of the masseter (unlike that of the horse) to the vascular groove, whence it runs along the ventral border of the buccinator and depressor labii inferioris to the lower lip. The cervical br. (Ramus collis) is absent in the ox.

c) The FACIAL MUSCLES include lip and cheek muscles, the muscles of the eyelids and nose, and ear muscles. The levator nasolabialis (5) is a broad thin muscle originating from the frontal bone and the frontalis. Between its superficial and deep layers pass the levator labii superioris (22) and caninus (23). These two muscles and the depressor labii inferioris (24) originate close together from the facial tuber. The levator labii superioris covers the ventral part of the infraorbital foramen, which is nevertheless palpable. The depressor labii inferioris (25) originates deep to the masseter from the caudal part of the alveolar border of the mandible. The zygomaticus (11) originates from the masseteric fascia ventral to the orbit and runs obliquely across the masseter and buccinator to the orbicularis oris (10) at the corner of the mouth. The buccinator (26) forms the muscular layer of the cheek. The molar part is covered by the masseter and the depressor labii inferioris. The buccal part is a thin layer of mostly vertical fibers.

The muscles of the eyelids are the orbicularis oculi (4), frontalis (1), levator palp. colli (superioris (see p. 41, 13) and malaris (20). The frontalis (not present in the horse) takes over the function of the absent retractor anguli oculi lat. and, augments the action of the levator palp. colli superioris. Of the ear muscles, the parotidoauricularis (13) extends on the surface of the parotid gland from the ventral part of the parotid fascia to the intertragic notch. The zygomaticoauricularis (12) begins on the zygomatic arch and runs back to end at the intertragic notch. The cervicoscutularis (2) originates from the lig. nuchae and the skull behind the intercornual protrus-berance. The short intercusscularis (3) comes from the cornual process and the temporal line, and has no connection with the contralateral muscle.

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**Arteries and Veins of the Head**

*V = Trigeminal n., V1 = Ophthalmic n. V2 = Maxillary n. V3 = Mandibular n.*
Arteries and Veins of the head, Facial n. and Facial muscles

1 Frontalis
2 Cervicoscutularis
3 Interscutularis
4 Orbicularis oculi

5 Levator nasolabialis
6 V. of angle of eye
7 Dorsal nasal v.
8 Facial v.
9 Lateral nasal v.

10 Orbicularis oris
11 Zygomaticus
12 Zygomaticoauricularis
13 Parotidoauricularis
14 Caudal auricular v.
15 Maxillary v.
16 Linguofacial v.

Legend:
A Cutaneous faciei
B Zygomaticoscutularis
C Frontoscutularis
D Scutolaoauricularis supf. dors.
E Scutolaoauricularis supf. accessorius
F Sternomandibularis

a Scutiform cartilage
b Parotid ln.
c Parotid gl.
d Mandibular gl.
e Mandible
f Facial a.
g Communicating br. between auriculotemporal n. (V3) and dorsal buccal br. (VII)
h Parotid br. of buccal n. (V3)

j Parotid duct
k External jugular v.

17 Cornual a. and v.
18 Rostral auricular v.
19 Dors. ext. ophthalmic v.

20 Malaris
21 Superior labial v.
22 Levator labii superioris
23 Caninus
24 Depressor labii superioris

25 Depressor labii inferioris
26 Buccinator
27 Deep facial v.
28 V. of lower lip
29 Auriculopalpebral n.
30 Transverse facial a. and v.
31 Supf. temporal a. and v.
32 Dorsal buccal br. of VII
33 Ventral buccal br.of VII
34 Ventral masseteric v.

(See p. 39)
a) The TRIGEMINAL N. (V) of the ox exhibits no marked differences in its branches from that of the dog and horse.

I. The mandibular n. (V3) is sensory to the teeth, oral mucosa, and skin of the lower jaw, as well as the tongue, parotid gl., and part of the ear. Unlike the other divisions of the trigeminal n. (V1 and V2) it also has somatic motor components. These are in the following branches: the *masticatory* n. (20) divides into the deep temporal n. (18) and massteric n. (19) which innervate the corresponding muscles. Branches to the pterygoids, tensor tympani, and tensor veli palatini have corresponding names. The *interior alveolar* n. gives off, before entering the mandibular foramen, the *mylohyoid* n. (29) for the muscle of that name and for the rostral belly of the digastricus. The *lateral pterygoid* n. branches to the rostral part of the intermandibular region. The following branches of the mandibular n. have no somatic motor components: The *many-branched buccal* n. (4) conducts sensory fibers and receives parasympathetic fibers from the glossopharyngeal n. (IX) via the *large otic ganglion* to the oral mucosa and the buccal salivary glands. Its *parotid* n. (16), which occurs only in ruminants, turns around the rostral border of the masseter and runs back to the parotid gland close to the duct. The *auriculotemporal* n. (26) runs caudally to the ear, skin of the temporal region, and parotid gland, supplying sensory branches and parasympathetic innervation (from IX via the otic ganglion). The nerve then turns rostrally and joins the dorsal buccal br. of VII as the *communicating br. with the facial* n. (1) thereby supplying sensation to the skin of the cheek. The *lingual* n. (30) is sensory to the sublingual mucosa and tongue. From the *chorda tympani* (VII—27) it receives a taste fiber for the rostral 2/3 of the tongue, and parasympathetic fibers for the sublingual and mandibular glands. Its *sublingual* n. (33) runs as in the dog but not as in the horse, on the lateral surface of the sublingual gl. to the floor of the mouth. The sensory *inferior alveolar* n. (28) passes through the *mandibular foramen* to the mandibular canal. It supplies the lower teeth and after emerging from the mental foramen as the *mental* n. (5) it supplies the skin and mucosa of the lower lip and chin.

II. The *maxillary* n. (V2—21) is sensory and contains parasympathetic components from VII via the pterygopalatine ganglion. It gives off the *zygomatic* n. and the *pterygopalatine* n. with the major palatine artery, and the *caudal nasal* n. Its rostral continuation is the *infraorbital* n. (6) which gives off sensory br. in the infraorbital canal for the upper teeth, and after emerging from the foramen divides into numerous branches for the dorum nasii, nos-tril, planum nasolabiale, upper lip, and the nasal vestibule. (For the *ophthalmic* n., V1, see p. 40.)

b) The MASTICATORY MM. INCLUDING THE SUPERFICIAL INTERMANDIBULAR MM. are innervated by the mandibular n. (V3). The caudal belly of the digastricus is innervated by the facial n. (VII). Of the *external masticatory mm.*, as in the horse, the *masseter* (13) is larger than the *temporalis* (17), and, covered by a glis-tening aponeurosis, presents a superficial layer with almost hori-zontal muscle fibers, and a deep layer with cardoventral fiber direction. The *internal masticatory mm.*: the *medial pterygoid* (22) and the *lateral pterygoid* (22), are clearly separate. The superficial inter-mandibular mm. are the *mylohyoideus* (25) *digastricus* (31). There is no *occipitomandibularis* in the ox. The digastricus, which does not *perforate* the *mylohyoideus*, terminates rostral to the vascular groove in the rostral surface of the mandible. Right and left digastrici are connected ventral to the lingual process of the basal hyoid by transverse muscle fibers.

c) The LARGE SALIVARY GLANDS are the parotid, mandibular, monostomatic sublingual, and polystomatic sublingual gl.

I. The *parotid* gland (14, p. 37, c) is elongated and thick. It lies along the caudal border of the masseter from the zygomatic arch to the angle of the mandible. Numerous excretory ducts converge to the *parotid duct* (15) at the ventral end of the gland. The duct runs with the facial vessels from medial to lateral through the vascular groove in the ventral border of the mandible, ascends in the groove along the rostral border of the masseter, and enters the oral vestibule opposite the fifth upper cheek tooth (M2). The deep surface of the gland is related to the maxillary and lingual parts. For the *occipitomandibularis* is demonstrated. The mandible is sawed through rostral to the first cheek tooth. After severing all structures attached to the mandibular surface of the mandible, the temporomandibular joint is disarticulated by strong lateral displacement of the mandible while the joint capsule is cut. The fibrocartilaginous *articular disc* compensates for the incongruence of the articular surfaces.

For the dissection of the temporals and masseter the covering facial muscles and superficial nerves and vessels are removed. The masseter is removed in layers, showing its tough tendinous laminae, its almost horizontal and oblique fiber directions and its innervation by the *massteric* n. (V3) passing through the mandibular notch. Medial to the masseter is the large *deep facial venous plexus* (2). To remove the zygomatic arch three sagittal cuts are made: I. at the temporomandibular joint, II. through the zygomatic bone rostral to its frontal and temporal processes, and III. through the zygomatic process of the frontal bone. In the course of disarticulation of the *temporomandib. joint* the temporals is separated from its termination on the coronoid proc., whereby its innervation from the deep temporal nn. is demonstrated. The mandible is sawed through rostral to the first cheek tooth. After severing all structures attached to the *temporal* surface of the mandible, the temporomandib. joint is disarticulated by strong lateral displacement of the mandible while the buccal and sublingual branches are enveloped by the parotid gland.

II. The *mandibular gland* (9) is curved, lying medial to the angle of the mandible and extending from the parotocaudal process to the bishoid. Its enlarged *bulbous end* is palpable in the *intermandibular region* in contact with the *contralateral mandibular gland*. The deep surface is related to the lateral *retropharyngeal ln., common carotid a.,* pharynx, and larynx. The *mandibular duct* (32) leaves the middle of the concave border of the gland and courses deep to the mylohyoideus and dorsal to the monostomatic sublingual gl. to the sublingual caruncle on the floor of the oral cavity rostral to the frenulum of the tongue.

III. The *monostomatic sublingual* gl. (24) is about 10 cm long. Its major *sublingual duct* ends near the mandibular duct under the sublingual caruncle.

IV. The *polystomatic sublingual* gl. (23) extends in a chain of lobs-ules from the palatoglossal arch to the incisive part of the mandible. The microscopic sublingual ducts open under the tongue on each side of a row of conical papillae extending caudally from the sublingual caruncle.

The small salivary glands:

The *buccal* gl. are developed best in the ox.

The superficial layer of the *dorsal buccal gl.* (3) is on the surface of the buccinator. The deep layer is covered by the muscle. They extend from the angle of the mouth to the facial tuber and are covered caudally by the masseter. The *middle buccal gl.* (7) are found in ruminants between two layers of the buccinator and dorsal to the vein of the lower lip. The *ventral buccal gl.* (8) lie on the mandible from the angle of the mouth to the rostral border of the masseter. They are the veins of the lower lip and covered, except the caudal part, by the buccinator. Small salivary gl. are present throughout the oral mucosa. Total secretion of saliva in the ox is about 50 liters in 24 hours.

d) The LYMPHATIC SYSTEM. Ruminant lymph nodes differ from those of the horse; they are usually single large nodes rather than groups of small nodes. All of the following nodes are routine-ly incised in meat inspection. The *parotid* ln. (12) lies between the rostral border of the parotid gl. and the masseter, ventral to the temporomandibular joint. It is palpable in the live animal. The *mandibular* ln. (10) lies ventral to the mandible, halfway between the rostral border of the masseter and the angle of the mandible, in contact with the facial vein. It is covered laterally by the ster-nomandibularis and the facial cutaneous m., but is palpable in the live animal; it is lateral to the bulbous ventral end of the mandibular gl., which is in contact with the contralateral gl. and should not be mistaken for the mandibular ln.

The medial *retropharyngeal* ln. is in the fat between the caudodorsal wall of the pharynx, through which it can be palpated, and the longus capitis. Its lateral surface is related to the large (1.5 x 0.5 cm) cranial cervical ganglion and cranial nn. IX to XII.

The lateral *retropharyngeal* ln. (11) receives all of the lymph from the other lymph nodes of the head and is drained by the tracheal trunk. It lies in the fossa between the wing of the atlas and the mandible, covered laterally by the mandibular gland.

* Somers, 1957
Mandibular n. (V3), Maxillary n. (V2), and Salivary glands

Legend:

a Mandible
b Levator labii superioris
c Caninus
d Depressor labii superioris
e Buccinator
f Facial vein
g Vein of lower lip
h Sternomandibularis

Legend:
j Linguofacial trunk
k Articular disc
l Maxillary a.
m Supf. temporal a.
n Linguofacial v.
o Maxillary v.
p Ext. jugular v.

(See pp. 37, 47, 49)
6. ACCESSORY ORGANS OF THE EYE

The ACCESSORY ORGANS include the eyelids and conjunctiva, the lacrimal apparatus, and the cone of striated bulbar muscles with their fasciae and nerves. They will be described in the order in which they are exposed (see also the text figure and p. 43).

I. The upper and lower eyelids (palpebra superior, A, and inferior, B) consist of an outer layer of haired skin, a middle fibromuscular layer, and the palpebral conjunctiva. The fibrous part of the middle layer is attached to the osseous orbital margin and increases in density toward the free border to form the tarsus, which contains the tarsal glands.

The eyelashes (cilia, D) of the lower lid are fewer and shorter than those of the upper lid, but they are present in the ox.

The striated muscles are: the strong orbicularis oculi (C), and in the upper eyelid, the termination of the levator palpebrae superioris (13) and fibers of the frontalis. The upper and lower tarsal mm. are parts of the smooth muscle system of the orbit, which retracts the eyelids and protrudes the eyeball under sympathetic stimulation. The palpebral conjunctiva (10) is continuous at the fornix (11) with the bulbar conjunctiva (12), which ends at the limbus of the cornea.

The third eyelid (8) consists of a fold of conjunctiva in the medial angle, enclosing the T-shaped outer end of the cartilage of the third eyelid.

The deep part of the cartilage is surrounded by the gland of the third eyelid, larger than in the horse, extending about 5 cm straight back into the fat medial to the eyeball and discharging tears through orifices on the bulbar side of the third lid.

II. The lacrimal apparatus. The lacrimal gl. (9) lies in the dorsolateral quadrant of the orbit, with the broad dorsal part under the root of the zygomatic proc., and a long thin tail which extends around the lateral margin of the orbit.

The lacrimal ducts pass from the ventral end of the gland to orifices in the lateral fornix. The gland of the third eyelid is the largest accessory lacrimal gland. The tears collect around the lacrimal caruncle (7) in the lacrimal lake in the medial angle anterior to the third eyelid. They are drained through the upper (5) and lower (6) lacrimal puncta and lacrimal canaliculi (4) which join at the lacrimal sac (3). This is drained by the nasolacrimal duct (2) to the nasolacrimal orifice (1) concealed on the mediodorsal surface of the alar fold.

III. The bulbar muscles are surrounded by the periorbita which, in the osseous part of the orbit, is the peristeme, containing the trochlea (19), but caudolaterally where the bony orbit is deficient in domestic mammals, the periorbita alone forms the wall of the orbit. It is a tough, fibrous, partially elastic membrane stretched from the lateral margin of the orbit to the pterygoid crest. The lacrimal gland and the levator palpebrae superioris are covered only by the periorbita. The remaining structures are also enclosed in the deep orbital fasciae: the fasciae of the muscles and the bulbar fascia (vagina bulbi).

The ophthalmic n. (V 1) (see p. 53) divides while still in the for. orbitotorundum into the following three nerves:

1. The usually double lacrimal n. runs along the lateral surface of the lateral rectus and gives off branches to the lacrimal gl. and the upper eyelid. The two strands of the lacrimal n. then unite and the zygomaticotemporal br. so formed perforates the periorbita and turns caudally under the zygomatic proc. of the frontal bone to the temporal region, where it sends twigs to the skin and continues ventral to the temporal line as the cornual branch to the skin on the cornual process.

2. The frontal n. gives rise to the nerve to the frontal sinuses, which perforates the wall of the orbit. The frontal n. then passes around the dorsal margin of the orbit (unlike that of the horse) and becomes the supraorbital n. to the frontal region.

3. The nasociliary n. gives off the long ciliary nn., which penetrate the sclera and supply sensation to the vascular tunic (see p. 42) and cornea; the ethmoidal n., with sensory and autonomic fibers to the caudal nasal mucosa; and the infratrochlear n. The last turns around the mediodorsal margin of the orbit to the skin of the medial angle of the eye and the frontal region.

Almost all of the striated bulbar muscles: dorsal (16), medial (14), and ventral (17) recti; ventral oblique (20), levator palpebrae sup. (13), and retractor bulbi (21), except its lateral part, are innervated by the oculomotor n. (III).

Only the dorsal oblique (18) is innervated by the trochlear n. (IV).

The lateral rectus (15) and the lateral part of the retractor bulbi (21) are served by the abducens n. (VI).

The bulbar muscles originate around the optic canal, with the exception of the ventral oblique, which comes from a fossa on the medial wall of the orbit just above the lacrimal bulla. With the exception of the levator palpebrae sup. all of the bulbar muscles terminate on the sclera.
Lacrimal apparatus

Legend:
1 Nasolacrimal orifice
2 Nasolacrimal duct
3 Lacrimal sac
4 Lacrimal canaliculi
5 Superior lacrimal punctum
6 Inferior lacrimal punctum
7 Lacrimal caruncle
8 Third eyelid
9 Lacrimal gland

Legend:
a Dorsal nasal concha
b Ventral nasal concha
c Venous plexus
d Maxillary sinus
e Palatine sinus

Bulbar muscles (Left eye)

Legend:
13 Levator palpebrae superioris
14 Medial rectus
15 Lateral rectus
16 Dorsal rectus
17 Ventral rectus
18 Dorsal oblique
19 Trochlea
20 Ventral oblique
21 Retractor bulbi

(See pp. 45, 47)
7. THE EYEBALL (BULBUS OCULI)

The eyeball of the ox is smaller than that of the horse, and is not flattened so much anteroposteriorly. For orientation, the pupil and the optic n. are taken as reference points. The pupil is at the anterior pole, and the optic n. is below and slightly lateral to the posterior pole. Like other ungulates, the ox has a transversely elliptical pupil (5). When it dilates, it becomes round. The black projections (granula iridica, 5) on the upper and lower margins of the pupil are vascular appendages covered by pigmented epithelium from the back of the iris. Those on the lower margin are small. On eyeballs sectioned on the equator and meridionally, one can study the external (fibrous) tunic, the middle (vascular) tunic, and the internal tunic (retina).

I. The fibrous tunic comprises the sclera (1), enclosing the greater part of the bulb in its dense white connective tissue, and the transparent cornea (3). These parts join at the corneal limbus (2).

II. The vascular tunic consists of the choroid, ciliary body, and iris. The choroid (15) is highly vascular and pigmented. In its posterior part, just above the optic disc, is the blue-green, reflective tapetum lucidum (16), a fibrous structure of roughly semi-circular outline with a horizontal base.

The ciliary body, containing the weak ciliary m. (J), is the anterior continuation of the choroid. Its most prominent feature is the ciliary processes (10), composed of vascular, radial ciliary fibers (9) extend to the equator of the lens. Posterior to the ciliary processes is the ciliary ring (orbicularis ciliaris, 11), a zone bearing minute ciliary folds (11). It is narrower medially than elsewhere. The posterior epithelium is the pars ciliaris retinae.

Between the ciliary body and the pupil is the iris (4) with the sphincter (G) and dilator (H) mm. of the pupil. The bovine iris is dark because of the heavy pigmentation of the posterior epithelium (pars iridica retinae).

III. The retina lines the entire vascular coat, so that each part of the vascular coat has a double inner layer derived from the two-layered ectodermal optic cup of the embryo. The greater part of the retina is the optical part (12), extending from the optic disc (20) to the ciliary body at the ora serrata (13). It contains the visual elements in its nervous layer and has an outer pigmented layer, which adheres to the vascular tunic when the nervous layer is detached. The outer layer is free of pigment over the tapetum.

The blind part (pars ceca, 14) of the retina lines the iris and ciliary body. In the iridial part the outer layer contributes the sphincter and dilator mm., and the inner layer is pigmented; in the ciliary part, the outer layer is pigmented.

At the optic disc (20) the nerve fibers of the retina exit through the area cribrosa of the sclera, acquire a myelin sheath, but no neurolemma, and form the optic n. (17), which is morphologically a tract of the brain, covered by a thin internal sheath (18) corresponding to the pia mater and arachnoida, and a thick external sheath (19) corresponding to the dura mater.

IV. The lens (6) is surrounded by the elastic lens capsule (j), which is connected to the ciliary body by the zonular fibers. Under the capsule, the anterior surface of the lens is covered by the lens epithelium. Toward the equator (k) the epithelial cells elongate to form the lens fibers—the substance of the lens. The fibers, held together by an amorphous cement, meet on the anterior and posterior surfaces of the lens in three sutures (radii lentis), which are joined to form a Y (the lens star), best seen in the fresh state.

V. Inside the eyeball the anterior and posterior chambers lie before the lens and the vitreous body lies behind it. The anterior chamber (7) is between the cornea and iris. It communicates freely through the pupil with the posterior chamber (8) which is between the iris and the lens with its zonula. Viewed from the anterior chamber the circular, retinal, venous plexus (8) is seen in the iridocorneal angle (g), attaching the iris by delicate radial trabeculae to the scleral ring at the corneal limbus. Between these trabeculae are the spaces of the iridocorneal angle (of Fontana), through which aqueous humor drains to the circular venous plexus of the sclera (42).

The vitreous chamber (22) lies between the lens and the retina, and is filled by the vitreous body. Its stroma is a network that holds in its meshes a cell-free jelly, the water content of which determines the intraocular pressure.

VI. The blood supply of the eye comes from the int. and ext. ophthalmalic aa. and the malar a. The small int. ophthalmalic a. (24) comes from the rostral epidural rete mirabile (see p. 50), accompanies the optic n., and anastomoses with the ext. ophthalmalic a. and the post. ciliary aa. The ext. ophthalmalic a. (23), from the maxillary a., forms the ophthalmalic rete mirabile deep in the orbit on the ventral surface of the dorsal rectus. The supraorbital a. arises from the rete, gives off in the orbit the ext. ethmoidal a. and ant. conjunctival aa., and enters the supraorbital canal, supplying the frontal sinus and emerging to supply the frontal m. and skin. Also arising from the rete are the muscular brr. (28) and the lacrimal a. The muscular brr. supply the eye muscles and give off ant. ciliary aa. (33) and posterior conjunctival aa. (35). The ext. ophthalmalic a. divides into two long post. ciliary aa. (25, 26), which give off short post. ciliary aa. (27) near the eyeball, and continue to the equator of the eyeball before they enter the sclera. In the ciliary region of the iris they form the major arterial circle of the iris (36). Near the bulb end of the optic n. the long post. ciliary aa. supply small choroidoretinal aa. (31), which accompany the optic n. and supply the four retinal arteries seen with the ophthalmoscope in the fundus of the eye. Accompanied by the corresponding veins, they appear near the center of the disc and spread out over the interior of the retina in a pattern characteristic of the ox, with the largest vessels directed dorsally. The venous blood of the eyeball is drained through the vorticose vv. (38–41), ciliary vv. (27–33), and the choroidoretinal vv. (31) to the intraorbital ophthalmalic venous plexus.

Legend: (See figures on p. 43)

23 Ext. ophthalmalic a.
24 Int. ophthalmalic a.
25 Lat. long post. ciliary a.
26 Med. long post. ciliary a.
27 Short post. ciliary a., and post. ciliary v.
28 Muscular br.
29 Episceral a.
30 Choroid aa. and vv.
31 Choroidoretinal a. and v.
32 Retinal arteries and veins
33 Ant. ciliary a. and v.
34 Aa. and vv. of ciliary body
35 Post. conjunctival a. and conjunctival v.
36 Major arterial circle of the iris
37 Aa. and vv. of the iris
38 Lat. dorsal vorticose v.
39 Lat. ventral vorticose v.
40 Med. dorsal vorticose v.
41 Med. ventral vorticose v.
42 Venous plexus of the sclera

Muscles of the eye:
A. Dorsal oblique
B. Ventral oblique
C. Dorsal rectus
D. Ventral rectus
E. Retractor bulbi
F. Orbicularis oculi
G. Sphincter pupillae
H. Dilator pupillae
J. Ciliaris

a. Upper eyelid (palpebra superior)
b. Tarsal gill.
c. Eyelashes (cilia)
d. Palpebral conjunctiva
e. Lacrimal a.
f. Fornix of conjunctiva
g. Iridocorneal angle
h. Pectinate lig.
i. Lower eyelid (palpebra inferior)
j. Lens capsule
k. Equator of lens
Organ of vision

Right eye

Legend:

Fibrous tunic:
1 Sclera
2 Limbus of cornea
3 Cornea
4 Iris
5 Pupil with granula iridica
6 Lens
7 Anterior chamber
8 Posterior chamber
9 Zonular fibers
10 Ciliary crown and ciliary processes
11 Ciliary ring (orbiculus ciliaris) and ciliary folds
12 Optical part of retina
13 Ora serrata
14 Blind part of retina (pars ceca)
15 Choroid
16 Tapetum lucidum
17 Optic n.
18 Internal sheath of optic n.
19 External sheath of optic n.
20 Optic disc
21 Hyaloid process
22 Vitreous chamber

Left eye

(See pp. 40, 41)
The nasal septum is removed to expose the nasal cavity.

a) NOSE.

I. The end of the nose and the upper lip are covered by hairless skin—the planum nasolabiale (22), where the skin is marked by minute grooves and raised areas with the openings of serous nasolabial glands. Incision reveals a thick layer of glandular tissue.

II. Each nasal cavity begins with the vestibule (12), a narrow zone of hairless skin and stratified squamous epithelium. The rest of the nasal cavity is lined by respiratory epithelium, except the olfactory region in the caudal part. The dorsal concha (5) is between the dorsal (4) and middle (6) meatuses. The caudal part of the middle meatus is divided into dorsal and ventral channels by the middle concha (2). The ventral concha (7) is between the middle and ventral (8) meatuses. The common meatus (3) is next to the nasal septum and connects the other three meatuses. Because the vomer is not attached to the caudal half of the hard palate, the right and left ventral meatuses communicate caudal to the plane of the second cheek tooth. The ventral concha is continued rostrally by the alar fold (11) to the wing of the nose. The nasolacrimal orifice (10) is just caudal to the mucocutaneous border, concealed on the medioventral surface of the alar fold, but in the live ox the wing can be drawn dorsolaterally to cannulate the nasolacrimal duct. The nasal septum (5) is divided by the transverse palatine fissure (c) into a flat apical part and a high, rounded torus linguae (19). Which enclose the orifices of the ducts of the mandibular gl. and the monostomatic sublingual gl. Caudal to the torus on each side is a row of conical papillae. Med. and lat. to the papillae are the minute orifices of the polystomatic sublingual gl. (p. 38).

b) ORAL CAVITY.

The lips are not so mobile and selective as in the horse; they accept nails and pieces of fence wire that cause traumatic r ticulitis. Near the angle of the mouth the cornified labial papillae (b) become long and sharp and directed caudally like the buccal papillae (b) inside the cheek. Together they serve to retain the cud during the wide lateral jaw movements of mastication. The oral vestibule (14) is the space between the teeth and the lips and cheeks. The oral cavity proper (17) is enclosed by the teeth and dental pad (a) (see also p. 32), except at the diastema and at the palatoglossal arches, where it opens into the pharynx. On the rostral two-thirds of the hard palate (c, d, 16) are the transverse palatine ridges (16) whose raised caudal borders bear a row of minute caudally directed spines. The palate venous plexus (c) is thickest between the premolars and just rostral to them. Attached to the floor of the oral cavity (see text figure) is the broad, double frenulum of the tongue (B). Rostrolateral to the the frenulum is the large, flat sublingual caruncle (A), which conceals the orifices of the ducts of the mandibular gl. and the monostomatic sublingual gl. Caudal to the caruncle on each side is a row of conical papillae. Med. and lat. to the papillae are the minute orifices of the polystomatic sublingual gl. (p. 38).

c) TONGUE.

The dorsal surface (dorsum linguae) is divided by the transverse lingual fossa (18) into a flat apical part and a high, rounded torus linguae (19). The tip (apex, 15) of the tongue is pointed. The apical half of the tongue is covered on the dorsum and margin by fine, sharp filiform papillae (D) directed backward and adapted to the use of the tongue as an organ of prehension in grazing. Scattered among the filiform papillae are round fungiform papillae (C), which bear taste buds, and do the vallate papillae (F). The latter form an irregular double row of about twelve on each side of the caudal part of the torus, which is covered by large conical and lenticiform papillae (E). Foliate papillae are absent. The palatoglossal arches (lat. to G) are attached to the sides of the root of the tongue (21). On the root and on both sides of the median glossoepiglottic fold are many small orifices of the crypts of the lingual tonsil (H) and its glands.

**Tongue**
Nasal cavity, Oral cavity, and External nose

(Paramedian section)

1 Ethmoid conchae
2 Middle concha
3 Common meatus
4 Dorsal meatus
5 Dorsal concha
6 Middle meatus
7 Ventral concha
8 Ventral meatus
9 Straight fold
10 Nasolacrimal orifice
11 Alar fold
12 Nasal vestibule
13 Basal fold
14 Oral vestibule
15 Apex of tongue
16 Palatine ridges
17 Oral cavity proper
18 Lingual fossa
19 Torus of tongue
20 Body of tongue
21 Root of tongue
22 Planum nasolabiale
23 Nostril
24 Alar groove and ala nasi
25 Med. accessory nasal cartilage
26 Dorsal lateral nasal cartilage
27 Lat. accessory nasal cartilage
28 Ventral lat. nasal cartilage
29 Cavernous venous plexuses

Legend:
a Dental pad
b Labial and buccal papillae
(See also text figure)
c Palatine venous plexus
d Hard palate
e Soft palate
f Dorsal conchal sinus
g Middle conchal sinus
h Ventral conchal sinus
h’ Bulla and cells of
i Frontal sinus
j Palatine sinus
k Pharyngeal septum and pharyngeal tonsil
l Proper lingual muscle
m Genioglossis
n Geniohyoideus
o Hyoepiglotticus
p Sternohyoideus

(See pp. 47, 49)
9. PHARYNX AND LARYNX

Dissection and study are carried out from the medial cut surface as well as the lateral side. Laterally, the pterygoids, digastricus, stylohyoides, and occipitohyoides are removed, as well as the remnants of the mandibular and parotid glands.

a) The cavity of the PHARYNX consists of three parts: the oropharynx, laryngopharynx, and nasopharynx. The oropharynx (pars oralis, B) communicates with the oral cavity through the isthmus of the fauces, which is bounded dorsally by the soft palate (velum palatinum), ventrally by the tongue, and laterally by the palatoglossal arches (p. 44, text fig.). The oropharynx extends to the base of the epiglottis, and its lateral wall contains the palatine tonsil (4, 14). The laryngopharynx (pars laryngea, D) lies below the intrapharyngeal ostium, which is surrounded by the free border of the soft palate (raised by forceps) and the right and left palatopharyngeal arches. The arches meet on the caudal wall over the arytenoid cartilages. When the animal is breathing, the larynx projects through the ostium into the nasopharynx, and the cavity of the laryngopharynx is obliterated, except for the lateral piriform recesses, which conduct saliva around the larynx to the esophagus without the necessity of swallowing. In swallowing, the intrapharyngeal ostium and the larynx are closed, and the function of the laryngopharynx changes from respiratory to digestive. The caudal part of the laryngopharynx (D) joins the esophagus over the cricoid lamina without visible demarcation. The nasopharynx (pars nasalis, A) extends from the choanae (p. 31, F) to the intrapharyngeal ostium, and is separated from the oropharynx by the soft palate (3). The choanae are divided dorsally by the crest of the vomer covered by mucosa with a thick submucosal cavernous venous plexus. Caudal to the vomer in ruminants, the membranous pharyngeal septum (2) divides the dorsal part of the nasopharynx lengthwise, and extends to the caudal dorsal wall, where it contains the pharyngeal tonsil (p. 45, k). On the wall of the nasopharynx lateral to the tonsil, is a slit—the pharyngeal orifice of the auditory tube (1), leading to the middle ear.

I. THE PHARYNGEAL MUSCLES are identified from the lateral surface, sparing the arteries and the pharyngeal branches of cranial nerves IX and X, which innervate the muscles and the mucosa. (See p. 49.)

MUSCLES OF THE SOFT PALATE: The tensor veli palatini (11), has a superficial part originating from the muscular process of the temporal bone and terminating in a tendon that passes around the hamulus of the pterygoid bone. The deep part originates on the pterygoid bone and terminates in a tendon that passes around the hamulus of the pterygoid bone. The deep part originates from the hamulus of the pterygoid bone and passes caudalward through the median line of the soft palate. The tensor veli palatini (11) also originates from the muscular process. With the contralateral muscle it forms a sling in the soft palate. The palatine (not illustrated) comes from the choanal border of the palatine bones and runs through the median line of the soft palate. The palatoglossus (p. 49, e) forms a thin band in the palatoglossal arch and acts as a constrictor of the intrapharyngeal ostium. It may also be classed with the:

Rostral pharyngeal constrictors: The pterygopharyngeus (13), comes from the hamulus of the pterygoid bone and passes caudally lateral to the levator. The rostral stylopharyngeus (not illustrated) lies on the lateral wall of the pharynx rostral to the stylohyoid bone. It is inconstant in most species, but constant in ruminants. It arises from the medial surface of the distal half of the bone and terminates with the pterygopharyngeus.

Middle pharyngeal constrictor: The hyothyreopharyngeus (16) originates mainly from the thyrohyoid, but also from the keratohyoid and the ventral end of the stylohyoid.

Caudal pharyngeal constrictors: The thyropharyngeus (17) comes from the oblique line on the thyroid cartilage. The cricothyroideus (18) comes from the lateral surface of the cricoid. All pharyngeal constrictors terminate on the pharyngeal raphe.

The only dilator of the pharynx is the caudal stylopharyngeus (15), originating from the proximal half of the stylohyoid, it passes between the rostral and middle constrictors, and in the ox, terminates mainly on the dorsal border of the thyroid cartilage, so that it draws the larynx upward and forward. Another part turns around the rostral border of the hypopharyngeus to terminate on the lateral pharyngeal wall and act as a dilator of the pharynx.

The rostral pharyngeal lymphatic ring consists of the palatine, pharyngeal, lingual, and tubal tonsils, and the tonsil of the soft palate.

b) The LARYNX (see also text fig.) Because there are no laryngeal ventricles or vestibular folds, the wall of the laryngeal vestibule (E) is smooth. The vestibular lig. of the horse is represented by a flat, fan-shaped sheet of fibers. The vocal fold (F) is only a low ridge containing the vocal ligament (G). The glottis (F) is composed of the vocal folds, arytenoid cartilages, and the glottic cleft (rima glottidis). Behind the glottis is the infrathyroid cavity (G).

I. The cartilages of the larynx show the following species differences in the ox: The epiglottic cartilage (H) is broad and rounded. The corniculate, vocal, and muscular processes of the arytenoid cartilages (J) resemble those of the dog and horse, but there is no cuneiform process. The thyroid cartilage (K) has a rostral notch (K'), absent in other species, and the caudal notch is not palpable in the live animal. The laryngeal prominence (K") is a landmark, is not at the rostral end of the cartilage, as is the human "Adam's apple", but two-thirds of the way toward the caudal end. The lamina of the cricoid cartilage (L) is short.

(dorsal)
Pharynx and Larynx

(Paramedian section)

1 Pharyngeal orifice of auditory tube
2 Pharyngeal septum
3 Soft palate
4 Sinus of palatine tonsil

Pharyngeal cavity
A Nasopharynx
B Oropharynx
C Palatopharyngeal arch
D Laryngopharynx

Pharyngeal cavity

Laryngeal cavity

Legend:

(Paramedian section)

1 Pharyngeal orifice of auditory tube
2 Pharyngeal septum
3 Soft palate
4 Sinus of palatine tonsil

Pharyngeal cavity
A Nasopharynx
B Oropharynx
C Palatopharyngeal arch
D Laryngopharynx

Pharyngeal cavity

Laryngeal cavity

Legend:

(Paramedian section)

1 Pharyngeal orifice of auditory tube
2 Pharyngeal septum
3 Soft palate
4 Sinus of palatine tonsil

Pharyngeal cavity
A Nasopharynx
B Oropharynx
C Palatopharyngeal arch
D Laryngopharynx

Pharyngeal cavity

Laryngeal cavity

Legend:

(Paramedian section)

1 Pharyngeal orifice of auditory tube
2 Pharyngeal septum
3 Soft palate
4 Sinus of palatine tonsil

Pharyngeal cavity
A Nasopharynx
B Oropharynx
C Palatopharyngeal arch
D Laryngopharynx

Pharyngeal cavity

Laryngeal cavity

Legend:

For the demonstration of these aa. and nn.: laterally the dorsocaudal third of the stylohyoid bone, and medially the rectus capitis ventralis and longus capitis are removed.

a) The ARTERIES OF THE HEAD show species-specific characteristics different from the dog and horse (for veins and arteries of the head, see text fig. p. 36).

The common carotid a. (16, see also p. 61) reaches the head-neck junction accompanied dorsally by the vagosympathetic trunk, and ventrally by the recurrent laryngeal n. Here it gives off the sternomandibularis br. (15). At the thyroid gl. it gives off, as in the horse, the inconstant caud. thyroid a. and the cran. thyroid a. (17). The latter gives rise to the caud. laryngeal br. which accompanies the caud. laryngeal n. The cran. laryngeal a. with its laryngeal and pharyngeal br. comes either directly from the common carotid a. or, as in the horse, from the cran. thyroid a. Shortly before its termination the common carotid a. gives off the ascending pharyngeal a. for the soft palate, tonsils, and pharynx.

The common carotid a. is continued by its largest terminal br., the external carotid a., whose origin is marked by the origin of the occipital a. (9) because the smaller terminal br., the internal carotid a., undergoes atrophy of its extracranial part in the ox. By three months after birth it is completely closed.

The external carotid a. (11), as it turns dorsally, gives off the lingual facial a. (4) rostroventrally. This divides into the facial and lingual aa. The lingual a. (5) runs medial to the mandible along the styllohyoid bone, gives off the sublingual a., and passes medial to the hyoglossus into the tongue. The latter gives rise to the lingual br. in the ox.

b) The THYROID GL. (18) consists of two flat lobulated irregularly triangular lobes connected by a parenchymatous isthmus. The lobes are lateral to the trachea, esophagus, and cricoid cartilage, and the isthmus passes ventral to the trachea at the first or second cartilage. In old cattle the isthmus may be reduced to a fibrous band.

c) The PARATHYROID GL. The external parathyroid gl. is 6–10 mm long and reddish-brown. It is always cranial to the thyroid gl., usually dorsomedial to the common carotid a., about 3 cm caudal to the origin of the occipital a. It may be on the caudal border of the mandibular gl. The internal parathyroid gl. is 1–4 mm long, and brown. It is on the tracheal surface of the lobe of the thyroid gl., near the craniodorsal border, embedded in the parenchyma.

d) The ESOPHAGUS (23, see also p. 60) in the cranial third of the neck, is dorsal to the trachea; between the third and sixth vertebræ it lies on the left side of the trachea; and at the thoracic inlet it is in a left dorsolateral position.

e) The TRACHEA (24, see also p. 60) of the ox changes the shape of its cross section in life and after death mainly by the state of contraction of the trachealis muscle attached to the inside of the tracheal cartilages. It is relatively small (4 x 5 cm).

f) CRANIAL NERVES OF THE VAGUS GROUP (IX–XI) emerge through the jugular foramen, as in the horse and dog.

I. The glossopharyngeal n. (IX, 3) innervates mainly the tongue with its large lingual br. Before it divides into dorsal and ventral brs., the lingual br. in the ox bears a lateropharyngeal ganglion medial and rostroventral to the stylohyoid. The pharyngeal br. supplies several branches to the pharynx.

II. The vagus n. (X, 20) has the widest distribution of all the cranial nn. Its nuclei of origin are in the nucleus ambiguus of the medulla oblongata for the motor fibers and in the parasympathetic nucleus of the vagus for the parasympathetic fibers. The sensory nuclei are in the nucleus of the solitary tract and in the nucleus of the spinal tract of C. N. V (see pp. 54, 55). The pseudounipolar nerve cells of the afferent fibers are in the proximal ganglion and in the distal ganglion of the vagus, which is very small in the ox, and lies near the jugular foramen. The vagus, after leaving the skull, first gives off the pharyngeal br. (21), whose cranial br. join those of C. N. IX in the pharyngeal plexus, supplying pharyngeal muscles and mucosa. The caudal continuation innervates the thyropharyngeus and cricopharyngeus and becomes the esophageal br. This is motor to the cran. part of the cervical esophagus, and joins the caudal laryngeal n. The cranial laryngeal n. (13) originates from the vagus caudal to the pharyngeal br. and runs cranioventrally, crossing lateral to the pharyngeal br. Its external br. usually joins the pharyngeal br., then separates again to innervate the cricothyroides. The internal br. of the cran. laryngeal n. enters the larynx through the thyroid fissure and innervates the mucosa. It then courses caudally inside the thyroid lamina and emerges caudal to the larynx to join the esophageal br. or the caudal laryngeal n. (19) which comes from the recurrent laryngeal n. In the thorax the vagus gives off the recurrent laryngeal n., which, on the right side, turns dorsally around the caudal surface of the subclavian a. and runs cranially between the common carotid a. and the trachea. On the left side the recurrent br. passes deep to the cricopharyngeus and becomes the esophageal br. This is motor to the cran. part of the cervical esophagus, and joins the caudal laryngeal nerves which pass deep to the cricopharyngeus to innervate all of the laryngeal muscles except the cricothyroides.

After giving off the recurrent laryngeal n., the vagus still carries parasympathetic and visceral afferent fibers serving the heart, lungs, and abdominal organs as far as the descending colon. The visceral afferents greatly predominate (see pp. 65, 73).

III. The accessory n. (XI, 10) divides at the level of the atlas into a dorsal br. to the cleidocricoidal and trapezius, and a ventral br. to the cleidomastoideus and sternocleidomastoideus (see p. 60).

g) The HYPOGLOSSAL N. (XII, 12) emerges through the hypoglossal canal. It innervates the proper (intrinsic) muscle of the tongue (f) and the following extrinsic muscles: styloglossus, hyoglossus, and genioglossus. The geniohyoideus (h) and thyrohyoideus (see p. 47) are also supplied by the hypoglossal n. with a variable contribution from the first cervical n. via the ansa cervicalis.

h) From the SYMPATHETIC TRUNK of the autonomic system, fibers pass in the region of the thoracic inlet through the cervicothoracic ganglion (p. 65) and middle cervical ganglion and then in the vagosympathetic trunk (14) to the head. Here in the cran. cervical ganglion (22), large in the ox, the fibers synapse with ganglion cells whose postganglionic sympathetic fibers run in perivascular (mainly parietal) plexuses in the adventitia of the large vessels of the head to their distribution in glands and internal eye muscles.
1. THE BRAIN

To remove the half-brain from the bisected head, the cut end of the spinal cord is first lifted from the dura mater, cutting the attachments of the denticulate lig. and the cervical nn. Then the brain is detached by identifying and cutting the cranial nn. in caudorostral order, midway between the brain and the dura. The roots of the hypoglossal n. (XII) emerge from the ventrolateral groove, lateral to the decussation of the pyramids, and exit through the dura, and to the hypoglossal canals. The nerves of the vagus group (IX, X, XI) also arise close together from the medulla, between the cerebellum and the trapezoid body, with VIII dorsolaterally to VII, and run dorsolaterally to the internal acoustic meatus. The small abducent n. (VI) passes out through the trapezoid body at the lateral edge of the pyramid, and enters a hole in the dura on the floor of the cranium in the transverse plane of the internal acoustic meatus. The larger trigeminal n. (V) comes from the end of the pons just rostral to the facial n. and runs rostroventrally to the largest aperture in the dura. Nn. IV and III come from the midbrain (13, 14). The trochlear n. (IV), the only one to emerge from the dorsal surface of the brain stem, arises behind the caudal colliculus, decussates with the contralateral nerve, and passes around the lateral surface of the midbrain, on or in the free border of the tentorium cerebelli, to the floor of the cranium. The larger oculomotor n. (III) arises from the crus cerebri, caudolateral to the hypophysis, which should be carefully dissected out of the Sella turcica (p. 31, 42) while maintaining its connection with the brain. The internal carotid a. will be cut between the rete mirabile and the arterial circle of the cerebrum. Nerves III, IV, VI, and the ophthalmic and maxillary nerves join outside the dura and leave the cranium through the orbitoround foramen in ruminants and swine. The optic n. (II) is cut distal to the optic chiasm. The optic tract connects the chiasm to the diencephalon. To free the cerebral hemisphere, the median dorsal fold of the dura (falx cerebri) is removed and preserved for study of the enclosed sagittal sinus, and the membranous tentorium cerebelli is cut at its dorsal attachment. (There is no osseous tentorium in ruminants.) The half-brain is lifted out of the dura by inserting scalpel handles between the cerebrum and the dura dorsally and between the olfactory bulb and the ethmoidal fossa, severing the olfactory nn. (I).

a) The BRAIN is relatively small. Because species-specific differences are of minor significance among domestic mammals, reference to a general textbook description is advised. Only a few features of the bovine brain will be mentioned here; greater importance will be given to the illustrations.

I. The dorsal part of the rhombencephalon, the cerebellum (17), is much more complex and irregular than in man, and the vermis (H) is not very prominent.

II. The midbrain (mesencephalon) exhibits four dorsal eminences, the rostral and caudal colliculi. The caudal pair is smaller. On the ventral surface is the cerebral crus.

III. The diencephalon is connected through its hypothalamus (9) with the infundibulum (10) of the hypophysis (11). Caudal to the infundibulum is the mammillary body (12). The pineal gl. (8) projects dorsocaudally from the diencephalon.

IV. The greatest part of the telencephalon (cerebrum) is the hemisphere (F). It consists of the cortex (A) and the white matter (B). It is markedly convoluted on the surface, bearing gyri (folds) and sulci (grooves). The herbivora have additional variable and inconstant sulci which make the brain more complex than the brains of carnivores. On the rhinencephalon (3) the olfactory bulb is smaller than in the dog and horse. It is continuous caudally with the olfactory peduncle, which branches into lateral and medial olfactory tracts.

b) The VENTRICULAR SYSTEM. In the roof of the fourth ventricle (h) the caudal medullary velum (j) is invaginated by a choroid plexus. The third ventricle (a) is in the median plane; it encircles the interthalamic adhesion (7), and with its choroid plexus (a’), extends over the pineal gl. as the suprapineal recess (d). The third ventricle also extends into the pineal gl. The cerebral aqueduct (g) connects the third and fourth ventricles. Rostrally, the third ventricle communicates on each side through an interventricular foramen (f) with a lateral ventricle, which contains a choroid plexus continuous with that of the third ventricle. A long process of the lateral ventricle extends into the olfactory bulb.

---

Legend:

A Cerebral cortex [Gray matter]  E Hippocampus  
B White matter  F Cerebral hemisphere  
C Head of caudate nucleus  G Cerebellar hemisphere  
D Choroid plexus of lateral ventricle  H Vermis
**Brain [Encephalon] and Cranial Nerves**

**Base of brain (ventral)**

- Cerebrum
- Longitudinal cerebral fissure
- Cerebral sulci
- Cerebral gyri
- Cerebral crus
- Pyramid of medulla oblongata
- Cerebellum
- Decussation of the pyramids
- Pyriform lobe
- Optic chiasm
- Optic tract
- Hypophysis [Pituitary gland]
- Medulla spinalis
- Olfactory nn.
- Olfactory peduncle
- Medial olfactory tract
- Lateral olfactory tract
- Olfactory trigone
- Accessory nerve (XI)
- Cranial roots
- Spinal roots
- Spinal cord
- Trapezoid body

**Median section of the brain**

**Legend:**
- a Third ventricle
- a' Choroid plexus of third ventricle
- b Optic recess
- c Infundibular recess
- d Suprapineal recess
- e Pineal recess
- f Interventricular foramen
- g Cerebral aqueduct
- h Fourth ventricle
- i Rostral medullary velum
- j Caudal medullary velum

**Cerebrum:**
1 Hemisphere
2 Corpus callosum
3 Rhinencephalon
4 Septum pellucidum
5 Rostral commissure

**Diencephalon:**
6 Thalamus
7 Interthalamic adhesion [Intermediate mass]
8 Epiphysis [Pineal gland]
9 Hypothalamus
10 Infundibulum
11 Hypophysis [Pituitary gl.]
12 Mamillary body

**Mesencephalon [Midbrain]:**
13 Lamina tecti [Rostral and caudal colliculi]
14 Tegmentum

**Rhombencephalon:**
15 Metencephalon
16 Pons
17 Cerebellum
18 Myelencephalon [Medulla oblongata]
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<tr>
<td>I</td>
<td>50</td>
<td>Olfactory nn. (special sensory)</td>
<td>Olfactory region in caud. nasal cavity</td>
<td>1st neuron in olfactory mucosa, synapse in olfactory bulb</td>
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<tr>
<td>II</td>
<td>42, 50</td>
<td>Oculomotor n. (m., psy.)*</td>
<td>Dorsal rectus, levator palpebrae superiors, retractor bulbi</td>
<td>Orig. mesencephalon, exits by for. orbitoro-tundum</td>
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<td></td>
<td></td>
<td></td>
<td>Med. and ventr. recti, ventral oblique</td>
<td>Psy. neurons synapse in ciliary gangl. and pass in ciliary nn. to eyeball</td>
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<td>III</td>
<td>40, 50</td>
<td>Trochlear n. (m.)</td>
<td>Dorsal oblique</td>
<td>Orig. mesencephalon, exits skull by for. orbitoro-tundum</td>
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<td>IV</td>
<td>40, 50</td>
<td>Trigeminal n.</td>
<td>Dorsum nasi, ethmoid bone, lacrimal gl., upper eyelid</td>
<td>Exits skull by foramen orbitoro-tundum</td>
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<td></td>
<td></td>
<td></td>
<td>Enters nasal cavity through ethmoid for. and cribriform plate</td>
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<td>V</td>
<td>38, 50</td>
<td>Mandibular n. (s., m.)</td>
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<td></td>
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<td>Masseter</td>
<td>Goes through mandibular notch</td>
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<td></td>
<td>Med. and lat. pterygoid nn. (m.)</td>
<td>Med. and lat. pterygoid mm.</td>
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<td></td>
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<td></td>
<td>Tensor tympani n. (m.)</td>
<td>The otic gangl. (s., psy.) at root of buccal n., is large in the ox</td>
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<td></td>
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<td>Tensor veli palatini n.</td>
<td>Tensor tympanic</td>
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<td></td>
<td></td>
<td></td>
<td>Auriculotemporal n. (s., psy., sy.)</td>
<td>Turns around the neck of the mandible, psy. fibers from otic ganglion</td>
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<td></td>
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<td></td>
<td>Communicating brr. with facial n. (s.)</td>
<td>Connection with dors. buccal br. (VII)</td>
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<td></td>
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<td>Buccal n. (s. psyche)</td>
<td>Mucosa of cheek and buccal gl.</td>
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<td></td>
<td>Parotid br. (psych)</td>
<td>Parotid gl.</td>
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<td></td>
<td></td>
<td></td>
<td>Lingual n. (taste, s., psy.)</td>
<td>Sensory to floor of mouth and tongue, taste from rostral 2/3 of tongue</td>
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<td></td>
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<td>Sublingual n. (s., psy.)</td>
<td>Mucosa of rostral floor of mouth</td>
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<td>Inferior alveolar n. (s.)</td>
<td>Inferior teeth and gingiva</td>
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<td>Mylohyoid n. (m.)</td>
<td>Mylohyoid, rostral belly of digastricus</td>
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<td></td>
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<td></td>
<td>Mental n. (s.)</td>
<td>Skin and mucosa of chin and lower lip</td>
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* Fiber function: s. = sensory, m. = motor and proprioceptive, sy. = sympathetic, psy. = parasympathetic
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<td>Orig.: Rhombencephalon; exits skull at for. orbitortotundum</td>
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<td>Facial n. (intermediofacial n.) (taste, m., psy.)*</td>
<td>Mm. of face and ear, lacrimal and salivary gl.</td>
<td>Goes through int. acoustic meatus into facial canal and leaves through stylomastoid for.; nerve of 2nd pharyngeal arch</td>
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<td>(33) Major petrosal n. (psy.)</td>
<td>Gl. of nose and palate, and lacrimal gl.</td>
<td>Joins the deep petrosal n. (sy.) to form the n. of the pterygoid canal, which goes to pterygopalatine ganglion</td>
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<td></td>
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<td>(34) N. to stapedius (m.)</td>
<td>Stapedius</td>
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<td>(35) Chorda tympani (taste, psy.)</td>
<td>Mandibular and sublingual gl., rostral 2/3 of tongue, taste</td>
<td>Leaves petrous temporal bone through petrotympanic fissure and joins lingual n. (V3)</td>
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<td>Int. auricular br. (s.)</td>
<td>Int. surface of auricle</td>
<td>Passes through auricular cartilage</td>
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<td>Caud. auricular n. (m.)</td>
<td>Auricular mm.</td>
<td>Communicates with the dors. br. of first 2 cervical nn.</td>
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<td>Digastic br. (m.)</td>
<td>Caud. belly of digasticus</td>
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<td>Rostral auricular br. (m.)</td>
<td>Rostral auricular mm.</td>
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<td>41</td>
<td>Zygomatic br. (m.)</td>
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<td>Ends with palpebral br.</td>
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<td>42</td>
<td>Dorsal buccal br. (m.)</td>
<td>Mm. of upper lip, planum nasale, and nostril</td>
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<td>Vestibulocochlear n. (special sensory)</td>
<td>Organ of cochlea</td>
<td>Orig.: Medulla oblongata; enters int. acoustic pore</td>
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<td></td>
<td>Cochlear n. (hearing)</td>
<td>Spiral organ of the cochlea</td>
<td>1st neuron: in spiral gangl. of cochlea; 2nd neuron: in rhombencephalon</td>
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<td>Vestibular n. (equilibrium)</td>
<td>Ampullae of semicircular ducts, maculae of utriculus and sacculus</td>
<td>1st neuron: in vestibular gangl.; 2nd neuron in rhombencephalon</td>
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<td>48, 50</td>
<td>Glossopharyngeal n. (taste, s., m. psy.)</td>
<td>Mucosa of tongue and pharynx, tonsils, tympanic cavity</td>
<td>Orig.: medulla oblongata; exits skull through jugular for. Nerve of 3rd pharyngeal arch; 1st n. of vagus group</td>
</tr>
<tr>
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<td>(44) Pharyngeal br. (s., m.)</td>
<td>Pharyngeal mucosa, caud. stylopharyngeus</td>
<td>Forms pharyngeal plexus with pharyngeal br. of vagus (X)</td>
</tr>
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<td></td>
<td></td>
<td>(45) Lingual br. (taste, s., psy.)</td>
<td>Mucosa of soft palate and root of tongue with its taste buds</td>
<td>Before it divides into dorsal and ventr. br. this n. bears the lateropharyngeal ganglion</td>
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<td>X</td>
<td>48, 50</td>
<td>Vagus n. (s., m., psy.)</td>
<td>Viscera of the head, neck, thorax, and abdomen</td>
<td>Orig.: medulla oblongata; exits skull from jugular foramen; n. of 4th pharyngeal arch; 2nd n. of vagus group</td>
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<td></td>
<td>(46) Auricular br. (s.)</td>
<td>Skin of ext. acoustic meatus</td>
<td>Enters the facial canal and joins the facial n. (VII)</td>
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<td></td>
<td></td>
<td>(47) Pharyngeal br. (s., m.)</td>
<td>Pharyngeal mm. and mucosa</td>
<td>Caud. contribution to pharyngeal plexus, ends as esophageal br.</td>
</tr>
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<td></td>
<td></td>
<td>(48) Cran. laryngeal n. (s., m.)</td>
<td>Branches off from distal ganglion and crosses lat. to pharyngeal br.</td>
<td></td>
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<tr>
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<td>(49) External br. (m.)</td>
<td>Cricothyroides</td>
<td>Joins pharyngeal br.</td>
</tr>
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<td>(50) Internal br. (s.)</td>
<td>Laryngeal mucosa rostral to the rima glottidis</td>
<td>Passes through the thyroid fissure</td>
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<tr>
<td></td>
<td></td>
<td>(51) Recurrent laryngeal n. (s., m., psy.)</td>
<td>Branches to cardiac plexus, trachea, and esophagus</td>
<td>Separates from the vagus in the thorax and turns cranially</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(52) Caud. laryngeal n. (s., m.)</td>
<td>All laryngeal mm. except cricothyroid, laryngeal mucosa caud. to rima glottidis</td>
<td></td>
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<td>XI</td>
<td>48, 50</td>
<td>Accessory n. (m.)</td>
<td>Exits skull through jugular for.; 3rd n. of vagus group</td>
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<td>(51) Cran. root: int. br. (m.)</td>
<td>Medulla oblongata, joins vagus n. and gives it motor fibers</td>
<td></td>
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<td></td>
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<td>(52) Spinal root: ext. br. (m.)</td>
<td>Org. cervical spinal cord</td>
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<td>(53) Dorsal br. (m.)</td>
<td>Trapezius and cleidooccipitalis</td>
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<td>(54) Ventral br. (m.)</td>
<td>Cleidomastoideus and sternocleidomastoideus</td>
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<td>XII</td>
<td>48, 50</td>
<td>Hypoglossal n. (m.)</td>
<td>Proper lingual m., genio-, stylo-, and hyoglossus; together with ventr. br. of 1st cervical n.: genio- and thyrohyoideus</td>
<td>Orig.: Medulla oblongata, leaves the skull via hypoglossal canal, forms the ansa cervicalis with 1st cervical n.</td>
</tr>
</tbody>
</table>

* Fiber function: s. = sensory, m. = motor and proprioceptive, sy. = sympathetic, psy. = parasympathetic
The following statements concern only a few specific characteristics of the ox. For the rest, the generally applicable textbook descriptions and the detailed illustrations in the neurological literature may be consulted.

a) The SPINAL CORD (MEDULLA SPINALIS) is surrounded by the meninges in the vertebral canal. In animals it has a greater biological importance than in man, and in the ox its mass is almost as great as that of the brain. The spinal cord presents a cervical enlargement and a lumbar enlargement. The central canal is predominantly transversely oval, as in the horse. The cord ends as the conus medullaris (16), containing the sacral and caudal segments. This extends in the two-month-old calf through vert. S3, and at ten months, through vert. S2*, but in the adult the conus extends only into vert. S1. The difference is caused by the so-called “ascent of the cord,” really by the continued growth of the vertebral column after the growth of the cord has slowed. This results in a longer course of the spinal nerves within the vertebral canal before they reach their intervertebral foramina, forming the cauda equina (18), which is composed of the conus medullaris, the terminal filament (17) of connective tissue, and the sacral and caudal nerves. The clinical importance is in the danger of injury to the cord by lumbosacral puncture. The space between the spine of vert. L6 and the sacral crest overlies the intervertebral disc and the cranial part of the body of vert. S1. In the mature ox, although the sacral segments of the cord are all in vert. L6, the caudal segments, the last lumbar nerve, the sacral nerves, and some caudal nerves are vulnerable. Epidural anesthesia is performed in the ox by injection between the first and second caudal vertebrae, and lumbosacral puncture is restricted to diagnostic withdrawal of cerebrospinal fluid.

b) THE AUTONOMIC NERVOUS SYSTEM includes the sympathetic part, the parasympathetic part, and the intramural intestinal plexuses.

The efferent nerve fibers:

1. The sympathetic part consists mainly of efferents with pre- and postsynaptic neurons, and also contains afferents with only one neuron. It is also called the thoracolumbar nervous system because it is supplied by efferent sympathetic neurons from the thoracic limb, and from the caudal sympathetic trunk, they reach the thoracic limb, and from the caudal sympathetic trunk they reach the pelvic limb. They first pass through the brachial plexus or lumbosacral plexus in the somatic nn., and more distally enter the adventitia of blood vessels.

2. The parasympathetic part to which cranial nn. III, VII, IX, and X and the pelvic n. (10) belong, supplies with its efferents the glands and smooth muscle cells in e.g. the gut, and also in the eye and in the salivary and lacrimal gl. The efferents are connected through two neurons in series to carry the impulse from the CNS to the target organ. In the vagus, the presynaptic axon is very long, extending from the CNS to the synapse with the second neuron in the target organ. Vagal fibers extend as far as the transverse colon. For the origin and distribution of the vagus, see pp. 48, 54, and 72.

The afferent nerve fibers:

The sympathetic and parasympathetic nn. contain afferents of sensory neurons that measure the contraction or distention of hollow organs and transmit pain. The vagus at the diaphragm contains more than 80 % afferent fibers. The cell bodies of the sympathetic afferents lie in the spinal ganglia, and those of the vagus are in the proximal (jugular) and distal (nodose) ganglia near the base of the skull (see p. 48).
Spinal cord and Autonomic nervous system

1 Cran. cervical ggl.
2 Vagosympathetic trunk
3 Middle cervical ggl.
4 Ansa subclavia
5 Cervicothoracic ggl. [Stellate ggl.]
6 Vagus n.
7 Cardiac plexus
8 Hypogastric n.
9 Pelvic plexus
10 Pelvic n.
11 Vertebral n.
12 Ggll. of sympathetic trunk
13 Major splanchnic n.
14 Celiac ggl. and cran. mesenteric ggl.
15 Caud. mesenteric ggl. and lumbar splanchnic nn.
16 Conus medullaris
17 Filum terminale
18 Cauda equina

Legend:
a Left common carotid a.
b Left subclavian a.
c Aorta
d Celiac a.
e Cran. mesenteric a.
f Caud. mesenteric a.
g Esophagus
h Longus colli
i Heart
j Diaphragm
k Small intestine
l Large intestine
m Rectum
CHAPTER 5: VERTEBRAL COLUMN, THORACIC SKELETON, AND NECK

1. VERTEBRAL COLUMN, LIGAMENTUM NUCHAE, RIBS, AND STERNUM

Review the basic parts of the bones on individual bones and mounted skeletons, and study the special features in the ox mentioned below.

a) The VERTEBRAL COLUMN is composed of seven cervical vertebrae, thirteen (12–14) thoracic vertebrae, six (7) lumbar vertebrae, five sacral vertebrae, and eighteen to twenty (16–21) caudal vertebrae.

The vertebrae are joined by fibrocartilaginous intervertebral discs, and surround the vertebral canal (7). The basic parts: body (1), arch (8), and processes are developed differently according to function.

I. The cervical vertebrae (C1–C7) are generally shorter than in the horse. The spinous process (12) is longer than in the horse, and inclined cranially. Only on the seventh is it almost vertical, and massive. The first, the spinous process is represented by a tubercle (29'). The third and fourth cervical vertebrae the free end is split. On the horse. The third and fourth cervical vertebrae the free end is split.

The cervical vertebrae (C1–C7) have relatively long bodies compared to those of the horse. The atlas (C1) lacks a transverse foramen (13); the dorsal arch bears a large dorsal tubercle (29'); and the ventral arch, a large ventral tubercle (30'), which is sometimes bifid. The axis (C2) is shorter than in the horse; its dens (32) is semicylindrical; the spinous process (12) is a high and straight crest, but not split caudally as it is in the horse. The lateral vertebral foramen (31'), absent in the dog, is very large.

II. The thoracic vertebrae (T1–T13) have relatively long bodies compared to the dog and horse. The spinous process (12) of the first to the fifth thoracic vertebra is broad with sharp cranial and caudal borders, and provided on the free end with a cartilaginous cap until about the third year. These ossify by the eighth year. The withers (interscapular region) is not as high as in the horse. The seventh to eleventh thoracic spines are strongly inclined caudally. The spine is vertical on the last thoracic (antclinal) vertebra. In most thoracic vertebrae the caudal vertebral notch (11) is closed by a bridge of bone to form a lateral vertebral foramen (11'). The mamillary processes (20) are not very prominent; on the last two thoracic vertebrae they merge with the cranial articular processes (16).

Costovertebral articulations

III. The lumbar vertebrae (L1–L6) have a long body and a flat arch with an almost square, cranially and caudally extended, spinous process (12). The horizontal transverse processes (13) are curved cranially and separated by wide spaces. The cranial lumbar vertebra often have lateral vertebral foramina as in the thoracic vertebrae. The mamillary processes are always fused with the cranial articular processes.

IV. The sacral vertebrae (S1–S5) are completely fused to form the sacrum after 3–4 years. Depending on breed, the sacrum is more or less arched dorsally. Ventrally it has a distinct groove for the median sacral artery. The spinous processes are fused to form a median sacral crest (35) (as in the dog, but unlike the horse) with an occasional interruption between the fourth and fifth vertebrae. The sacral promontory (38) is the cranial ventral prominence of the first sacral vertebra. It is palpable per rectum. The auricular surfaces of the alae face caudodorsally. The fused articular processes form a ridge, the intermediate sacral crest (37), which bridges over the narrow dorsal sacral foramina (39), and lies medial to the last sacral foramen. This is very large and not divided into dorsal (39) and ventral (40) foramina because the last two transverse processes are not completely fused.

V. The caudal [coccygeal] vertebrae (Cd1+) and their processes are significantly larger and better developed than in the horse. The progressively narrowing vertebral canal (7) extends to the fifth caudal vertebra. The paired hemal processes (21) (present as in the dog, unlike the horse) may be closed to form hemal arches (22) from the second to the fifth caudal vertebra.

b) Of the thirteen RIBS, eight are sternal ribs (41) and five are sternal (42). They increase in length to the tenth rib and, especially in the middle of the thorax, they are flat toward the sternal end with sharp caudal borders, and wider than in the dog and horse, whereby the intercostal spaces become narrower. The head (45) and the tubercle (49) are well developed and separated by a long neck (47). The knee [genus costae, 53] is at the costochondral junction.

c) The body of the STERNUM, formed by five sternebae (56), is slightly arched dorsally and flattened dorsoventrally. The triangular manubrium sterni (54) is raised craniodorsally and has no manubrial cartilage. It is attached to the body of the sternum by a true joint. The xiphoid process (57) is smaller than in the horse. A sternal crest is absent, as in the dog.

d) The elastic NUCHAL LIGAMENT is generally better developed than in the dog and horse. It consists of a paired funiculus (A) and a lamina (B), which is paired in the cranial part and unpaired in the caudal part.

The funiculus is divided into right and left halves attached to the external occipital protuberance. They extend, without attachment to the cervical vertebrae, to the withers, and become gradually wider to form the sagittally positioned, flat, wide parts lateral to the first to fifth thoracic spinous processes, but not capping them. The wide parts gradually become narrower and unite to form the supraspinous ligament (C), which extends to the sacrum. It is elastic cranially, but becomes collagenous in the midlumbar region. The lamina arises with its cranial paired part from spinous processes C2–C4 and fuses with the funiculus. The caudal unpaired part, also elastic, which in the horse is thin and contains few elastic fibers, arises from vertebrae C5–C7 and terminates on the first thoracic spinous process under the wide parts of the funiculus. A supraspinous bursa may be present between the first few thoracic spines and the wide parts of the funiculus.
Vertebral column, Thoracic skeleton, and Nuchal ligament

Vertebral column and Bones of the thorax

- Cervical vertebrae (C1–C7)
- Thoracic vertebrae (T1–T13, 14)
- Lumbar vertebrae (L1–L6)
- Sacral vertebrae (S1–S5)
- Caudal vertebrae (Cd1–Cd16, 21)

Body of vertebra (1)
- Ventral crest (2)
- Cranial end (3)
- Caudal end (4)
- Caudal costal foramen (5)
- Cranial costal foramen (6)
- Vertebral canal (7)
- Vertebral arch (8)
- Intervertebral foramen (9)
- Cranial vertebral notch (10)
- Vertebral canal (11)
- Lat. vertebral foramen (11)

Spinal process (12)
- Transverse process (13)
- Ventral tubercle (C3–C5) (13')
- Dorsal tubercle (C3–C5) (13')
- Costal foramen (T1–T13, 14)
- Transverse foramen (C2–C6) (15)
- Cranial articular process (16)
- Caudal articular process (17)
- Costal process (18)
- Hemal process (Cd2–Cd15) (21)
- Hemal arch (Cd4 + Cd5) (22)
- Intervertebral space:
  - Lumbosacral (23)
  - Sacrococcygeal (24)

Atlas (C1)
- Lateral mass
- Transverse proc. [Wing of atlas, Ala] (26)
- Alar foramen (27)
- Lat. vertebral foramen (28)
- Dorsal arch (29)
- Dorsal tubercle (29')
- Ventral arch (30)
- Ventral tubercle (30')

Axis (C2)
- Lat. vertebral foramen (31')
- Dens (32)

Sacrum (S1–S5)
- Wing [Ala] of sacrum (33)
- Median sacral crest (35)
- Lat. sacral crest (36)
- Intermediate sacral crest (37)
- Promontory (38)
- Dorsal sacral foramen (39)
- Ventral sacral foramen (40)

Ribs (Costae)
- Sternum ribs (41)
- Asternal ribs (42)
- Costal bone (Os costale) (44)
- Head of rib (45)
- Artic. surface of head (46)
- Neck of rib (47)
- Body of rib (48)
- Costal tubercle (49)
- Artic. surf. of tubercle (50)
- Angle of rib (51)
- Costal cartilage (52)
- Knee of rib (53)

Sternum
- Manubrium (54)
- Body of sternum (55)
- Sternumbrae (56)
- Xiphoid process (57)

Legend:
- Nuchal ligament:
  - A. Funiculus nuchae
  - B. Lamina nuchae
  - C. Supraspinous lig.
2. NECK AND CUTANEOUS MUSCLES

A dorsomedian skin incision is made from the skull to the level of the last rib, and laterally along the last rib to its costochondral junction. A skin incision from the cranial end of the first incision is directed ventrally behind the base of the ear and across the angle of the mandible to the ventromedian line. The skin is reflected ventrally, sparing the cutaneous muscles, ext. jugular v., and cutaneous nerves, and continuing to the ventromedian line of the neck, on the lateral surface of the limb to the level of the sternum, and to a line extending from the axilla to the last costochondral junction. This flap of skin is removed. Note the dewlap [Palæar], a breed-variable ventromedian fold of skin on the neck and pretrernal region.

a) Of the CUTANEOUS MUSCLES, the cutaneus colli is thin and often impossible to demonstrate. It originates from the ventro-median cervical fascia. The cutaneus trunci resembles that of the horse; whereas the cranially attached cutaneus omobrachialis, absent in the dog, is thinner than in the horse, and occasionally unconnected to the cutaneus trunci. For the preputial muscles, see p.66.

b) The SUPERFICIAL SHOULDER GIRDLE MUSCLES (TRUNK—THORACIC LIMP MUSCLES):

The trapezius with its cervical part (11) and thoracic part (11') is significantly better developed than in the horse. This fan-shaped muscle originates from the funicular nuchal lig. and supraspinous lig. between the atlas and the 12th (10th) thoracic vertebra and ends on the spine of the scapula. The cervical part is joined ventrally to the omotransversarius (8), which, as in the dog, extends between the acromion and the transverse process of the atlas (axis), where it is fused with the tendon of the splenius. The brachiocephalicus consists of the cleidobrachialis (clavicular part of deltoideus, p. 4) and the cleidomastoideus. The two parts of the latter in the ox are the cleido-occipitalis and the cleidomastoideus. The cleido-occipitalis, and the cleidomastoideus, originate from the clavicular intersection—an indistinct line of connective tissue across the brachiocephalicus cranial to the shoulder joint. The cleido-occipitalis is joined to the cleidomastoideus as far as the middle of the neck, separates from it, and attaches to the ventro-cranial border of the trapezius, and ends on the funicular nuchal lig. and occipital bone. The cleidomastoidea (6) lies ventral to the cleido-occipitalis, is partially covered by it, and ends as a thin muscle with a slender tendon on the mastoid process and the tendon of the longus capitis. The sternocleidomastoideus mm. (4) originate from the manubrium sterni only, are fused in the caudal third of the neck, and terminate in common with the cleidomastoideus. The sternomandibularis (5) originates laterally from the manubrium and from the first rib; and, crossing the sternomastoideus, runs ventral to the jugular groove and ends with a thin tendon on the rostral border of the masseter and aponeurotically on the mandible and the depressor labii inferioris.

The sternomastoideus and cleidomastoideus are homologous to the human sternocleidomastoideus.

The latissimus dorsi (12) arises from the thoracolumbar fascia and from the 11th and 12th ribs. The fibers run cranioventrally to a common termination with the teres major and an aponeurotic connection with the coracobrachialis and deep pectoral as well as the long head of the triceps.

Of the superficial pectoral muscles, the flat transverse pectoral (25') originates from the sternum and ends on the medial deep fascia of the forearm. The descending pectoral (25) is a thick muscle originating from the manubrium and ending with the brachiocephalicus on the crest of the humerus. It is not as visible under the skin as in the horse.

c) JUGULAR GROOVE AND LATERAL PECTORAL GROOVE:
The jugular groove is bounded dorsally by the cleidomastoideus, ventrally by the sternomandibularis, and, in the cranial half of the neck, medially by the sternocleidomastoideus. The ext. jugular vein (3) lies in the groove. At the junction of the head and neck it bifurcates, giving rise to the maxillary (2) and linguofacial (1) veins. At the thoracic inlet it gives off a dorsal branch, the superficial cervical vein (21); and gives off the cephalic vein (10) to the lateral pectoral groove between the brachiocephalicus and the descending pectoral muscle.

d) VISCERA AND CONDUCTING STRUCTURES OF THE NECK:

The superficial shoulder girdle muscles and the sternomastoideus and sternomandibularis are transected near their attachments on the limb and sternum and removed, leaving short stumps. The accessory n. (c) and the roots of the phrenic nerve (C5 to C7, q) must be spared in the dissection.

a) DEEP SHOULDER GIRDLE MUSCLES: The rhomboideus consists of the rhomboideus cervicis (28) and thoracis (28') but no rhomboideus like the dog is present in the ox, and the do-occipitalis are separated from the trapezius, originate from the funicular nuchal lig. and supraspinous lig. between C2 and T7 (T8), and terminate on the medial surface of the scapular cartilage. The deep pectoral (26 and p. 5, t) is a strong unified muscle which ends primarily on the major and minor tubercles. A branch of the tendon fuses with the latissimus dorsi and ends on the tendon of origin of the coracobrachialis. The subclavius (26'), absent in the dog, is not well developed. It extends from the first costal cartilage to the deep surface of the clavicular intersection. The serratus ventralis extends from the 2nd (3rd) cervical vertebra to the 9th rib, and is clearly divided into serratus ventralis cervicis (27) and thoracis. The serratus ventralis thoracis (27') arises by distinct muscle slips and is interspersed with strong tendinous layers. It is attached not only to the facies serrata of the scapula, but penetrates with a thick broad tendon between the parts of the subscapularis to end in the subscapular fossa.

b) LONG HYOID MUSCLES: The sternohyoideus (14), sternothyroideus (15), and omohyoideus do not belong to the shoulder girdle muscles, but are long muscles of the hyoid bone and thyroid cartilage. The first two resemble those of the horse, but do not have a tendon of insertion: they are, however, connected by a hyolymph muscle band in the middle of the neck. The omohyoideus (13) is thin and does not come from the shoulder, but from the deep cervical fascia, and therefore indirectly from the transverse processes of the 3rd and 4th cervical vertebrae. In the angle between the sternomastoideus and sternomandibularis, and crossed laterally by the external jugular vein, it passes medially under the mandibular gland to end with the sternohyoideus on the basihyoid.

c) VISCERA AND CONDUCTING STRUCTURES OF THE NECK: In the middle of the space for the viscera and conducting structures is the trachea (19). In life the tracheal cartilages are arched to give it a vertical oval section, but after death it has a tear-drop shape. Dorsolateral to the trachea is the common carotid artery (16), with the vagosympathetic trunk (17). The latter is accompanied by the small int. jugular v. This may be absent. The esophagus (18) is dorsal in the first third of the neck; in the other two thirds it is on the left side of the trachea and at the thoracic inlet it is dorsolateral. The left recurrent n. (18) accompanies the esophagus ventrally; the right recurrent n. accompanies the trachea dorsolaterally.

d) LYMPHATIC SYSTEM AND THYMUS: The superficial cervical lymph node (9) lies in the groove cranial to the suprascapularis, covered by the omotransversarius and cleido-occipitalis. It receives lymph from the neck, thoracic limb, and thoracic wall back to the thoracic duct. The caudal deep cervical lymph node (22) lies near the thyroid gland; the middle deep cervical lymph node (23), in the middle third of the neck on the right of the trachea and on the left of the esophagus. The caudal deep cervical lymph node (24) are placed around the trachea near the first rib. They receive lymph from the cervical viscera, ventral cervical muscles and preceding lymph nodes of the head, neck, and thoracic limb. (See the table of lymph nodes.) Some of their efferents have the same termination as those of the superficial cervical lymph node; others end in the cran. vena cava. The thymus (20) is fully developed only in the fetus. It consists of an unpaired left thymic part (may be maintained to six years of age), a V-shaped paired cervical part with the unpaired apex directed toward the thoracic cavity, and a paired cranial part (already retrogressed at birth).
Regions of the neck and chest

1 Linguofacial v.
2 Maxillary v.
3 External jugular v.
4 Sternochondromastoideus
5 Sternomandibularis
6 Cleidomastoideus
7 Cleidoccipitalis
8 Omohyoides
9 Supf. cervical ln.
10 Cephalic v.

Legend:

- a Great auricular n. and caud. auricular v.
- b Transverse n. of the neck
- c Accessory n.
- d Intercostobrachial n.
- e External intercostal mm.
- f External oblique abd. m.
- g Internal oblique abd. m.
- h Longus capitis
- i Intertransversarius longus
- j Vertral cervical intertransversari
- k Splenius
- l Semispinalis capitis
- m Spinalis et semispinalis thoracis cervicis
- n Longissimus
- n’ Longissimus capitis et atlantis
- n” Longissimus cervicis
- n” Longissimus thoracis
- n”” Longissimus lumborum
- o Iliocostalis cervicis
- o’ Iliocostalis thoracis
- o’’ Iliocostalis lumbarum
- p Scalenus:
- p’ Scalenus dorsalis
- p’’ Scalenus ventralis
- q C6 root of phrenic n.
- r Serratus dors. cranialis
- r’ Serratus dors. caudalis
- s Brachial plexus
- t Cran. pectoral nn.
- u Caud. pectoral nn.
- v Long thoracic n.
- w Lat. thoracic n.

Cdm = Med. dors. cut. br. of cervical nn. Tdl = Dorsolat. cut. br. of thoracic nn. Tvl = Ventrolat. cut. br. of thoracic nn.
The deep shoulder girdle muscles and the vessels and nerves of the limb, with attention to their roots, are cut as close as possible to the thoracic wall, and the limb is removed. The diaphragmatic line of pleural reflection, where the costal pleura is reflected as the diaphragmatic pleura, is clinically important as the caudoventral boundary of the pleural cavity. In the dorsal end of the 11th intercostal space, a small opening is made through the intercostal muscles into the pleural cavity; then the caudoventral limits of the costodiaphragmatic recess (7) are probed and marked on the ribs as the intercostal muscles are removed. The line extends from the knee of the 7th or 8th rib, through the middle of the 11th, to the angle of the 13th rib at the lateral border of the muscles of the back. The basal border of the lung is also marked on the ribs. After study of the lung field, the ribs, with the exception of the 3rd, 6th, and 13th, are cut above the line of pleural reflection and removed, sparing the diaphragm and noting the slips of origin of the ext. oblique abdominal muscle.

The RESPIRATORY MUSCLES (see appendix on myology) belong partly to the muscles of the back and partly to those of the thorax. They function as respiratory muscles in the contraction of the thorax or as inspiratory muscles in the expansion of it. The obligate respiratory muscles are aided by the auxiliary respiratory muscles. The diaphragm is the primary respiratory muscle and the partition between the thoracic and abdominal cavities.

The line of diaphragmatic attachment rises steeply, running across the ribs from the knee of the 8th, across the 11th rib below its middle to the vertebral end of the 13th rib. In ruminants the two costal parts (3) of the diaphragm are clearly separated from the 13–15 cm wide sternal part (not illustrated) by clefts between muscle fibers. The lumbar part (2) resembles that of the horse in its relation to the aortic hiatus and esophageal hiatus, but sends muscle fiber bundles from the right and left crura, sometimes with fibrocartilaginous inlays, to the foramen venae cavae (5). This lies on the right in a relatively large tendinous center (4), which on inspiration is at the level of the 7th rib.

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b) The THORACIC CAVITY is protected by the bony thoracic cage (thorax) and extends from the especially narrow cranial thoracic aperture (thoracic inlet) to the diaphragm. It contains the two pleural cavities of unequal size. The pleural sacs project into the thoracic inlet as the cupulae pleurae (15). The left one does not extend beyond the first rib. The right one projects 4–5 cm cranial to the first rib. The parietal pleura includes the costal pleura (6), diaphragmatic pleura (8), and the mediastinal pleura (16), where right and left pleural sacs adjoin and where they cover the pericardium as pericardial pleura (18). The visceral pleura covers the lungs as the pulmonary pleura, which is connected to the mediastinal pleura by the short pulmonary ligament. This is present only in the caudal area. The mediastinal recess (9) is a diverticulum of the right pleural cavity containing the accessory lobe of the right lung.

The costodiaphragmatic recess (7) is the potential space between the basal border of the lung and the diaphragmatic line of pleural reflection. The latter runs slightly craniodorsal to the line of diaphragmatic attachment, dipping ventrally at every intercostal space.

c) The MEDIASTINUM is thicker than in the horse. The heart occupies the middle mediastinum and divides the rest of the mediastinum into cranial (16), caudal, dorsal, and ventral parts. The mediastinum is composed of the two mediastinal pleural layers and the fibrous substantia propria between them. It encloses the usual organs and structures: the esophagus, trachea, blood and lymph vessels, lymph nodes, nerves, and the pericardium. The cranial mediastinum is pushed against the left thoracic wall in the first and second intercostal spaces, ventral to the great vessels, by the cranial lobe of the right lung. The caudal mediastinum, containing the left phrenic nerve, is attached to the left side of the diaphragm. Together with a fold on the right, the plica venae cavae (h), they enclose the mediastinal recess (9), containing the accessory lobe of the right lung. Perforations of the mediastinum, allowing communication between right and left pleural cavities, as described in the dog and horse, do not occur in the ox.

d) The LUNGS are accessible for percussion and auscultation in a cranial and a caudal lung field. The total area is relatively small. The cranial lung field is of lesser significance for clinical examination. It lies cranial to the thoracic limb in the first three intercostal spaces. The caudal lung field is bounded cranially by the tricipital line and dorsally by the muscles of the back. The basal border as determined by percussion or auscultation is 3–4 cm above the actual border of the lung, which is too thin for clinical examination. It is almost straight in contrast to the curvature in the dog and horse. It intersects the cranial border at the knee of the 6th rib. In the 7th intercostal space it intersects the dorsal plane through the shoulder joint. In the 11th space it meets the dorsal border.

The right lung is considerably larger than the left lung. The interlobar and intralobar fissures are distinctly marked so that both the right and left cranial lobes are divided into cranial (19) and caudal (20) parts, unlike the dog and horse. In addition to the caudal lobe (30) of both lungs, the right lung has an accessory lobe (29), as in all domestic mammals, and a middle lobe (23), absent in the horse. In addition, the right cranial lobe has a special tracheal bronchus (22) that comes from the tracheal bronchus to the bifurcation (26). Also, the bovine lung has a distinctly visible lobular structure outlined by an increase in the amount of connective tissue.

e) The LYMPHATIC SYSTEM is not only clinically important (as in the dog and especially in the horse), but also of great practical interest in meat inspection; therefore a knowledge of it is indispensable. (See the appendix on the lymphatic system.) Lymph nodes routinely examined in meat inspection are the left (24), middle (27), and cranial (21) tracheobronchial lnn., the latter lying cranial to the origin of the tracheal bronchus; and the small, inconstant right tracheobronchial lnn. (25), called the supervisor’s node. Routinely palpated for enlargement are the pulmonary lnn. (28) concealed in the lung near the main bronchi. Also routinely examined are the cranial (14), middle (12), and caudal (13) mediastinal lnn. The latter consist of a group of small nodes between the esophagus and aorta and one 15–25 cm long ln. that extends dorsal to the esophagus to the diaphragm and drains a large area on both sides of the latter. Finally, included in the routine examination are the thoracic aortic lnn. (11) dorsal to the aorta and medial to the sympathetic trunk.

In special cases the following are examined: the intercostal lnn. (10) lateral to the sympathetic trunk, and the cranial sternal ln. (17) dorsal to the manubrium sterni and ventral to the internal thoracic vessels. The caudal sternal lnn. and the phrenic ln. on the thoracic side of the foramen venae cavae are unimportant for meat inspection.

Most of the lymphatic drainage passes through the mediastinal lnn. and the terminal part of the tracheal duct, as well as the thoracic duct (1), which does not go through the aortic hiatus, but through the right crus of the diaphragm. At T5 it crosses to the left side of the esophagus and trachea. It may be enlarged to form an ampulla before it opens into the bifurcator trunk.
a) The HEART (COR) is relatively small in comparison to that of the horse. Its weight varies between 0.4 and 0.5 percent of the body weight. Its absolute weight in cows averages 2.4 kg and in bulls 2.6 kg.

The heart is located between the planes of the 3rd and 5th intercostal spaces in the ventral half of the thoracic cavity. The inclination of the cardiac axis is relatively steep, with the base of the heart directed craniadorsally. The apex (x) of the heart is directed caudoventrally, but does not reach the sternum. The greater part of the heart lies on the left of the median plane and brings the pericardium into contact with the left thoracic wall in the 3rd and 4th intercostal spaces. Its left ventricular border (w) presses the pericardium into contact with the left side of the diaphragm close to the median plane, and this is clinically significant because of the proximity of the retroperitoneum, with its penetrating hardware. The heart field, clinically important for auscultation and percussion, is an outline of the heart projected on the left thoracic wall from the 3rd to the 5th intercostal space. On the surface of the heart in addition to the paracaval (16) and subaortic (18) interventricular grooves, there is an interventricular groove on the left ventricular border that does not reach the apex. Also species-specific are the distinctly dentate margins of the auricles, which overhang the base of the heart, but are smaller than those of the horse. The friable white structural fat (suet) that can make up as much as 24 percent of the weight of the heart lies in four interconnected lobes on the right and left atria between the great vessels and in the coronary grooves.

The pericardium is attached by two divergent sternopericardiac ligaments (14) to the sternum at the level of the notches for the 6th costal cartilages.

Of the coronary arteries, the left coronary a. (15) is substantially larger (left coronary supply type as in the dog, but unlike the horse and pig.) It gives off the paracaval (16) and subaortic (18) interventricular grooves. The right coronary a. (19) takes a circumflex course in the coronary groove between the right atrium and ventricle.

The heart bones are remarkable features of the heart skeleton—the fibrous rings around and between the valves. The large, 3–6 cm, three-pronged right heart bone (g) and the small, 2 cm, left heart bone (g) are in the aortic ring.

b) The remaining BLOOD VESSELS show greater differences from the dog than from the horse.

The first branch of the aortic arch, as in the horse, is the brachiocephalic trunk (13), the common trunk of the vessels to cranial parts of the thorax, to the thoracic limbs, and to the head and neck. It gives off first the left subclavian a., then the right subclavian a., and continues as the bicarotid trunk for the left (4) and right (see p. 63) common carotid a. The left (6) and right (see p. 63) subclavian a., give off cranially the costocervical trunk (3) for vessels to the vertebrae, spinal cord, and brain (vertebral a. 2); to the neck (deep cervical a., 2 and dorsal scapular a. 1); and to the ribs (supreme intercostal a., which can also originate from the subclavian a. or the aorta). Dorso cranially the subclavian gives off the superficial cervical a. (5), and caudally, the internal thoracic a. (7), which is the last branch before the subclavian turns around the first rib and becomes the axillary a. The thoracic aorta (8) gives off dorsal intercostal a. a. and on the right, dorsal to the base of the heart, the bronchoesophageal a., whose bronchial (12) and esophageal (11) branches may originate as separate arteries from the aorta or an intercostal a. The tracheal bronchus is supplied by its own branch, either from the aorta or from the bronchial branch.

The veins show a distribution similar to that of the arteries. A right ayzygos v. (see p. 63), present in the dog and horse, is only rarely developed as far as the last thoracic vertebra in the ox, and may be absent caudal to the 5th dorsal intercostal v. The left ayzygos v. (10) is always present. It drains into the coronary sinus of the right atrium. It does not occur in the dog and horse.

c) The NERVES in the thoracic cavity are the same as in the dog and horse. The greater splanchic n. takes origin from the sympathetic trunk (9) at the 6th to 10th ganglia, unlike the dog and horse, and separates from the trunk just before they pass over the diaphragm in the lumbocostal arch.

Section through the Base of the Heart

Legend:*  
A Right atrium  
B Right ventricle  
C Left atrium  
D Left ventricle  
a Sinus of venae cavae  
b Coronary sinus  
c Pectinate mm.  
d Veins of right heart  
e Right atroventricular valve  
e'1 Parietal cusp  
e'2 Septal cusp  
e'3 Angular cusp  
e'4 Small papillary mm.  
e'5 Great papillary m.  
e'6 Subarterial papillary m.  
f Pulmonary valve  
g Right heart bone  
g' Left heart bone  
h Fossa ovalis  
i Epicardium  
j Myocardium  
k Endocardium  
r Left atroventricular valve  
r'1 Parietal cusp  
r'2 Septal cusp  
r'3 Subauricular papillary m.  
r'4 Subtrabecular papillary m.  
s Aortic valve  
s1 Right semilunar valvule  
s2 Left semilunar valvule  
s3 Septal semilunar valvule  
t Right semilunar valvule  
t2 Left semilunar valvule  
t3 Intermediate semilunar valvule  
i Atrioventricular orifice  
m Interventricular septum  
n Septomarginal trabeculae  
o Trabeculae carneae  
p Tendinous cords

* The letters in this legend are framed in the heart illustrations (pp. 64, 65).
Left Thoracic cavity and Heart

Legend: (Lnn. see p. 63)

a Trachea and int. jugular v.
b Cervicothoracic ganglion
c Middle cervical ganglion
d Thoracic duct
e Vagus n.
f Intercostal aa. and vv.
g Left phrenic n.
h Thymus
i Right auricle
j Left auricle
k Conus arteriosus
l Pulmonary trunk
m Left pulmonary a.
n Right pulmonary a.
o Lig. arteriosum
p Pulmonary vv.
q Caud. vena cava
r Cran. vena cava
s Costocervical v.
t Middle cardiac v.
u Great cardiac v.
v Right ventricular border
w Left ventricular border and intermediate groove
x Apex of heart
y Longus colli m.

Right atrium and Right ventricle
(Atrial surface)

Left auricle and Left ventricle
(Auricular surface)
CHAPTER 7: ABDOMINAL WALL AND ABDOMINAL CAVITY

1. THE ABDOMINAL WALL

For demonstration of the five layers of the abdominal wall (a, b, d, e, f), the remaining skin is cut along the dorsomedian line and along the transverse plane of the tuber coxae, and reflected ventrally to the base of the udder or prepuce. Remnants of the cutaneous trunci, abdominal muscles, and internal fascia of the trunk are cut just ventral to the ilioiliosais lumbarum and reflected ventrally, one after the other, to the subcutaneous abdominal vein and the lateral border of the rectus abdominis.

a) The SKIN (1) of the lateral abdominal wall (flank) is easily moveable. Dorsally the surgically important triangular paralumbar fossa (b) is outlined by the ends of the transverse processes of the lumbar vertebrae, the last rib, and the prominent ridge formed by the part of the internal oblique that extends from the tuber coxae to the knee of the last rib. Ventrally, the subcutaneous cranial superficial epigastric v. (“milk vein”—3) in the cow, is conspicuous, meandering, and 2–5 cm thick. It comes from the int. thoracic v. and emerges from the “milk well” (anulus vena subcutanatis abdominis) at the second tendinous intersection of the rectus, ventral to the 7th to 9th intercostal spaces. It joins the cranial mammary v. (caudal superficial epigastric v., p. 91, 12) at the udder.

b) The SYSTEM OF THE EXTERNAL FASCIA OF THE TRUNK includes the superficial fascia and deep fascia.

I. The superficial fascia of the trunk envelops the cutaneous trunci and the cranially related cutaneus omobrachialis, which are essentially the same as in the horse. The strong cranial preputial muscles, present in the cow, and not in the horse, originate mainly from the region of the xiphoid cartilage and secondarily from the anterior border of the cutaneous trunci, and form a loop around the preputial orifice. The caudal preputial muscles (see text figure p. 80) are inconspicuous in the dog and absent in the horse and polled breeds of cattle. They originate from the deep fascia, mainly lateral to the tunica vaginalis, but often also medial to it, and terminate at the loop formed by the cranial preputial muscles.

The 8–12 cm long subiliac lymph node (5), absent in the dog, differs from the multiple nodes of the horse. It is a single large node above the patella on the abdominal wall near the cranial border of the tensor fasciae latae, easily palpable in the live ox. A small accessory node may be present.

II. The deep fascia of the trunk covers the external oblique, and on the ventrolateral abdomen is also known as the yellow abdominal tunic (4) due to the inclusion of yellow elastic fibers. With its colagenous laminae the deep fascia completely envelops the two abdominal obliquies; whereas it covers only the external surface of the rectus and transversus. On both sides of the ventral median line the yellow tunic gives off the elastic medial laminae of the udder, or in the bull, radiates into the prepuce. The linea alba is the ventromedial fixation of the two recti (see p. 80). The linea alba is conspicuous in the dog and absent in the horse and polled breeds of cattle.

The deep layer of the deep fascia includes the aponeurosis of the external oblique and rectus abdominis. The aponeurosis is a component of the external lamina of the sheath of the rectus.

c) The NERVES OF THE ABDOMINAL WALL

I. The dorsal branches of spinal nerves T12–L3 divide into medial and lateral mixed motor and sensory branches. The lateral br. (Tdl, Ldl) pass out between the longissimus and iliocostalis muscles and divide into dorsomedial cutaneous br. and dorsolateral cutaneous br. The latter innervate the skin of the abdomen down to the level of the patella. On p. 67 the small dorsomedial cutaneous br. is mislabeled Ldl. The dorsolateral cutaneous br. are cut off short. Those of T13 and L1 and L2 cross the paralumbar fossa to a line from the ventral end of the last rib to the patella, but cannot be traced that far. They are supplied by the posterior cutaneous branches (Tvl, Lvl) extending to the ventral midline and cranial portions of the prepuce or udder, and terminate in the rectus and parietal peritoneum. The relations of nerves T13–L2 to the transversus processes of the vertebrae are of great clinical importance for anesthesia of the abdominal wall. The lateral cutaneous femoral n. (11) comes from L3 and L4 through the lumbar plexus. It accompanies the caudal branches of the deep circumflex iliac a. and v., at first medial then cranial lateral to the tensor fasciae latae, down to the stifle. (For the innervation of the udder see p. 90.)

d) The SKELETAL MUSCLE LAYER consists of four broad muscles.

I. The external oblique abdominal m. (2). The lumbar part originates on the last rib and thoracolumbar fascia and runs to the tuber coxae, and caudoventrally to the inguinal lig. and prepubic tendon (see p. 80). The costal part begins with its digitations on the last 8–9 ribs, touching part of the ventral border of the latisimus dorsi. It ends with the aponeurosis mainly on the linea alba, but also on the prepubic tendon by means of its abdominal and pelvic tendons (see pp. 79, 80). The transition of the muscle to its aponeurosis follows the curve of the costal arch (see p. 80) to the tuber coxae. The aponeurosis is a component of the external lamina of the sheath of the rectus.

II. The internal oblique abdominal m. (10) originates mainly from the tuber coxae and the iliac fascia (see p. 81). It also arises from the thoracolumbar fascia and the lumbar transverse processes. The dorsal part ends on the last rib, and the portion running from the tuber coxae to the knee of the last rib forms the caudoventral border of the paralumbar fossa. The main termination is by its aponeurosis on the linea alba; the caudal border of the aponeurosis joins the abdominal and pelvic tendons of the external oblique and the tendon of the rectus in the prepubic tendon. The aponeurosis, unlike that of the dog, is involved only in the external lamina of the sheath of the rectus. (For its contribution to the deep inguinal ring see p. 80.)

III. The transversus abdominis (7) originates with a tendinous lumbar part from the lumbar transverse processes, and a fleshy costal part interdigitating with the diaphragm on the last 7–8 costal cartilages. It terminates on the linea alba, its aponeurosis forming the internal lamina of the sheath of the rectus. Its caudal extent is at the transverse plane of the tuber coxae.

IV. The rectus abdominis (6) takes origin from the 4th–9th costal cartilages and has five tendinous intersections. The terminal tendons of the recti become abruptly narrower near the inguinal region and turn their inner surfaces toward each other, forming in the cow a narrow median trough. Near the prepubic tendon the rectus tendons twist into sagittal planes and fuse by decussation caudal to the intertendinous fossa (see p. 78 c). They form a common median tendon incorporated in the prepubic tendon and continuos with the symphysial tendon.

e) The INTERNAL FASCIA OF THE TRUNK (see p. 80) lines the transversus and rectus on the lateral and ventral abdominal wall as the fascia transversalis. Dorsally it covers the psoas and iliacus as iliac fascia. It joins the pelvic fascia on the pelvic wall.

f) The PERITONEUM (see also p. 80). The peritoneum extends into the pelvic cavity as the rectopectinal, vesicogenous, and pubovesical pouches (excavations) and in the bull is evaginated into the scrotum as the vaginal tunic.
Pectoral and abdominal regions

(lateral)

1 Skin
2 External oblique abd. m.
3 Cran. supf. epigastric v.
   (Milk v.)
4 Yellow abdominal tunic
5 Subiliac ln.
6 Rectus abdominis and tendinous intersections
7 Transversus
8 Iliohypogastric n.
9 Ilioinguinal n.
10 Int. oblique abd. m.
11 Lat. cut. femoral n.

Legend:

a Supf. cervical ln.
b Paralumbar fossa
c Rectus thoracis
d Int. intercostal mm.

(See p. 61)
A knowledge of the topographic relations of the abdominal organs to the body wall is essential for their examination from the exterior as well as for laparotomy and rectal examination. The abdominal wall is divided into cranial, middle, and caudal regions, and these are subdivided on each side as follows: I. The large cranial abdominal region consists of a) left, and b) right caudal ventral parts of the costal regions and the hypochondriac regions (covered by the costal cartilages), and c) the xiphoid region between the costal arches. II. The middle abdominal region consists of the a) left and b) right lateral abdominal regions (flanks) with the paralumbar fossa and the c) umbilical region. III. The caudal abdominal region consists of right and left inguinal regions and the pubic region. In the costal and hypochondriac regions the intrathoracic abdominal organs are not in contact with the thoracic wall, but are separated from it by the lungs and diaphragm. The rumen extends from the diaphragm to the pelvic inlet. It takes up most of the left half of the abdominal cavity. Its extension to the right and toward the pelvic inlet depends on the age of the animal, the kind of feed, and, if pregnant, the stage of gestation. These factors also affect the position and relations of all other abdominal organs.

I. a) In the left costal and hypochondriac regions the atrium (3) and recess (6) of the rumen are projected on the thoracic wall, as well as the spleen (4), adherent to the dorsolateral surface of the atrium from the vertebral ends of the 12th and 13th ribs, over the middle of the 10th rib, to the level of the knees of the 7th and 8th ribs. The reticulum (2) is in contact with the left abdominal wall in the ventral third of the 6th and 7th intercostal spaces. Near the median plane it may extend caudally as far as the transverse plane of the 9th intercostal space, and ventrally to the level of the xiphoid cartilage. Of the liver (1), only the left border is projected in the narrow space between the diaphragm and reticulum in the ventral 3rd of the 6th intercostal space. The fundus of the abomasum (5) lies on the left side between the reticulum and the atrium of the rumen.

I. b) In the right costal and hypochondriac regions the liver (25), covered by the diaphragm, and mostly also by the lung, is projected on the thoracic wall, its border forming a caudally convex curve. It lies almost entirely on the right side, including the left lobe (1), right lobe (25), and caudate process (24). It extends from the ventral end of the 7th costal cartilage to the dorsal end of the 12th rib. The percussion field of the liver, however, is limited to a zone about 6 cm wide along the border of the lung in the last four intercostal spaces.

Ventral to the caudate process is the cranial part of the descending duodenum (13) with the right lobe of the pancreas (15) in the mesoduodenum. Ventral to the descending duodenum, covered by the greater omentum, are cranial loops of the jejunum (19) and cranial to them, the gall bladder (27) in the ventral part of the 10th intercostal space. Directly cranial to the gall bladder is the cranial part of the duodenum (26), continuous ventrocaudally with the pylorus, which varies in position from the ventral end of the 9th to that of the 12th intercostal space.

Cranial to the pyloric part of the abomasum (28) is the omasum (30), covered by the lesser omentum, between the transverse planes of the 7th and 11th ribs, but because of its spherical shape, it presses the lesser omentum against the thoracic wall in the 7th–9th intercostal spaces only.

II. a) In the left lateral abdominal region only rumen compartments adjoin the abdominal wall. The dorsolateral abdominal wall in the region of the paralumbar fossa is in contact with the dorsal sac (7) and the caudodorsal blind sac (8). The ventrolateral abdominal wall is indirectly in contact, through the superficial wall (21) of the greater omentum, with the ventral sac (9) and the caudodorsal blind sac (10) of the rumen.

II. b) In the right lateral abdominal region, projected from dorsal to ventral on the dorsolateral abdominal wall, are the right kidney (14) from the last rib to the 3rd lumbar vertebra, the right lobe of the pancreas (15) with the descending duodenum (13), which passes into the caudal flexure (12) at the level of the tuber coxae, and immediately caudal to that, the sigmoid part of the descending colon (11). Ventral to the duodenum, in the supraomental recess (23) of the greater omentum, are the proximal loop of the ascending colon (16) and the caudal flexure. The middle of the lumbar region to the pelvic inlet. The apex of the cecum projects cranially from the supraomental recess. (Relations between the descending duodenum and the parts of the large intestine may vary but are not necessarily abnormal.) The ventral part of the abomasum (28) ventrally along the right costal arch back to the knee of the 12th rib, and middle and caudal parts of the jejunum (19) from the last rib to the plane of the last lumbar vertebra. The jejunum overarches the greater omentum caudally and passes into the straight ileum (18) just ventral to the cecum.

III. Ventrally in the xiphoid region, are the reticulum (2) cranially, more on the left than on the right, the fundus of the abomasum (5) caudal to the reticulum; the omasum (30) ventral to the right costal arch, covered by the lesser omentum, between the transverse planes of the 7th and 11th intercostal spaces; the fundus of the abomasum, caudal to the reticulum; and the atrium of the rumen on the left. Ventrally in the middle abdominal region the body of the abomasum (29) lies on the median line with more of it on the left than on the right. At the angle of the abomasum the pyloric part (28) curves to the right around the omasum, with the greater curvature crossing the median line at the transverse plane of the last rib. The jejunum (19) is caudal to the abomasum on the right as far caudally as the last lumbar vertebra, partly within the supraomental recess. On the left of the median plane, caudally and also slightly to the right, the ventral sac (9) and caudal ventral blind sac (10), covered by the greater omentum, lie on the abdominal floor.

Study of the abdominal organs is carried out by the students on both sides of the body at the same time. On the left side the stomach and spleen are studied and the adhesions of the organs with the abdominal wall and with other organs and structures are noted. The interior relations of the compartments of the stomach are exposed by fenestration of the dorsal sac of the rumen from the lumbar transverse processes to the left longitudinal groove of the rumen, and removal of the contents. Prepared demonstrations of the stomach are also studied. On the right side, before the study of the liver and intestines, the special relations of the greater omentum are examined and the omental foramen is explored. Then the superficial wall (21) of the greater omentum is cut ventral and parallel to the descending duodenum, opening the caudal recess of the omental bursa (22). The duodenum with the mesoduodenum and pancreas are carefully reflected dorsally to the ventral surface of the right kidney. After study of the liver and its vessels, nerves, and ducts, the common bile duct, hepatic a., portal v., portal h., and nerves are severed at the porta of the liver, and the hepatic ligaments and caval vena cava cranial and caudal to the liver, are cut and the liver is removed. After complete transection of the superficial wall down to the pylorus, the deep wall of the greater omentum is cut ventral to the distal loop of the ascending colon and the transverse colon, and the supraomental recess (23) is opened for study of the remaining intestines. The blood vessels, nerves, and lymph nodes are identified with attention to species-specific peculiarities. For final exenteration the duodenum between the cranial and descending parts, and the rectum cranial to the caudal mesenteric a. are double-ligated and cut. Also the cranial and caudal mesenteric a. ventral to the aorta, and the splenic and gastroduodenal vv. at the portal v. are cut. While separating the mesentery and mesocolon from the dorsal abdominal wall, the intestinal mass is removed from the abdominal cavity and the parts of the intestines are identified on the isolated intestinal tract.
Abdominal cavity and Digestive system

(Left side)

Legend:
1 Left lobe of liver
2 Reticulum
3 Atrium of rumen
4 Spleen
5 Fundus of abomasum
6 Recess of ventral sac of rumen covered by omentum
7 Dorsal sac of rumen
8 Caudodorsal blind sac of rumen covered by omentum
9 Ventral sac of rumen covered by omentum
10 Caudoventral blind sac of rumen covered by omentum
11 Sigmoid part of descending colon
12 Caudal flexure of duodenum
13 Descending duodenum
14 Right kidney
15 Right lobe of pancreas

(Right side)

Legend:
16 Prox. loop of ascending colon
17 Cecum
18 Ileum
19 Jejunum
20 Deep wall
21 Supf. wall
22 Caudal recess
23 Suprapromental recess
24 Caudate process of liver
25 Right lobe of liver
26 Cranial part of duodenum
27 Gall bladder
28 Pyloric part of abomasum
29 Body of abomasum
30 Omasum covered by lesser omentum

(See pp. 17, 63, 65, 67)
The ruminant stomach is one compartmentalized complex stomach which consists of three nonglandular compartments lined with stratified squamous epithelium (rumen, reticulum, and omasum) and one compartment with glandular mucosa (abomasum). The individual compartments all develop from one spindle-shaped gastric primordium like that of the simple stomach. The total capacity of the stomach varies with body size from 100 to 200 l.

At about 18 months the compartments have reached the following approximate percentages of total stomach capacity: rumen 80 percent, reticulum 5 percent, omasum 7 percent, and abomasum 8 percent.* These postmortem measurements on isolated stomachs are not reliable indications of capacity in the live animal.

a) The capacity of the RUMEN (A) is 102–148 l. Most of the interior bears papillae (21). Its parietal surface lies against the left and ventral abdominal wall and its visceral surface is in contact with the intestines, liver, omasum, and abomasum. The wide ruminoreticular orifice (22) and close functional relationship has given rise to the term ruminoreticular. The dorsal curvature (1) is adherent to the internal lumbar muscles, right and left crura of the diaphragm, and on the abomasal side by glandular mucosa. The thick muscular omasal pillar runs across the floor of the groove.

At the caudal end of the rumen on both sides the two rumen sacs are divided by dorsal (11) and ventral (12) coronary grooves from the caudodorsal (13) and caudoventral (14) blind sacs, both of which extend about the same distance toward the pelvis. At its cranial end there are no coronary grooves; however the atrium of the rumen (8) can be recognized craniodorsal to the cranial groove, and the large recess of the rumen (10) is the cranial part of the ventral sac.

The external grooves of the rumen correspond to the internal muscular pillars (20) of the same names, covered by nonpapillated mucosa. The ruminoreticular groove (15) forms the internal ruminoreticular fold (23).

b) The RETICULUM (B) has its cranial diaphragmatic surface in contact with the diaphragm and left lobe of the liver. Its caudal visceral surface is in contact with the rumen, omasum, and abomasum. Its greater curvature lies against the left abdominal wall, while its lesser curvature contains the reticular groove. The fundus of the reticulum is in the xiphoid region.

The mucosa forms a network of crests (29) in three orders of height. The crests contain muscle, are covered with papillae, and enclose four- to six-sided cells (29), which become smaller and more irregular toward the reticular groove.

c) The GASTRIC GROOVE is the shortest route between the esophagus and the pylorus. It consists of three segments: the reticular groove, the omasal groove, and the abomasal groove.

It begins at the cardia (24), which opens caudally, as determined by transruminal palpation in the live ox. Buloes expelled from the esophagus go directly over the ruminoreticular fold (23) into the atrium (8). From the cardia the 15–20 cm long reticular groove (25) runs ventrally along the lesser curvature (right wall) of the reticulum. Its muscular right (26) and left (27) lips, are named for their relation to the cardia, over which they are continuous. As the lips descend, the right lip becomes caudal and the left lip cranial, and they run parallel and straight to the reticulo-omasal orifice (28), where the right lip overlaps the left. The floor of the reticular groove has longitudinal folds that increase in height toward the omasum and at the orifice bear long sharp claw-like papillae which continue into the omasum.

d) The OMASUM (C) is almost spherical with slightly flattened sides and lies on the right on the floor of the intrathoracic part of the abdominal cavity. The parietal surface is cranioventrolateral (see p. 69); the visceral surface is caudodorsomedial; and the curvature (30) is between them facing dorsally, caudally, and to the right. All of the omasum except the ventral part of the parietal surface is covered on the right by the lesser omentum (p. 69, 30). Cranioventrally the base of the omasum (31), containing the omasal groove, contacts the reticulum, rumen, and abomasum. Cranially and dorsolaterally the omsas joins the liver, and medially, the rumen. From the externally visible neck of the omasum the internal omasal orifice (35) leads to the omasoabomasal orifice (36). This is bounded by two folds of mucosa, the vela abomasic (45), which are covered on the omasal side by stratified squamous epithelium and on the abomasal side by glandular mucosa. The thick muscular omasal pillar runs across the floor of the groove.

About 100 omasal laminae (32) in four orders of size project from the curvature and the sides of the omasum toward the omasal groove. The groove and the free borders of the largest laminae form the omasal canal. Between the laminae are the interlaminar recesses (33). The laminae are covered by conical papillae (34).

e) The ABOMASUM is thin-walled and capable of great distension and displacement. It has a capacity of up to 28 l. The drawing of the right surface of the stomach (p. 71) shows the organ after removal from the abdominal cavity and inflation, which distorts the relation of abomasum to omasum. Its parietal surface and part of the greater curvature (37) lie on the ventral abdominal wall. The caudal part of the greater curvature is separated from the intestines by the greater omentum. The visceral surface is in contact with the rumen. The lesser curvature (38) bends around the omasum. The fundus of the abomasum (39) is a cranial recess in the left xiphoid region. It is continuous with the body of the abomasum (40) and both have internal permanent oblique, but not spiral, abomasal folds (44) of reddish-gray mucosa containing proper gastric glands. The folds begin at the omasoabomasal orifice and from the sides of the abomasal groove (46) and reach their greatest size in the body. The more lateral folds diverge toward the greater curvature, whereas the folds near the abomasal groove run more nearly parallel to it. The folds diminish toward the pyloric part which begins at the angle of the abomasum and consists of the pyloric antrum, pyloric canal, and pylorus. It is lined by wrinkled yellowish mucosa containing pyloric glands.

The pyloric sphincter (43) and the torus pyloricus (42) that bulges from the lesser curvature into the pylorus can close off the flow from the abomasum to the duodenum.

The abomasal groove runs along the lesser curvature, bordered by low mucosal folds, from the omasoabomasal orifice to the pylorus.

* Getty, 1975
**Stomach [Ventriculus]**

**Legend:**

**A Rumen**
1. Dorsal curvature
2. Ventral curvature
3. Left longitudinal groove
4. Left accessory groove
5. Cranial groove
6. Caudal groove
7. Dorsal sac
8. Atrium
9. Ventral sac
10. Recess of ventr. sac of rumen

**B Reticulum**
22. Ruminoreticular orifice
23. Ruminoreticular fold
24. Cardia
25. Reticular groove
26. Right lip
27. Left lip
28. Reticulo-omasal orifice
29. Reticulo-omasal orifice
30. Curvature
31. Base
32. Omasal laminae
33. Interfamilial recesses
34. Papillae
35. Omasal groove
36. Omasoabomasal orifice

**C Omasum**
30. Curvature
31. Base
32. Omasal laminae
33. Interfamilian recesses
34. Papillae
35. Omasal groove
36. Omasoabomasal orifice

**D Abomasum**
37. Greater curvature
38. Lesser curvature
39. Fundus
40. Body
41. Pyloric part
42. Torus pyloricus
43. Pyloric sphincter
44. Abomasal folds
45. Velum
46. Abomasal groove

**E Duodenum**
(See pp. 69, 73)
4. BLOOD SUPPLY AND INNERVATION OF THE STOMACH; LYMPH NODES AND OMENTA

a) The CELIAC A. (1) originates from the aorta at the level of the first lumbar vertebra. It has a relatively long course, and after giving off phrenic arteries and adrenal branches, divides on the right dorsal surface of the rumen into hepatic, splenic, and left gastric aa. The arteries of the rumen and reticulum correspond to small branches of the splenic and left gastric aa. on the simple stomach.

The splenic a. (3) enters the dorsal part of the spleen. Near its origin it gives off the large right ruminal a. (4) to the right accessory groove as the main artery of the rumen. This gives off right dorsal and ventral coronary aa., goes through the caudal groove, and comes out on the left side of the rumen, where it gives off left dorsal and ventral coronary aa. and anastomoses with the left ruminal a. (5), which passes through the cranial groove of the rumen from right to left. Near its origin it gives off the reticular a. (6), which passes dorsally on the diaphragmatic surface of the lesser curvature of the reticulum. The veins, branches of the portal v., have a predominantly corresponding course.

b) The innervation by AUTONOMIC NERVES is accomplished in general as in the dog and horse.

The dorsal and ventral trunks of the vagus nn. are of special clinical interest in regulating the functions of each compartment of the stomach. The rumen is innervated mainly by the dorsal vagal trunk (a), but the atrium of the rumen and the other three compartments are innervated by both vagal trunks. Individual brs. of these nerves may vary in location or extent. The dorsal vagal trunk supplies the right side of the atrium (h), the br. to the celiac plexus (c), the dorsal ruminal br. (d), and the right ruminal br. (b), which runs back in the right accessory groove, giving br. to the dorsal and ventral sacs, and passing around in the caudal ruminal groove to the left side. A branch of the dorsal trunk is also given off to the cranial ruminal groove and left longitudinal groove (e) and to the greater curvature of the abomasum (g). Branches of the dorsal trunk (f) pass over the omasum and the visceral side of the lesser curvature of the abomasum, innervating the right lip of the reticular groove, the caudal (visceral) surface of the reticulum, both sides of the omasum, and the visceral surface of the abomasum to the pylorus.

The ventral vagal trunk (j) gives branches to the left side of the atrium (l), the diaphragmatic surface of the reticulum (k), and branches that run in the lesser omentum to the liver, cranial part of the duodenum, and pylorus (p). Branches of the ventral trunk (m) innervate the left lip of the reticular groove (see p. 70, c), and continue across the parietal side of the neck of the omasum and run in the lesser omentum along the parietal surface of the base of the omasum and the lesser curvature of the abomasum to the pylorus, innervating the parietal surface of the omentum and abomasum.

c) The LYMPH NODES of the stomach and spleen include the following:Celiac Inn. (p. 76, A) 2–5 are found with the cran. mesenteric Inn. (p. 77) at the origin of the aa. of the same names. Splenic (or atrial) Inn. (E) 1–7 are grouped dorsocranial to the spleen between the atrium of the rumen and the left crus of the diaphragm. Among the numerous gastric lymph nodes, the reticuloabomasal (A), ruminoabomasal (B), left ruminal (C), right ruminal (D), cranial ruminal (not illustrated), reticular (F), omasal (not illustrated), dorsal abomasal (G), and ventral abomasal (H) lie in the grooves and in the omental attachments of the stomach compartments. Their efferent lymphatic vessels go to the splenic nodes or nodes preceding them, gastric trunks, visceral trunks, or the cisterna chyli (p. 74).

d) OMENTA. The embryonic dorsal mesogastrium and ventral mesogastrium undergo important changes in form and position with the development of the four compartments of the stomach.

After the rotation of the spindle-shaped stomach primordium through about 90° to the left, with the axis of the stomach directed at first from craniocaudal to caudoventral, three protuberances appear on the greater curvature. In craniocaudal order they are the primordia of the rumen, reticulum, and greater curvature of the abomasum. The craniodorsal end of the rumen tube is divided by the future caudal groove into the future dorsal and ventral caudal sacc.

The only protuberance on the lesser curvature is the primordium of the omasum. In the course of further development, the reticulum mesogastrium, the third saccus of the rumen, is divided cranially and then caudally, so that cranial and caudal blind saccs become dorsal and ventral. The caudal groove is extended on both sides of the rumen as the right and left longitudinal grooves, and a flexure in the rumen tube becomes the cranial groove. The abomasum approaches the rumen and reticulum, and its greater curvature becomes ventral as it continues the rotation clockwise as viewed from the head. The omentum comes up on the right side.

In spite of these complicated translocations, the attachments of the dorsal and ventral mesogastria to the greater and lesser curvatures of the stomach are maintained. The lining of the stomach of the dorsal mesogastrium on the stomach in the adult runs from the dorsal surface of the esophagus at the hiatus to the right longitudinal groove, through the caudal groove and the left longitudinal groove of the rumen, across a part of the left surface of the atrium and reticulum, and along the greater curvature of the abomasum to the cranial part of the duodenum.

The greater omentum (see the lower left figure) with its deep wall (15) and superficial wall (14), together with the omental bursa, is the main derivative of the dorsal mesogastrium. It extends caudally, ventrally, and to the right. Caudally near the pelvis, as in the dog, the deep wall is reflected as the supf. wall, forming the omental bursa and the caudal recess of the omental bursa (16). Ventrally, because the attachment of the dorsal mesogastrium to the rumen followed the right longitudinal, caudal, and left longitudinal grooves, the ventral sac is enclosed by the greater omentum and forms a part of the wall of the omental bursa. On the right, the greater omentum is adherent to the medial surface of the mesoduodenum from the cranial flexure, along the descending part, to the caudal flexure of the duodenum (p. 69, 12). In the sling formed by the deep and supf. walls of the greater omentum between the mesoduodenum and the right longitudinal groove of the rumen, is the supraomental recess (13), open caudally and containing the bulk of the intestines. The deep wall of the greater omentum passes from the mesoduodenum, ventral to the intestines, to its attachment in the right longitudinal groove of the rumen, whereas the supf. wall passes ventral to the intestines and the ventral sac of the rumen to the left longitudinal groove. Both walls of the omentum meet in the cranial groove. Cralnial parts of the dorsal mesogastrium disappear or are shortened in the adult by expansion of the atrium and adhesion with its surroundings. The spleen on the left and the left lobe of the pancreas are held between the rumen and the diaphragm by adhesions. The line of origin of the dorsal mesogastrium is displaced to the right and runs obliquely craniodorsally from the level of the esophageal hiatus through the origin of the celiac a. to the level of the distal loop of the ascending colon.

The ventral mesogastrium is divided by the developing liver into the lesser omentum on the visceral surface of the liver and the falci form lig. (see p. 75, 13) on the diaphragmatic surface. The lesser omentum extends, as the hepatogastric lig., from the porta of the liver ventrally to the esophageal hiatus, the lesser curvature of the reticulum, the base of the omasum, and the lesser curvature of the abomasum, covering the right surface of the omasum (p. 69, 30). The lesser omentum ends as a free border, the hepatoduodenal lig., from the porta of the liver to the cranial flexure of the duodenum. It contains the portal vein and forms the ventral border of the omental (epiploic) foramen, which leads to the vestibule of the omental bursa. The vestibule opens into the caudal recess.
Gastric Vessels, Nerves, and Lymph nodes

Legend:

A Reticuloabomasal ln.  
B Ruminioabomasal ln.  
C Left ruminal ln.  
D Right ruminal ln.  
E Splenic (or atrial) ln.  
F Reticular ln.  
G Dorsal abomasal ln.  
H Ventral abomasal ln.  

1 Celiac a.  
2 Hepatic a.  
3 Splenic a. and v.  
4 Right ruminal a. and v.  
5 Left ruminal a.  
6 Reticular a. and v.  
7 Caud. esophageal brr.  
8 Left gastric a. and v.  
9 Left gastroepiploic a. and v.  
10 Accessory reticular a. and v.  
11 Right gastric a. and v.  
12 Right gastroepiploic a. and v.  

Legend:

13 Supraomental recess  
14 Greater omentum: 
15 Superficial wall  
16 Deep wall  
17 Omental bursa:  
18 Caudal recess  
19 Duodenum:  
20 Descending part  
21 Ascending part  
22 Jejunum  
23 Ileum  
24 Cecum  
25 Distal loop  
26 Descending colon  
27 Aorta  
28 Left kidney  

(See pp. 65, 67)
5. SPLEEN, LIVER, PANCREAS, AND LYMPH NODES

a) The SPLEEN is relatively small, red-brown in the bull and blue-gray in the cow. It is up to 50 cm long and its average weight varies with that of the animal. In one very large bull, age, and body size from the Hereford breed, the spleen weighed 3900 g. It is an elongated oval, tongue-shaped organ of about equal width throughout. Its position is almost vertical (see p. 69, 4). The dorsal end (2) is near the vertebral column and the ventral end (6) is a hand's breadth dorsal to the 7th-8th costochondral junction. The cranial (4) and caudal (5) borders are rounded in the bull, acute in the cow. The spleen does not extend caudal to the line of pleural reflection. The diaphragmatic surface is applied to the diaphragm; the visceral surface, dorsomedially to the atrium of the rumin and cranioventrally to the reticulum. Both surfaces of the dorsal part are more or less extensively fused with the surroundings, so that a phrenicosplenic lig. (1) and a gastrosplenic lig. are only vestigial. The rather small hilus (3) is in the dorsal third of the cranial border in the area of adhesion to the rumen.

b) The LIVER reaches its adult size by the third year and after that its weight ranges from 4–10 kg depending on breed, age, and nutritional condition. The weight is relatively greater in the calf. Its color varies from yellowish in the calf to reddish-brown in the adult. Because of the enlargement of the rumen it is almost entirely displaced to the right (see p. 69), except for a small portion ventral to the esophagus.

The right lobe is caudodorsal and the left lobe is cranioventral. The thick dorsal border (28) is almost in the median plane. Here the caudal vena cava (h) runs in a groove inclined ventrally to the foramen venae cavae. Between the caudate lobe and the left lobe is the esophageal impression (w), distinct only in fixed livers. The acute ventral border (27) is caudoventral on the right. The fixed specimen shows a large oesophageal impression (q) and ventral to it, a reticular impression (r). In contrast to the dog and horse the liver is not distinctly lobated. Except for the fissure for the round ligament (p), interlobar notches are absent. The left lobe (26) is not divided. The gallbladder fossa separates the right lobe (17), undivided as in the horse, from the quadrate lobe (22). The caudate lobe lies between the vena cava and the left (intrahepatic) branch of the portal vein. As in the dog it has a papillary process (24), which overlaps the left branch of the portal vein. The short caudate process (15) overlaps the right lobe and is partially fused with it. Together they form the renal impression for the cranial end of the right kidney. On the visceral surface is the porta hepatis where the portal v., hepatic a., and autonomic nn. enter the liver, and the bile-carrying hepatic duct and lymph vessels leave the liver. Of the hepatic ligaments, the right triangular lig. (7) goes to the dorsal abdominal wall, and dorsomedial to it, the heptorenal lig. (8) connects the caudate process to the right kidney. The left triangular lig. (14) is found on the diaphragm near the esophageal hiatus. The coronary lig. (21) attaches the liver to the diaphragm and connects the triangular ligg. and the falciform lig. Its line of attachment to the liver passes from the left triangular lig, around ventral to the caud. v. cava and along the right side of the caud. v. cava. On the right lobe it divides into two laminae that surround the area nuda (16). The falciform lig. (13) with the round lig. in its free border is attached to the diaphragmatic surface of the liver on a line from the coronary lig. at the foramen venae cavae to the fissure for the round lig. It is attached to the diaphragm on a horizontal line from the foramen venae cavae to the costochondral junction. Unlike that of the horse, it does not go to the umbilicus. The diaphragmatic attachment is a secondary adhesion resulting from the displacement of the liver to the right, and in many adults the falciform and round ligg. have disappeared. The gallbladder (25) is pear-shaped with a total length of 10–15 cm. It extends beyond the ventral (right) border of the liver. The right and left hepatic ducts join to form the common hepatic duct (12), which receives the cystic duct (20) and becomes the short, wide common bile duct (19, ductus choledochus), which opens into the duodenum about 60 cm from the pylorus on the oblique greater duodenal papilla. Hepatocystic ducts open directly into the gall bladder.

c) The main duct of the bovine PANCREAS is the accessory pancreatic duct (m), which opens in the descending duodenum 30–40 cm from the greater duodenal papilla. The pancreatic duct is represented in the ox by small ducts that open into the common hepatic duct in its course across the pancreas. The left lobe (10) extends to the spleen and is attached by connective tissue to the rumen and the left crus of the diaphragm. The body of the pancreas (11) lies between the liver and the omasum ventral to the portal vein, which passes dorsally through the pancreatic notch (11) to the liver. The right lobe (9) is enclosed in the mesoduodenum descending and extends to the plane of the right kidney.

d) The LYMPH NODES of the spleen, liver, and pancreas. The 1–7 splenic lnn. (p. 73) lie dorsocranial to the spleen between the atrium of the rumen and the left crus of the diaphragm, and are regularly examined in meat inspection.

The 6–15 hepatic (portal) lnn. (23) are grouped around the porta of the liver and are regularly examined in meat inspection. The accessory hepatic lnn. (29) are found on the dorsal border of the liver near the caudal vena cava. The outflow of lymph occurs, together with that of the dorsal and ventral abdominal lnn., through the hepatic trunk. The pancreaticoduodenal lnn. (see p. 76, 1) lie between the pancreas and descending duodenum and between the pancreas and transverse colon.

The lymph drainage is through the intestinal trunk (A) which joins the hepatic trunk (B), and after receiving the gastric trunk (C) with lymph from the stomach and spleen, becomes the visceral trunk (D) and enters the cisterna chyli (E). The valveless cisterna chyli receives the lumbar trunk (F), which drains the lymph from the pelvic limbs, genital organs, and the pelvis.

The thoracic duct (G), emerging cranially from the cisterna chyli, passes in the ox through a slit in the muscle of the right crus of the diaphragm into the thorax. It does not pass through the aortic hiatus as in the horse and dog. For lymph nodes of the pelvic cavity, see also pp. 82–83.

![Lymph nodes and Lymphatic vessels*](See p. 82)
Spleen, Liver, and Pancreas (Abdominal surface of diaphragm)

Spleen:
1 Phrenicosplenic lig.
2 Dorsal end of spleen
3 Hilus of spleen
4 Cran. border of spleen
5 Caud. border of spleen
6 Ventral end of spleen

Pancreas:
9 Right lobe of pancreas
10 Left lobe of pancreas
11 Pancreatic notch
12 Body of pancreas

Legend:

Diaphragm:
- a Lumbar part
- b Tendinous center
- c Costal part
- d Sternal part
- e Aorta
- f Cran. mesenteric a.
- g Celiac a.
- h Caud. vena cava
- i Splenic a. and v.
- k Portal v.
- l Duodenum
- m Accessory pancreatic duct
- n Esophagus
- o Lesser omentum
- p Fissure for round lig.
- q Oesophageal impression
- r Reticular impression
- s Hepatic a.
- t Right gastric a.
- u Gastro-duodenal a.
- v Renal impression
- w Esophageal impression (cut edge)

Liver
15 Caudate proc.
16 Bare area (Area nuda)
17 Right lobe
18 Common hepatic duct
19 Common bile duct (Ductus choledochus)
20 Cystic duct
21 Coronary lig.
22 Quadrant lobe
23 Hepatic Inn.
24 Papillary proc.
25 Gallbladder
26 Left lobe
27 Ventral border
28 Dorsal border

(See p. 69)
6. INTESTINES WITH BLOOD VESSELS AND LYMPH NODES

a) The INTESTINAL TRACT is displaced to the right half of the abdominal cavity by the enormous expansion of the stomach, primarily the rumen, on the left. Most of the intestines, attached by the mesentery, lie in the supraomental recess. The intestinal tract has considerable length – 33–59 m, whereas the lumen, especially of the large intestine, is small compared to the horse.

The small intestine has a total length of 27–49 m. The duodenum begins ventrally on the right at the pylorus with the cranial part (1), which runs dorsally to the porta of the liver. Here it forms the sigmoid flexure (1), turns caudally at the cranial flexure, and continues as the descending part of the duodenum (2) (see also p. 69). This runs caudodorsally, accompanied at first by the right lobe of the pancreas, to the plane of the tuber coxae. Here it turns sharply mediad to the caudal border of the mesentery at the caudal flexure (3), and continues cranially as the ascending part of the duodenum (4). The descending colon (17) is dorsal to the ascending duodenum and adherent to it. The caudal free border of this adhesion is the duodenocolic fold (5). Under the left lobe of the pancreas and on the left side of the cranial mesenteric a., the ascending duodenum passes through the duodenoejejunal flexure into the jejunum (6). This surrounds the disc of the coiled colon like a wreath. It begins cranially at the liver and pancreas and runs caudoventrally through many loops until it passes without a clear boundary into the ileum cranial to the pelvic inlet. The caudal part, called the "flange" is of clinical significance because of its longer mesentery. The ileum (7) is described as the part of the small intestine attached to the ileocecal fold (8), but in the ox the fold extends on the left side of the mesentery to the apex of the flange. Therefore by this definition the bovine ileum has a convoluted part as well as the 1 m long straight part near the cecum. The ileum opens into the large intestine at the ileal orifice, on the ileal papilla (p. 77, lower figure) which marks the boundary between the cecum and colon at the transverse plane of the 4th lumbar vertebra.

The large intestine including the cecum, colon, and rectum has neither bands nor sacculations, unlike that of the horse. The cecum is cylindrical, 50–70 cm long, and slightly curved. It lies in the dorsal part of the right abdominal cavity and extends to the pelvic inlet with a free, rounded blind apex (10). The body of the cecum (9) is attached by the common mesentery to the proximal and distal loops of the colon, and is continuous with the colon, with no change in the lumen, at the cecocolic orifice (p. 77, lower figure). The colon is about 7–9.5 m long, and consists of the ascending colon, transverse colon, and descending colon. The ascending colon, the longest part of the large intestine, has three parts. The proximal loop (11) runs cranially for a short distance to the plane of the right kidney, where it doubles back dorsal to the first part and the cecum. It then turns mediodorsally around the caudal border of the mesentery and runs cranially on the left side of the mesentery. Near the left kidney it becomes narrower and turns ventrally into the elliptical coil formed by the spiral loop. This is variable, but usually consists of 1.5–2 centrifugal gyri (12), the central flexure (13), and the same number of centrifugal gyri (14). The last (outer) centrifugal gyrus passes into the narrow distal loop (15) at the plane of the first lumbar vertebra. The distal loop runs first dorsally on the left side of the mesentery, ventral to the ascending duodenum and dorsal to the proximal loop. At the plane of the 5th lumbar vertebra it turns sharply around the caudal border of the mesentery and runs forward on the right to the short transverse colon (16). It turns around the cranial mesenteric a. from right to left and becomes the descending colon (17) that runs caudally ventral to the vertebral column. Its fat-filled mesocolon lengthens at the last lumbar vertebra, and the sigmoid colon (18) forms at the pelvic inlet. The rectum (19) begins at the pelvic inlet with a shortened mesorectum, but no structural transition.

b) The MESENTERY. The derivatives of the primitive dorsal mesentery that are attached to the parts of the small and large intestines are fused in the intestinal mass to form a common mesentery. Only the transverse and sigmoid colon have a free mesocolon. The proximal and distal loops and the cranial part of the descending colon are adherent to the cranial part of the cecum and ascending duodenum in a fat-filled mass around the root of the mesentery.

c) The BLOOD SUPPLY to the intestines comes from the cranial and caudal mesenteric aa. The long cran. mesenteric a. (a) gives off pancreatic br. directly to the right lobe of the pancreas, and the caud. pancreaticoduodenal a. (b). It also gives off the middle colic a. (c) directly. From the proximal part of the ileocolic a. (d) the right colic aa. (e) are given off to the distal loop of the colon and to the centrifugal gyri. From the distal part of the ileocolic a. the colic branches (f) go to the proximal loop of the colon and the cecal and sigmoidal gyri. All of the arteries of the spiral loop may originate from the ileocolic a. by a common trunk. They anastomose via collateral branches. The cecal a. (g) passes to the left of the ileocolic junction into the ileocecal fold and can give off an antimesenteric ileal branch (h), which is constant in the dog. In addition, the cranial mesenteric a. gives off a large collateral branch (i), peculiar to the ox, that runs in the jejunal mesentery along the last centrifugal gyrus, to which it gives branches, and rejoins the cranial mesenteric a. Both give off jejunal aa. (f') and finally anastomose with the ileal aa. (k). The mesenteric ileal branch (h') from the ileocolic a. or cecal a. also supplies several branches to the neighboring parts of the spiral colon. The caudal mesenteric a. (l) gives off the left colic a. (m) to the descending colon, and the cranial rectal a. (n) and sigmoidal aa. (o). The portal v. and its main branches are generally similar to those of the horse and dog. The veins predominantly follow the course of the corresponding arteries.

d) The LYMPH NODES. The cranial mesenteric and celiac lnn. (A) lie at the origin of the cranial mesenteric a. The following are regularly examined in meat inspection: the jejunal lnn. (E) are in the mesentery of the jejunum and ileum near the intestinal border, unlike the dog and horse. The cecal lnn. (D) are inconstant. Three groups of colic lnn. (C) are most numerous on the right surface of the spiral loop; others are present on the proximal and distal loops. The caudal mesenteric lnn. (B) are on the sides of the descending colon. The lymph drainage goes into the cisterna chyli.

Legend:

| A | Celiac and cran. mesenteric lnn. |
| B | Caud. mesenteric lnn. |
| C | Colic lnn. |
| D | Cecal lnn. |
| E | Jejunal lnn. |
| F | Aortic lumbar lnn. |
| G | Proper lumbar lnn. |
| H | Renal lnn. |
| I | Pancreaticoduodenal lnn. |
| K | Anorectal lnn. |
| L | Gastric trunk |
| M | Hepatic trunk |
| N | Intestinal trunk |
| O | Cisterna chyli |
| P | Thoracic duct |
| Q | Lumbar trunk |
| R | Visceral trunk |

* Smith, 1984
** see also Baum, 1912
CHAPTER 8: PELVIC CAVITY AND INGUINAL GENITAL ORGANS

1. PELVIC GIRDLE WITH THE SACROSCIATIC LIG. AND SUPERFICIAL STRUCTURES IN THE PUBIC AND INGUINAL REGIONS

a) The PELVIC GIRDLE consists of the two hip bones (ossa coxarum), each composed of the fused ilium, pubis, and ischium. The two hip bones are joined in the pelvic symphysis, which ossifies progressively with age.

I. On the ilium the tuber coxae (13) is thick in the middle and undivided, and the gluteal surface (17) faces dorsolaterally. The wing of the ilium (10) is broad, but smaller than in the horse. On the sacrospinal surface (18) the auricular surface (19) and the iliac surface (20) are separated by a sharp crest.

II. On the ischium the ischial tuber (28) has three processes, and the ischial arch (29) is deep.

III. The right and left pubic bones join in the pubic symphysis to form a ventral pubic tubercle (35) and an elongated dorsal pubic tubercle (35'). The iliopubic eminence (34) is an imposing large rough tubercle. The pelvic symphysis (1) is composed of the pubic symphysis and the ischial symphysis. The latter is marked by a ventral symphyseal crest (1') with a prominent caudal tubercle. The sciatic spine (7) is high, with a sharp edge, and inclined slightly medially. In the acetabulum (3) the lunar surface (6) is divided by an additional cranioventral notch into a lateral greater pubic part (6') and a medial lesser part (6*). The oval obturator foramen (2) is especially large, with a sharp margin. The pelvic floor slopes medioventrally, is excavated by a deep transverse trough, and rises caudodorsally. Sexual dimorphism is not as striking as in the horse. The transverse trough is broader in the cow.

The bony pelvis is the solid framework of the birth canal which is evaluated by measurements (pelvimetry). The transverse diameter between the right and left psoas tubecles (22) is significant because constriction occurring there is a hindrance to the birth process. The vertical diameter extends from the cranial end of the pelvic symphysis to the dorsal wall of the pelvis. The farther caudally the vertical diameter meets the dorsal wall, the more this tight passage in the birth canal can be enlarged by drawing the pelvic floor cranially. (The pelvic lig. are relaxed in parturition.) On the whole, the pelvis of the cow is not as well adapted to parturition as that of the mare. The transverse diameter meets the dorsal wall, the more this tight passage in the birth canal can be enlarged by drawing the pelvic floor cranially. (The pelvic lig. are relaxed in parturition.)

b) The SACROSCIATIC LIGAMENT (LIG. SACRATUBERALE LATUM) extends from the lateral part of the sacrum to the ilium and ischium. The cranial part is attached to the sciatic spine (7) as far as the greater sciatic notch (23). Ventral to the sacral tuber it leaves the greater sciatic foramen (A) free for passage of the sciatic nerve and the cranial gluteal a., v., and n. The caudal (sacrospinous) part of the ligament extends to the dorsal process of the tripartite ischial tuber (28).

Cranial to that, in the lesser sciatic notch (27), is the lesser sciatic foramen (B) for the passage of the caudal gluteal a. and v. Because of the absence of vertebral heads of the caudal thigh muscles, the caudal part of the sacrosciatic lig. is the dorsolateral boundary of the ischiorectal fossa between the root of the tail and the ischial tuber. The fossa is also present in the dog, but not in the horse.

c) SUPERFICIAL STRUCTURES IN THE PUBIC AND INGUINAL REGIONS

The intertendinous fossa (2), open ventrally, is cranial to the ventral pubic tubercle and contains the terminal part of the linea alba (b). The fossa lies between bilateral semiconical pillars converging toward the symphyseal tendon at the apex of the prepubic tendon. These pillars are covered by the yellow abdominal tunic (a) and are formed by the abdominal tendons of the external oblique muscles sheathing the ventral borders of the rectus tendons. The latter fuse and terminate in the symphyseal tendon and on the symphyseal crest (1').

Sacrosciatic ligament

The gracilis muscles (5) originate mainly from the symphyseal tendon. The external pudendal a. and v. (1) pass through the superficial inguinal ring (8) as in the dog and horse. The caudomedial angle of the ring is close to the median plane.

The lacuna vasorum (9) is a space between the caudal border of the pelvic tendon of the ext. oblique and the ilium. It conducts the femoral a. and v. (4) through its lateral part and the caudal (larger) head of the sartorius (14) through the medial part. Cranial and caudal heads of the muscle embrace the femoral vessels and then unite below them to form a single muscle belly. The femoral a. and v. and saphenous n. pass laterally through the sartorius into the femoral triangle (p. 18, a) and are therefore covered medially by the muscle and not by fascia alone as in the dog and horse. The lacuna vasorum was formerly called the femoral ring, and the femoral triangle was called the femoral canal by many veterinary anatomists, but the terms femoral ring and femoral canal are preempted for their meaning in human anatomy: the ring is in the medial angle of the lacuna vasorum, covered by transversalis fascia and peritoneum, and leads to the canal, which is only 1.25 cm long in man and contains nothing but fat and a lymph node. In adult domestic mammals the femoral ring is usually obscured by the deep femoral (h) and pudendoepigastric (g) vessels. The large deep femoral vessels (h) usually originate from the external iliac vessels, give off the pudendoepigastric trunk and vein (g) in the abdominal cavity (p. 81, s, t), and pass out through the medial part of the lacuna vasorum, but the origin of the deep femoral vessels is variable. They may come from the femoral vessels in the femoral triangle, so that the pudendoepigastric a. and v. must pass back into the abdominal cavity through the femoral ring to reach the inguinal canal. They divide into the caudal epigastric a. and v. (p. 81, u) and the external pudendal a. and v. (1). The latter vessels always exit through the inguinal canal.

Through the lacuna musculorum (10) between the inguinal lig. and the ilium pass the iliopecto, the smaller cranial head of the sartorius (14), the femoral n. (13), divided into its branches, and the saphenous n. (6). Ventrally the lacuna musculorum is covered by the yellow abdominal tunic and by the tendinous femoral lamina (12) from the external oblique (7), as in the horse.
Bones of the pelvic girdle

**Hip bone (Os coxae)**
- Pelvic symphysis (1)
- Symphysial crest (1')
- Obturator foramen (2)
- Acetabulum (3)
- Acetabular fossa (4)
- Acetabular notch (5)
- Lunar surface (6)
- Greater part (6')
- Lesser part (6")
- Sciatic spine (7)

**Ilium**
- Body of the ilium (8)
- Ventr. caud. iliac spine (9)
- Iliac crest (10)
- Tuberc coxae (13)
- Sacral tuber (14)
- Gluteal surface (17)
- Ventr. glutéal line (17')
- Caud. glutéal line (17")
- Auricular surface (19)
- Iliac surface (20)
- Arcuate line (21)
- Tubercle of psoas minor (22)
- Greater sciatic notch (23)

**Ischium**
- Body of the ischium (24)
- Tabula of the ischium (25)
- Ramus of the ischium (26)
- Symphysis: surface
- Lesser sciatic notch (27)
- Ischial tuber (28)
- Ischial arch (29)

**Pubis**
- Body of the pubis (30)
- Caud. ramus of the pubis (31)
- Symphysis: surface
- Cran. ramus of the pubis (32)
- Pecten pubis (33)
- Iliopubic eminence (34)
- Ventr. pubic tubercle (35)
- Dors. pubic tubercle (35')

**Pubic and inguinal regions**

**Legend:**
- a Yellow abdominal tunic
- b Linea alba
- c Cremaster m. and cranial br. of genitofemoral n.
- d Tunica vaginalis
- e Transversalis fascia
- f Transverse acetabular lig.
- g Pudendoepigastric a. and v.
- h Deep femoral a. and v.
- i Pectineus (and long adductor)
- j Cran. femoral a. and v.
- k Vastus medialis
- l Rectus femoris
- m Tensor fasciae latae
- n Deep circumflex iliac a. and v. and lat. cut. femoral n.
- o Internal oblique m.
- p External oblique
- q Supf. inguinal ring
- r Lacuna vasorum
- s Lacuna musculorum and ilioinguinal n.
- t 11 iliopectineus
- u 12 Tendinous femoral lamina of pelvic tendon of ext. oblique
- v 13 Femoral n.
- w 14 Sartorius

(See p. 81)
a) The **INGUINAL CANAL** extends from the deep inguinal ring (13) to the superficial inguinal ring (8). In the bull the vaginal tunics (18) and the cremaster muscle (19) pass through the canal. In the cow the vaginal tunic and the cremaster are absent. The round lig. of the uterus, unlike that of the bitch and mare, **ends on the internal surface of the abdominal wall near the inguinal canal without passing through it.** In both sexes, the inguinal canal, as in the dog and horse, conducts the external pudendal a. and v., the lymphatics, and the genital branch of the genitofemoral n. from l.2, l.3, l.4. The latter is divided into cranial (19) and caudal (11) branches. In the ox the angles of the deep inguinal ring are medial and dorsolateral; whereas those of the superficial ring are caudal and cranial. The distance between the inguinal rings is much shorter medially than craniodorally.

The length of the inguinal canal, as in the horse, is about 15 cm from the dorsolateral angle of the deep ring to the caudal angle of the superficial ring.

**I. The skin** is not involved in the formation of the inguinal canal. It is continuous with the skin of the scrotum or vulva.

**II. The yellow abdominal tunic (7) is the deep elastic lamina of the external fascia of the trunk.** At the level of the superficial inguinal ring it gives off the **elastic external spermatic fascia (7), reinforces both angles of the ring,** and ensheathes the structures that pass through the ring. In the bull the **caudal preputial muscle** (see p. 66) originates on the deep (spermatic) fascia mainly lateral to the vaginal tunic. In the cow the yellow abdominal tunic forms the medial laminae and part of the lateral laminae of the **suspensory apparatus of the udder** (see p. 88). In the bull it gives off the **fundiform lig.** (from Latin: *fundus* = sling): bilateral elastic bands that pass around the penis and blend with the scrotal septum. From the fascia on the lateral crus of the superficial inguinal ring, the **fascial femoral lamina (10)* is given off toward the thigh as in the horse. In the bull it is thick and elastic; in the cow it is thin and collagenous. In the inguinal groove the fascia passes to the medial surface of the thigh as the femoral fascia. The **linea alba (6)** enters the prepubic tendon and splits into a dorsal (internal) part to the pecten pubis and a ventral (external) part to the symphyseal tendon and crest.

**III. The aponeurosis of the external oblique abdominal m. (3) is divided by the superficial inguinal ring (8) into an abdominal tendon whose border is the **medial crus** of the ring, and a pelvic tendon whose border is the **lateral crus** of the ring.** The two tendons overlap and join the prepubic tendon.

The aponeurosis of the **internal oblique abdominal m.** (12) and the abdominal tendon of the **external oblique** (5) form the cranial border of the **deep inguinal ring** (13). The caudal border is the pelvic tendon of the **external oblique** (4). The vaginal tunic with its contents and the cremaster pass through the **dorsolateral angle** (14) which is fixed by the origin of the internal oblique from the iliac fascia near the external iliac vessels. The ext. pudendal vessels and the genital branches of the genitofemoral n. go through the ring more medially. The **medial angle** (15) lies close to the median line against the prepubic tendon. The label, 2, marks only the caudal part of the prepubic tendon, which extends to the junction of the aponeurosis of the int. oblique (12) and the fused tendons of the **rectus abdominis mm.** (17). (See c) Prepubic tendon.) The caudal border of the **transversus** (16) is in the plane of the tuber coxae and has no relation to the inguinal canal.

The cremaster (19) originates from the inguinal ligament and runs parallel to the caudal border of the internal oblique.

IV. The **fascia transversalis (B)** evaginates at first as the covering of the vaginal process of the peritoneum—the **internal spermatic fascia (B')** and after a short course becomes loose connective tissue. The bull lacks the annular thickening peculiar to the horse at the beginning of the evagination.

**V. The peritoneum (A) evaginates at the vaginal ring (A') as the vaginal process of the peritoneum (A**), becoming the vaginal tunic after descent of the testis, passing through the inguinal canal into the scrotum, and covering the testis and epididymis.

b) **The INGUINAL LIG.** (20)* **consists of a twisted cord of fibers** of the tendon of origin of the internal oblique that begins at the tuber coxae, is interwoven with the iliac fascia in its course, and, giving origin to the cremaster, ends lateral to the passage of the ext. iliac a. and v. through the lacuna vasorum. Unlike the condition in the dog and horse, the inguinal lig. does not join the caudal border of the pelvic tendon of the ext. oblique at this point to form a continuous inguinal arch from the tuber coxae to the prepubic tendon.

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*a* No tendinous lamina radiates from the lateral crus (it is composed of fascia).

** Trueter, 1968  *** Habel and Budras, 1992
Inguinal canal, Inguinal lig., and Prepubic tendon

Legend:

- a: Iliocostalis
- b: Longissimus dorsi
- c: Multifidus
- d: Psoas minor and sympathetic trunk iliohypogastric
- e: Psoas major
- f: Iliacus
- g: Quadratus lumborum
- h: Internal iliac fascia
- i: Tuber coxae
- j: Psoas minor tubercle
- k: Iliopubic eminence
- l: Dorsal pubic tubercle
- m: Caudal vena cava
- n: Aorta
- o: Deep circumflex iliac vessels
- p: External iliac a.
- q: Internal iliac a.
- r: Caudal mesenteric a.
- s: Deep femoral a. and v.
- t: Pubinodopigastric vessels
- u: Caudal epigastric a. and v.
- v: Iliohypogastric
- w: Lat. cut. femoral n.
- x: Obturator n.
- y: Lat. iliac ln.
- z: Iliofemoral ln.

1. Pectineus (and adductor longus)
2. Prepubic tendon (caudal part)
3. External oblique
4. Pelvic tendon and caud. border of deep ing. ring
5. Abdominal tendon and cran. border of deep inguinal ring
6. Linea alba
7. Yellow abdominal tunic
8. Cran. angle of supf. inguinal ring
9. Medial femoral fascia
10. Femoral lamina of fascia
11. Ext. pudendal vessels and caud. br. of genitofemoral n.
12. Internal oblique
13. Deep inguinal ring
14. Dorsolateral angle
15. Medial angle
16. Transversus
17. Rectus
18. Vaginal tunic
19. Cremaster and cran. br. of genitofemoral n.
20. Inguinal lig.

(See p. 79)
(See p. 83)
3. LYMPHATIC SYSTEM, ADRENAL GLANDS, AND URINARY ORGANS

After the study of the topography of the lymph nodes, adrenals, and urinary organs, the kidneys are removed with attention to their coverings, and their peculiarities in the ox are studied.

a) The LYMPHATIC SYSTEM in the dorsal abdominal and pelvic cavities includes the following lymph nodes. The 12–15 small lumbar aortic lnn. (8) lie dorsal and ventral to the aorta and caudal vena cava and are examined in meat inspection in special cases. There are also up to 5 inconstant unilateral or bilateral proper lumbar lnn. between the lumbar transverse processes. The 1–4 renal lnn. (9) are found on both sides between the renal a. and v. (10). They are routinely examined in meat inspection. The lymph drainage is through the lumbar trunk or directly into the cisterna chyli. The medial iliac lnn. (4), 1–5 in number, lie at the origin of the external iliac aa. (f). The lateral iliac lnn. (12) at the bifurcation of the deep circumflex iliac a. (11) may be double. Both groups are routinely examined in meat inspection. The sacral lnn. (5), 2–8 in number, lie in the angle between the internal iliac aa. (h). The sciatic lnn. (p. 17, B) is in the lesser sciatic foramen or dorsal to it on the outside of the saccrotrochanteric ligament. The anorectal lnn. (p. 77) are dorsal and lateral to the rectum and anus. The iliofemoral lnn. (6) is up to 9 cm long and located in the angle between the deep circumflex iliac and external iliac vessels. It is clinically important because it receives lymph from the superficial inguinal (mammary) lnn. and can be palpated per rectum cranial to the shaft of the iliobrachial lumbrosacral a.

b) The ADRENAL GLANDS (7) are 5–8 cm long, flattened, relatively smooth, and reddish brown to dark gray, sometimes also with black spots. Each weighs 15–23 g. They are retroperitoneal and covered ventrally by fat. The right adrenal lnn. (9) are found on both sides between the renal a. and v. (10). They are routinely examined in meat inspection. The renal a., or the lumbar trunk into the cisterna chyli, which is 1.5–2 cm long and extends from the last thoracic vertebra to the 1st or 2nd lumbar vertebra, dorsal to the vena cava and aorta.

c) The URINARY ORGANS

I. The kidneys differ remarkably in position as a result of the developmental expansion of the rumen.

The flat elongated oval right kidney (1) is retroperitoneal and extends from the 12th intercostal space to the 2nd or 3rd lumbar vertebra. The pit-like hilus is medial. The cranial end is in contact with the liver (see p. 75, v). The dorsal surface is applied to the right crus of the diaphragm and the lumbar muscles. The ventral surface lies on the pancreas, cecum, and ascending colon. The left kidney (10) is not illustrated in its normal position. In the live ox it is pushed to the right side by the rumen. It is almost completely surrounded by peritoneum and therefore pendulous, and lies ventral to lumbar vertebrae 2–5, and caudal to the right kidney, from which it is separated by the descending mesocolon. Because the left kidney undergoes a 90-degree rotation on its long axis, its hilus (24) is dorsal. Medially it adjoins the rumen and laterally, the intestinal mass.

The kidneys are red-brown; their combined weight is 1200–1500 g. They are marked on the surface by the renal lobes (26), unlike any other domestic mammal. In the ox, two or more fetal lobes remain distinct; others are partially or completely fused in the cortex, resulting in 12–15 simple or compound lobes of various sizes. The actual boundaries of the lobes can be seen only by the course of the interlobar aa. and vv. (19). On the cut surface the reddish light brown renal cortex (23) with its distinct renal columns (21) contrasts with the dark red external zone (17) and the light internal zone (18) of the renal medulla (15). The renal pyramids (16) project with their prominent renal papillae (20) into the urine collecting renal calices (25). These open into cranial and caudal collecting ducts which join within the irregular fat-lined renal sinus to form the ureter. The ox lacks a renal pelvis.

II. In the standing live ox the right ureter (3) takes a course on the ventral surface of its kidney and dorsal to the left kidney toward the pelvic cavity. The left ureter runs along the dorsal surface of the caudal half of its kidney, inclines to the left of the median plane and enters the urinary bladder.*

III. The urinary bladder (n) (see also text figure) is relatively large. When moderately filled it extends into the ventral abdominal cavity further than in the horse. The apex (27) and body (28) are covered with peritoneum. The neck (31) is extraperitoneal and attached to the vagina by connective tissue. On the apex there is a distinct conical vestige of the urachus, which in the three-month-old calf can still be as long as 4 cm. The ureters open close together in the middle of the neck of the bladder. The ureteric folds (30) run caudally from there inside the bladder and converge to form the narrow vesical triangle (29). The lateral ligaments of the bladder (13) contain in their free border the small, in old age almost obliterated, umbilical artery (round lig. of the bladder; p. 87, e). The middle lig. of the bladder (14) runs from the ventral wall of the bladder to the pelvic symphysis and to the ventromedial abdominal wall.

IV. The male urethra (see p. 92, K) consists of a pelvic part surrounded by a stratum spongiosum, and a penile part surrounded by the corpus spongiosum penis. The pelvic part is also surrounded by the disseminate prostate (see p. 92), and ventrally and laterally by the thick striated urethral muscle (93, g). Just inside the ischial arch is the urethral recess, present in ruminants and swine; it opens caudally and practically prevents catheterization. The recess is dorsal to the urethra and separated from it by a fold of mucosa that bifurcates caudally into lateral folds on which the ducts of the bulbourethral glands open. The lumen of the urethra passes through the narrow slit between the folds.

V. The female urethra (see text figure) is about 12 cm long and attached to the vagina by connective tissue and the urethral muscle. The urethral crest (32), 0.5 cm high, passes through the urethra on its dorsal wall to the slit-like urethral orifice, which is on the cranial side of the neck of the clinically important, blind, suburethral diverticulum (33). The latter extends cranially for 2 cm from its common opening with the urethra on the floor of the vestibule, and must be avoided in catheterization. (See p. 87, x.)

* Fabisch, 1968
Abdominal cavity and Urinary organs as seen at autopsy, in dorsal recumbency with stomach and intestines removed
5. ARTERIES, VEINS, AND NERVES OF THE PELVIC CAVITY

a) The ABDOMINAL AORTA (1) gives off the paired external iliac aa. at the level of the 6th lumbar vertebra, and the paired internal iliac aa. with its dorsally directed unpaired median sacral a. (13) at the level of the sacral promontory.

The external iliac a. (5), while still in the abdominal cavity, gives off the deep circumflex iliac a. (6) and shortly before entering the femoral triangle, it gives origin to the deep femoral a. with the attached pudendoprosthetic trunk (7), which divides into the caudal epigastric a. (8) and the external pudendal a. (9). The latter passes through the inguinal canal and gives off branches to the scrotum or udder (see also p. 91).

The internal iliac a. (15) is, in contrast to that artery in the dog and horse, a long vessel that extends to the lesser sciatic notch and ends there by dividing into the caudal gluteal and internal pudendal aa. Its first branch is the umbilical a. (17), which gives off the a. of the ductus deferens in the bull and the uterine a. (18) in the cow, and in both sexes the cranial vesical a. (19) with the obliterated termination of the umbilical a. as the round lig. of the bladder.

Also originating from the internal iliac a. are the iliolumbar a. (16) and the cranial gluteal a. (31). Also originating from the internal iliac a. are the iliolumbar a. (16) and the cranial gluteal and internal pudendal aa. The iliolumbar a. is a long vessel that extends to the lesser sciatic foramen and accompanies the uterine a.

b) The BLOOD SUPPLY OF THE PENIS comes mainly from the external pudendal a. (9), and additionally from the internal pudendal a. (32) via the perineal perineal a. (36). The external pudendal a., with a sigmoid flexure, enters the base of the udder dorsally and divides into the cranial and caudal mammary aa.

The cranial mammary a. (caud. supf. epigastrica a., 10) supplies the cranial and caudal quarters, including the teats. The caudal mammary a. (11) goes mainly to the caudal quarter. A third (middle) mammary artery may be present, arising from the other two or from the external pudendal a. at its bifurcation. There are many variations in all three arteries.

The cranial and caudal mammary aa. are branches of the external pudendal. The cranial mammary v. (10) is also continuous with the caud. supf. epigastrica v., which joins the cran. supf. epigastrica v. to form the large, sinuous milk vein (subcutaneous abdominal v.). The caudal mammary v. (11) joins the large ventral labial v. (37), which is indirectly connected to the internal pudendal v. Further details of the mammary vessels will be discussed with the udder (p. 90).

c) The BLOOD SUPPLY OF THE UDDER comes mainly from the internal pudendal a. (9), and additionally from the internal pudendal a. (32) via the perineal perineal a. (36). The external pudendal a., with a sigmoid flexure, enters the base of the udder dorsally and divides into the cranial and caudal mammary aa.

The cranial and caudal mammary aa. are branches of the external pudendal. The cranial mammary v. (10) is also continuous with the caud. supf. epigastrica v., which joins the cran. supf. epigastrica v. to form the large, sinuous milk vein (subcutaneous abdominal v.). The caudal mammary v. (11) joins the large ventral labial v. (37), which is indirectly connected to the internal pudendal v. Further details of the mammary vessels will be discussed with the udder (p. 90).

d) The BLOOD SUPPLY OF THE UTERUS is provided mainly by the uterine a. (18), which originates from the first part of the umbilical a. near the internal iliac a. It runs on the mesometrial border of the uterine horn in the parametrium. Its branches form anastomotic arches with each other and with the uterine a. (2') of the ovarian a. and caudally with the uterine a. (24) of the vaginal a. In the cow the uterine a. is palpable per rectum after the third month of pregnancy as an enlarged vessel with a characteristic thrill (fremitus) in addition to the pulse. The uterine a. is an insignificant vessel that comes from the internal iliac v. and accompanies the uterine a. The main veins are the uterine br. of the ovarian v. (2), the uterine br. of the vaginal v. (24), and the accessory vaginal v. (22), which comes from the internal iliac v. and has no accompanying a.
Legend:

Arteries, veins:
1 Abd. aorta and caud. vena cava
2 Ovarian or testicular a. and v.
2' Uterine br.
3 Cran. mesenteric a. and v.
4 Cran. rectal a. and v.
5 Ext. iliac a. and v.
6 Deep circumflex iliac a. and v.
7 Pudendoepigastric trunk and v.
8 Caud. epigastric a. and v.
9 Ext. pudendal a. and v.
10 Caud. supf. epigastric a. and v.
(Cran. mammmary a. and v.)
11 Caud. mammary a. and v. or Vent. scrotal br. and v.
12 Lumbar aa. and vv.
13 Median sacral a. and v.
14 Median caud. a. and v.
14' Ventrolat. caudal a. and v.
14'' Dorsolat. caudal a. and v.
15 Int. iliac a. and v.
16 Iliolumbar a. and v.
17 Umbilical a.
18 Uterine a. or a. of ductus deferens
19 Cran. vesical a.
20 Obturator v.
21 Cran. gluteal a. and v.
22 Accessory vaginal v.
23 Vaginal or prostatic a. and v.
24 Uterine br. and v. or v. of ductus deferens
25 Caud. vesical a. and v.
26 Ureteric br.
27 Urethral br.
28 Middle rectal a. and v.
29 Dors. perineal a. and v.
30 Caud. rectal a. and v.
31 Caud. gluteal a. and v.
32 Int. pudendal a. and v.
33 Urethral a. and v.
34 Ventrolat. a. and v.
35 A. and v. of clitoris or penis
36 Ventr. perineal a. and v.
37 Ventr. labial v. and mammmary br.
38 A. and v. of bulb of penis
39 Deep a. and v. of penis
40 Dors. a. and v. of penis

Nerves:
a iliohypogastric n.
b Iliinguinal n.
c Genitofemoral n.
d Lat. cut. femoral n.
e Femoral n.
f Sciatic n.
g Obturator n.
h Pudendal n.
i Cran. gluteal n.
j Caud. gluteal n.
k Caud. cut. femoral n.
l Caud. rectal nn.
m Caudal mesenteric plexus
n Hypogastric n.
o Pelvic plexus
p Pelvic n.
5. FEMALE GENITAL ORGANS

a) The OVARY (6) has a different position from that of the bitch and mare because of the longer developmental “descent” of the ovary and parietal attachment of the mesovarium (2) toward the pelvis. This results in the spiral of the uterine horn and gives the long axis of the ovary an obliquely transverse direction. The tubal end of the ovary is dorsolateral and the uterine end is ventromedial. The ovary lies near the lateroventral part of the pelvic inlet, cranial to the external iliac a. In the pregnant cow it is drawn cranioventrally. The mesovarium contains the ovarian a., coming from the aorta, and gives off laterally the thin mesosalpinx (3) for the uterine tube. The cranial border of the mesovarium is the suspensory lig. of the ovary (1). Caudally the mesovarium is continuous with the mesometrium (4). The mesovarium, mesosalpinx, and mesometrium together form the broad ligament (lig. latum uteri) which contains smooth muscle.

The ovary measures 3.5 x 2.5 x 1.5 cm, about the size of the distal segment of the human thumb. Compared to that of the mare it is relatively small. It is covered by peritoneum on the mesovarian margin only, and by the superficial epithelium elsewhere. There is no ovarian fossa, which is a peculiarity of the mare. The cortex and medulla are arranged as in the bitch. On the irregularly tuberculuated surface there are always follicles and corpora lutea of various stages of the estrous cycle which can be palpated per rectum. A follicle matures to about 2 cm; a corpus luteum can reach the size of a walnut. The single corpus luteum changes color during the cycle from yellow or ocher-yellow to dark red, red-brown, gray-white, and black. This can be seen on a section through the ovary.

b) The UTERINE TUBE (14) is somewhat tortuous and at 28 cm, relatively long. The mesosalpinx (3) with the uterine tube surrounds the ovary cranially and laterally like a mantle and forms with the mesovarium the flat voluminous ovarian bursa (13) with a wide cranioventromedial opening. The infundibulum of the tube (16) with its fimbriae surrounds the ovary. It funnels into the abdominal orifice of the tube (15). The ampulla and isthmus of the tube do not show any great difference in the size of the lumen. The uterine tube ends, unlike that of the bitch and mare, without a uterine papilla at the uterine orifice of the tube (7) in the apex of the uterine horn. Here the proper ligament of the ovary (8) ends and the round lig. of the uterus begins. The latter is attached by a serosal fold to the lateral surface of the mesometrium and extends to the region of the inguinal canal. Both ligaments develop from the gubernaculum of the ovary. (The mammalian uterine tube differs in form and function from the oviduct of lower animals.)

c) The UTERUS, as in all carnivores and ungulates, is a uterus bicornis. The horns of the uterus (cornua uteri, 9) are 30–40 cm long, rolled through cranioventral to caudodorsal, and fused caudally into a 10–15 cm long double cylinder. Cranial to the union the horns are connected by the dorsal and ventral intercornual ligg. (11). Internally the true, undivided body of the uterus (12) is only 2–3 cm long. The neck of the uterus (cervix uteri, 26) with the cervical canal (26) begins at the internal uterine orifice (27) and ends at the external uterine orifice (25) on the vaginal part of the cervix (portio vaginalis, 25). The cervix is 8–10 cm long and can be distinguished from the body of the uterus and the vagina by its firm consistency.

The three layers of the wall of the uterus are formed by the peritoneum (perimetrium), the muscular coat (myometrium), and the mucosa (endometrium). The mucosa of the uterus forms longitudinal and transverse folds and in each uterine horn four rows of 10–15 round or oval caruncles (10)* of various sizes. These project dome-like on the internal surface, and in the pregnant uterus can reach the size of a fist. The total number of caruncles in the uterus, including the body, is about 100.

DURING PREGNANCY THEY FORM, TOGETHER WITH THE COTYLEDONS,* THE PLACENTOMES. Cotyledons are bunches of villi on the fetal amniochorion and allantoic chorion that invade the caruncles. (See text figure.) The cervical mucosa presents longitudinal folds and, with the support of the musculature, bulges into the lumen, usually in four characteristic circular folds, and closes the cervical canal. This is clinically important. The last circular fold projects into the vagina as the portio vaginalis cervicis (25).

d) The Vagina (18), 30 cm long, is longer than in the mare, hollow and its fornic (17) arches over the portio vaginalis cervicis dorsally. The cranial part of the vagina is covered by peritoneum in the area of the rectogenital excavation (5) which extends caudally to the middle of the pelvic cavity or to the first caudal vertebra. Caudally the vagina joins the vestibule (23), sometimes without a distinct boundary, sometimes with only a faint transverse fold, the hymen (19). The external urethral orifice (20) opens into the cranial end of the vestibule 7–11 cm from the ventral commissure of the labia. The suburethral diverticulum (x) lies ventral to the urethral orifice.

The openings of the vestibial deferent ducts (remnants of the caudal parts of the mesonephric ducts) are found on each side of the urethral orifice. The ducts run between the mucosa and the musculature and can reach a considerable length. They end blindly and can become cystic. The major vestibular gland (w) is cranial to the constrictor vestibuli (m). It is 3 cm long and 1.5 cm wide, and has 2–3 ducts that open in a small pouch (24) lateral to the urethral orifice. The microscopic minor vestibular glands open on the floor of the vestibule cranial to the clitoris.

e) The VULVA surrounds with its thick labia (22) the labial fissure (rima pudendi). The dorsal commissure of the labia is, in contrast to the mare, more rounded, and the ventral commissure is pointed, with a tuft of long coarse hairs.

The clitoris (21) is smaller than in the mare, although 12 cm long and tortuous. The end is tapered to a cone. The glans is indistinct. The prepuce is partially adherent to the apex of the clitoris so that an (open) fossa clitoridis is almost absent.

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* Carunculae=se. L. = papilla
** Cotyledon=onis L., Gr. = cup
Female genital organs

(Left side)

1 Suspensory lig. of the ovary

Broad lig. of the uterus:

2 Mesovarium
3 Mesosalpinx
4 Mesometrium

5 Rectogenital excavation
Vesicogenital excavation
Pubovesical excavation

(See pp. 17, 19, 93)

Legend:

a Middle gluteal m.
b Longissimus lumborum
c Iliacus
d Sacroiliac ligg.
e Sacrocaudalis dorsalis medialis
f Sacrocaudalis dorsalis lateralis
g Sacrocaudalis ventralis lateralis
h Intertransversarii
i Coccygeus
j Levator ani
k Ext. anal sphincter
l Urethralis
m Bulbospongiosus:
  n Constrictor vestibuli
  o Retractor clitoridis
  p Intrapelvic part of ext. obturator
q Descending colon
r Ureter
s Urinary bladder
t Lat. lig. and round lig. of bladder
u Median lig. of bladder
v Rectum
w Major vestibular gl.
x Suburethral diverticulum
y Supf. inguinal inn.
z Peritonum (Sectio)

(dorsal)

6 Ovary
7 Uterine orifice of uterine tube
8 Proper lig. of ovary
9 Horn of uterus
10 Caruncles
11 Intercomual ligg.
12 Body of uterus
13 Ovarian bursa
14 Uterine tube
15 Abdominal orifice of uterine tube
16 Infundibulum and fimbrae of uterine tube

17 Fornix of vagina
18 Vagina
19 Hymen
20 Ext. urethral orifice
21 Clitoris
22 Labia of vulva
23 Vestible of vagina
24 Orifice of major vestibular gl.
25 Ext. orifice of uterus and portio vaginalis of cervix
26 Cervix and cervical canal
27 Int. orifice of uterus
The udder is composed of four mammary glands—modified skin glands that occur in this form only in true mammals (Eutheria). The mammary secretion is milk (lact). The first milk secreted after parturition is colostrum, containing a high concentration of antibodies, which give the newborn passive immunity. Cow’s milk and also milk from sheep and goats, is a valuable human foodstuff. It contains proteins, fats, sugar, and minerals (for example, calcium and phosphorus). Therefore milk production is of great economic significance in agriculture. Diseases of the udder lead directly to reduced milk production that persists throughout the lactation period. For that reason early treatment of udder diseases is especially important in veterinary practice. The diagnosis of udder diseases and the possible need for surgery, such as removal of half of the udder (mastectomy) or the amputation of a teat, require anatomical knowledge of the structure of the udder, its suspensory apparatus, blood vessels, lymph drainage, and innervation.

The four mammary glands of the bovine udder are attached to the body in the inguinal region and are commonly called quarters. At the height of lactation each quarter may reach enormous size. Each mammary gland consists of a teat (papilla mammae, 5) and a body (corpus mammae, 4). The size of the body and the length of the teat vary with the individual cow, functional status, and form. The teats are about as thick as the thumb and as long as the index finger. The teat canal, with its orifice on the end of the teat, may incompletely closed, permitting ascending bacterial inflammation of the udder (mastitis). A narrow, partly blocked teat canal will restrict the flow of milk. Rudimentary accessory glands and teats occur and are not rare. They are usually caudal to the normal teats, but may be between them or cranial to them. Rudimentary teats occur in the bull cranial to the scrotum. The right and left halves of the udder are divided by a median intermammary groove. The udder is covered by modified skin that is hairless and without skin glands on the teat, and sparsely haired elsewhere. The skin of the healthy udder is easily slipped on the subcutis, but this mobility is lost in inflammation, and together with pain, edema, and heat serves to diagnose mastitis. **Suspensory apparatus: lateral laminae** (1) of fascia pass over the surface of the udder from the symphyseal tendon and the lateral crus of the superficial inguinal ring in a mainly cranioventral direction. The **medial laminae** (2) separate the right and left halves of the udder. (This median separation can be demonstrated by blunt dissection between the medial laminae from their caudal borders.) Composed mostly of elastic tissue, they originate as a paired paramedian suspensory lig. (2). This comes from the yellow abdominal tunic on the exterior surface of the prepubic tendon (p. 66) at its junction with the symphyseal tendon. **From both the lateral and the medial laminae, thin suspensory lamellae (3)** penetrate the mammary gland, separating the parenchyma into curved, overlapping lobes (7). When filled with milk the udder has considerable weight, which stretches the suspensory apparatus, especially the medial laminae. Therefore the teats of the tightly filled udder project laterally and cranially because the elastic medial laminae are stretched more than the lateral laminae, which consist mainly of regular dense collagenous tissue. In contrast to the bitch and mare, each mammary gland of the cow contains only one duct system and the associated glandular tissue. In addition the gland contains interstitial connective tissue with nerves, blood vessels, and lymphatics. The duct system ends on the apex of the teat with the orifice (5) of the narrow teat canal (papillary duct, 5), surrounded by the teat sphincter (b).

The teat canal drains the lactiferous sinus with its papillary part (teat sinus, 9") and glandular part (gland sinus, 9). The boundary between the parts is marked by the annular fold (9") of mucosa, containing a venous circle (of Fuerstenberg). A venous plexus (a) in the wall of the teat forms an erectile tissue that makes hemostasis difficult in injuries or surgery. The mucosa of the teat canal bears longitudinal folds (11), and the proximal ends of the folds form a radial structure called Fuerstenberg's rosette at the boundary between the teat sinus and the teat canal.

In the gland sinus are the openings of several large collecting ducts (ductus lactiferi colligentes, 8). Each of these receives milk from one of the numerous lobes through small lactiferous ducts (14) and alveolar lactiferous ducts (13), which drain the lobules (10). A lobule resembles a bunch of grapes, measures 1.5 x 1.0 x 0.5 mm, and consists of about 200 alveoli. Many alveoli are connected directly, and this construction has led to the term, "storage gland". The alveoli are surrounded by septa containing nerves and vessels. The duct systems are separate for each quarter, as demonstrated by injections of different colored dyes, even though quarters on the same side have no septum between them. Therefore ascending infections may be limited to one quarter. The separate medial laminae make it possible to amputate one lateral half of the udder. The teat canal has a defensive mechanism in its lining of stratified squamous epithelium that produces a plug of fatty desquamated cells in the canal between milkings. This is an important factor in resistance to infection.
Udder

Transverse section through forequarters, cranial surface

Suspensory apparatus:
1 Lateral lamina
2 Medial laminae (Suspensory lig.)
3 Suspensory lamellae
4 Body (Corpus) of right forequarter

5 Teat (Papilla)
5' Teat canal (Ductus papillaris)
5" Teat orifice

6 Yellow abdominal tunic
7 Cran. mammary a. and v. and cran. br. of genitofemoral n.
8 Collecting duct
7 Lobe of mammary gl.
9 Glandular part (Gland sinus)
9' Annular fold and Venous circle
9" Papillary part (Teat sinus)

Lactiferous sinus:

Mammary gland and Teat

Legend:
10 Lobule
11 Longitudinal folds
12 Alveoli
13 Alveolar lactiferous ducts
14 Lactiferous duct

a Venous plexus of the teat
b Teat sphincter muscle
c Lactocyte
d Fat droplet
e Myoepithelial cell
f Basement membrane
I. The blood vascular system is adapted to the high milk production of the udder. Up to 600 liters of blood must flow through the udder to produce one liter of milk. Therefore the blood vessels are remarkable for their large calibre, and they have received additional names. The ext. pudendal a. and v. bifurcate into the cran. ductus venosi, which supplies the udder to produce one liter of milk. Therefore the blood vessels are continuous with the mammary br. and ventral labial v. (5), which usually come from the ventral perineal vessels, but in some cows they come from the dorsal perineal vessels (see p. 95, 16).

The cran. supf. epigastric vein in milk cows can be seen bulging under the skin of the ventral abdominal wall. It is therefore called the subcutaneous abdominal v. (18). The place where it perforates the abdominal wall in the xiphoid region from the int. thoracic v. is the “milk well” [anulus venae subcutanae abdominis]. The caud. supf. epigastric v. is also called the cran. mammary v. (12). The caudal and cranial supf. epigastric vv. Anastomose end-to-end and form the “milk vein”. This is enlarged during the first lactation and its valves become incompetent, making blood flow possible in either direction. The right and left cran. mammary v. Anastomose on the cran. border of the udder. This connection, with that of the caudal mammary vv., completes the venous ring around the base of the udder. Many veins of the udder join this ring. The vent. labial v. is large and tortuous in the dairy cow (see p. 95, 16). In most of its extent the valves indicate that blood flows toward the caud. mammary v.

II. The lymph from the udder is conducted to 1–3 supf. inguinal inn. (mammary inn., B). They lie caudally on the base of the udder (the surface applied to the body wall) and can be palpated between the thighs about 6 cm from the skin at the caudal attachment of the udder. Small intramammary inn., may be present. The lymph flows to the iliohypogastric n. (deep inguinal n., A). These inn. are routinely incised in meat inspection.

III. The innervation of the udder is sensory and also autonomic (sympathetic). The skin and teats of the forequarters and the cranial part of the base of the udder are supplied by the iliohypogastric n. (a), ilioinguinal n. (b), and the cran. br. of the genitofemoral n. (c). The skin and teats of the hindquarters are innervated by the caud. br. of the genitofemoral n. (c') and the mammary br. of the pudendal n. (f). The cran. and caud. br. of the genitofemoral n. pass through the inguinal canal into the body of the udder. The sensory innervation of the teats and skin of the udder is the accessory path of the neurohormonal reflex arc, which is essential for the initiation and maintenance of milk expulsion from the mammary glands. The stimulus produced by sucking the teats and massaging the mammary gll. is conducted by the afferent nerves to the CNS, where, in the nuclei of the hypothalamus, the hormone oxytocin is produced. The afferent nervous stimulus causes the hormone to be released through the neurohypophysis into the blood, which carries it into the mammary gll. Here oxytocin causes contraction of the myoepithelial cells on the alveoli, by which milk is pressed into the lactiferous ducts and sinus. This expulsion of milk is disturbed under stress by secretion of the hormone adrenalin, which suppresses the action of oxytocin on the myoepithelial cells. (For details, see textbooks of histology and physiology.)

IV. The prenatal development of the udder begins in the embryo in both sexes on the ventrolateral body wall between the primordia of the thoracic and pelvic limbs. This linear epidermal thickening is the mammary ridge. It is shifted ventrally by faster growth of the dorsal part of the body wall. Local epithelial sprouts grow down into the underlying mesenchyme from the ridge, forming the mammary buds in the location and number of mammary glands of each species. The mesenchyme surrounding the epithelial sprout is called the areolar tissue. Each mammary bud is bordered by a slightly raised ridge of skin. The teat develops in ruminants, as in the horse, by the growth of this areolar tissue, as a proliferation teat. The surrounding skin ridge is completely included in the formation of the teat. (For details see the textbooks of embryology.)

Postnatally the mammary glands are inconspicuous in calves of both sexes because the teats are short and the mammary glands are hardly developed. The duct system consists only of the teat canal, the sinus, and the primordia of the collecting ducts, which are short solid epithelial cords. Normally, the male udder remains in this stage throughout life. During puberty some bull calves can undergo a further temporary growth of the mammary glands under the influence of an elevated level of estrogen, as is natural in females. In young heifers during pubertal development ovarian follicles ripen and cause the level of estrogen in the blood to rise. In the udder this results in an increase of connective and adipose tissue, and also further proliferation of the epithelial buds as primordia of the lactiferous ducts, which divide repeatedly, producing the small collecting ducts. The mammary gland primordia rest in this stage of proliferation until the first pregnancy.

During the first pregnancy further generations of lactiferous ducts develop by growth and division of the epithelial cords. In the second half of pregnancy the still partially solid glandular end-pieces are formed, while space-occupying adipose tissue is displaced. Toward the end of gestation (about 280 days) under the influence of progesterone and estrogen, a lumen develops in these glandular end-pieces, and under the influence of prolactin the lactocytes begin the secretion of milk (lactogenesis). In the first five days after parturition the milk secreted is colostrum. This is rich in proteins; it contains immunoglobulins, and it may be reddish due to an admixture of erythrocytes. In addition to the passive immunization of the newborn, colostrum has another function: it has laxative properties that aid in the elimination of meconium (fetal feces). Lactation can begin a few days or a few hours before parturition, and the first drops of milk on the end of a teat are taken as an indication of impending birth.

After birth milk secretion is maintained only in the quarters that the sucking uses. The unused quarters rapidly undergo involution. This occurs naturally when the calf is weaned by the dam, but in U.S. dairy practice the calf is removed from the dam and fed artificially, beginning with colostrum from the dam. Milk secretion is maintained by milking twice a day. After about ten months, lactation is stopped by decreasing the ration and reducing the milking to a dry period of about 60 days before calving. During involution the secretory cells in the alveoli and in the alveolar lactiferous ducts degenerate. The glandular tissue is replaced by fat and connective tissue. This is important for the clinical evaluation of the consistency of individual quarters. The size of the udder decreases, but never returns to the small size of an udder that has not yet produced milk.

Accessory (supernumerary) mammary gll. may be present on the udder, a condition called hypermastia. The presence of supernumerary teats is called hyperthelia (Gk. thele, nipple). They may be located before, between, or behind the main teats. If they occur on main teats they interfere with milking and must be removed.
Arteries, Veins, and Nerves of the Udder

Left side

Legend:
1 Aorta
2 Caud. vena cava
3 Int. iliac a. and v.
4 Int. pudendal a. and v.
5 Vent. labial v. and mammary br. of vent. perineal a.
6 Ext. iliac a. and v.
7 Deep femoral a. and v.
8 Pudendoepigastric vessels
9 Caud. epigastric a. and v.
10 Ext. pudendal a. and v.
11 Caud. mammary a. and v.
12 Cran. mammary a. and v.  
   [Caud. supf. epigastric a. and v.]
13 Brachiocephalic trunk and cran. vena cava
14 Left subclavian a. and v.
15 Int. thoracic a. and v.
16 Cran. epigastric a. and v.
17 Cran. supf. epigastric a.
18 Subcutaneous abdominal v.  
   [Cran. supf. epigastric v.]
A Iliofemoral ln.
[B Deep inguinal ln.]
B Mammary ln.
[C Supf. inguinal ln.]
C Afferent lymphatic vessels
C' Efferent lymphatic vessels

Left cran. and caud. mammary gl.

a Iliohypogastric n.
b Ilioinguinal n.
c Genitofemoral n.
c' Cran. branch
c" Caud. branch
d Lat. cut. femoral n.
e Pudendal n.
f Mammary br. of pudendal n.
8. MALE GENITAL ORGANS AND SCROTUM

a) The SCROTUM (5) is attached in the cranial pubic region. It is elongated dorsoventrally and bottle-shaped. It is generally flesh-colored and fine-hairied, and bears two rudimentary tests on each side of the cranial surface of the neck.

b) The elongated oval TESTES (4 and 16) hang vertically in the scrotum and weigh about 300 g each. The capital end is proximal and the caudate end is distal. (Names derived from the head and tail of the epididymis.) In ruminants the epididymal border of the testis is median or caudomedial and the free border is lateral. The part of the mesorchium (p) between the vaginal ring and the testis contains the testicular vessels and nerves. It is covered by the visceral lamina of the vaginal tunica, which is attached to the parietal lamina along the caudomedial surface. The ductus deferens runs in the mesoductus deferens (q), a narrow fold attached to the cranial surface of the mesorchium. This location is important for vasectomy. The spermatic cord (10) extends from the vaginal ring (d) to the testis and consists of the mesorchium and its contents, the ductus deferens, and the mesoductus deferens. The mesorchium continues distally along the epididymal border of the testis. At the tail of the epididymis the mesorchium ends in a short free fold, the lig. of the tail of the epididymis (o), the vestige of the distal part of the gubernaculum testis. Between the testis and the tail of the epididymis is the very short proper lig. of the testis (n), the vestige of the proximal part of the gubernaculum.

c) The EPIDIDYMIS begins with a long head (caput, 12) on the cranial end and adjacent free bodier of the testis. The head consists of a descending limb, and an ascending limb that crosses the mesorchium to the slender body of the epididymis (14). This descends medial to the testis along the caudal side of the mesorchium to the prominent tail of the epididymis (19). Between the body of the epididymis and the testis is the testicular bursa (17), often obliterated by adhesion.

d) The DUCTUS DEFERENS (e) ascends in its mesoductus on the medial side of the testis, cranial to the mesorchium, to the spermatic cord (10), which is longer and narrower than in the horse. After it enters the abdominal cavity the duct crosses the lateral lig. of the bladder and the ureter (f) and enters the genital fold. It ends in the urethra on the colliculus seminalis in a common orifice with the duct of the vesicular gland.

e) The ACCESSORY GENITAL GLANDS are all present as in the horse, but fully developed only in the bull—not in the steer. The bilateral vesicular gland (11) is the largest accessory genital gland in the bull. It is a lobated gland of firm consistency—not vesicular. It is 10–20 cm long and lies dorsal to the bladder and lateral to the ureter and the ampulla of the ductus deferens (13). The ductus deferens narrows again caudal to the ampulla and, with the duct of the vesicular gland, passes under the body of the prostate. The two ducts open on the colliculus seminalis (see above). The body of the prostate (15) projects on the dorsal surface of the urethra between the vesicular glands and the urethral muscle. The disseminate part of the prostate, 12–14 cm long, is concealed in the wall of the urethra and covered ventrally and laterally by the urethral muscle. The bilateral bulbourethral gland (18) is the size of a walnut. It lies on each side of the median plane dorsal to the urethra in the transverse plane of the ischial arch. It is mostly covered by the bulbospongiosus muscle. Its duct opens on the lateral fold that extends caudally from the septum between the urethra and the urethral recess (see p. 82).

f) The PENIS of the bull belongs to the fibroelastic type. It extends from its root (h) at the ischial arch to the glans penis (A) in the umbilical region. It is covered by skin, is about one meter long, and in the body [corpus penis (i)], has a sigmoid flexure (j) that is caudal to the scrotum. The proximal bend is open caudally and the distal bend, open cranially, can be grasped through the skin caudal to the thighs. The penis is sheathed by telescoping fascia. The short collagenous suspensory lig. of the penis (l) are attached close together on the ischial arch, and the dorsal nn. and vessels of the penis pass out between them. They should not be confused with the fundiform lig. of the penis (p. 80). The penis consists of the dense corpus cavernosum penis, which begins at the junction of the crura penis (7), attached to the ischial arch. It is surrounded by a thick tunica albuginea (F) containing cartilage cells. The cavernae are mainly peripheral, and axially there is a dense connective tissue strand (j). The free part of the penis (k), 8 cm long, is distal to the attachment of the internal lamina of the prepuce (2). It is twisted to the left as indicated by the oblique course of the raphe of the penis (D) from the midventral raphe of the prepuce (D’) to the external urethral orifice (B) on the right side. Just before ejaculation an added left-hand spiral of the free part of the penis is caused by the internal pressure acting against the right-hand spiral of the collabenseous fibers of the subcutaneous tissue and tunica albuginea, and against the apical lig. The latter originates dorsally from the tunica albuginea, beginning distal to the sigmoid flexure. * Midventral on the penis is the penile urethra, surrounded by the corpus spongiosum penis (K). The urethral process (C) lies in a shallow groove between the raphe and the cap-like glans penis (A), which is connected to the corpus spongiosum, but contains little erectile tissue. The prepuce consists, as in the dog, of an external lamina (1) and an internal lamina (2), and the apical lig. (3). The frenulum of the prepuce (D’) connects the raphe of the prepuce to the raphe of the penis. The muscles of the penis: The ischiocavernosus (7) extends from the medial surface of the ischial tuber to the body of the penis, covering the crus penis. The bulbospongiosus (6) covers the bulb of the penis and a large part of the bulbourethral gland and extends to the beginning of the body of the penis. During erection both muscles regulate the inflow and outflow of blood. The paired smooth muscle retractor penis (8) originates from the caudal vertebrae, receives reinforcing fibers from the internal anal sphincter, extends across the first bend of the sigmoid flexure and is attached to the second bend. The two muscles then approach each other on the ventral surface and terminate on the tunica albuginea 15–20 cm proximal to the glans. In erection these muscles relax, permitting the extension of the sigmoid flexure and elongation of the penis.

The lymphatic vessels of the scrotum, penis, and prepuce drain to the superficial inguinal lnn. (9) which lie dorsolaterally on the penis at the transverse plane of the pecten pubis, just caudal to the spermatic cord. The lymph vessels of the testes go to the medial iliac lnn. (p. 82).

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Penis

(Cross section cranial to sigmoid flexure) (Right surface)

Legend:

A Glans penis  
B Ext. urethral orifice  
C Urethral process  
D Raphe of penis  
D’ Frenulum of prepuce  
D” Raphe of prepuce  
E Fascia of penis  
F Tunica albuginea  
G Trabeculae of J  
H Deep veins of penis  
J Corpus cavernosum  
K Corpus spongiosum and urethra  
k Free part of penis

* Ashdown, 1958; Ashdown 1969; Seidel and Foote, 1967
Male genital organs

(Left side)

Prepuce:
1 Ext. lamina
2 Int. lamina
3 Preputial orifice

4 Left testis
5 Scrotum

6 Bulbospongiosus and Bulb of penis
7 Ischiocavernosus and Crus penis
8 Retractor penis
9 Supr. inguinal Inn.

(See pp. 17, 19, 87)

Legend:

a Rectus abdominis
b Cremaster
c Testicular a. and v.
d Vaginal ring
e Ductus deferens
f Ureter
g Urethralis
h Root of the penis
i Body of the penis
j Sigmoid flexure
k Free part of penis
l Suspensory ligg. of penis
m Male mammary gl.
n Proper lig. of testis
o Lig. of the tail of the epididymis
p Mesorchium
q Mesoductus deferens
r Mesofuniculus
s Pampiniform plexus

Testis and Epididymis

(caudal)

10 Spermatic cord
11 Vesicular gl.
12 Head of epididymis
13 Ampulla of ductus deferens
14 Body of epididymis
15 Body of prostate
16 Left testis
17 Testicular bursa
18 Bulbourethral gl.
19 Tail of epididymis

Accessory genital gl.

(dorsal)

11 Vesicular gl.
12 Head of epididymis
13 Ampulla of ductus deferens
14 Body of epididymis
15 Body of prostate
16 Left testis
17 Testicular bursa
18 Bulbourethral gl.
19 Tail of epididymis
9. PERINEUM, PELVIC DIAPHRAGM, ISCHIORECTAL FOSSA, AND TAIL.

The clinically important perineum is studied by first removing the skin from the perineal region to see the superficial muscles, nerves, and vessels. The fat is removed from the ischiorectal fossa, exposing the distal cutaneous br. of the pudendal n. (19) where it emerges on the medial surface of the tuber ischiadicum and supplies the superficial perineal nn. (4). The caudal rectal a. (21) is exposed in its course along the lateral border of the ext. anal sphincter, and branches of the dorsal and ventral perineal aa. are seen. The superficial fascia is incised from the labia to the udder to expose the large, convoluted, and often double ventral labial v. (16), draining blood from the perineum to the caudal mammary v. The mammary br. of the pudendal nn. are traced on the lateral borders of the vein. The corresponding nerve in the bull is the preputial and scrotal br., and the vein is the ventral scrotal. In deeper dissections the fascia is removed from the terminations of the coccygeus (2) and levator ani (3) and from the constrictor vestibuli (13) and constrictor vulvae (14). The smooth muscle retractor clitoris (15) is seen between the constrictor vestibuli and constrictor vulvae in the cow, and the retractor penis between the bulbospinosus and ischiocavernosus in the bull.

a) The PERINEUM and PERINEAL REGION. The perineum is the part of the body wall that closes the pelvic outlet, bounded by the first caudal vertebra, the sacrosciatic lig. (1), the tubera ischiadica (b), and the ischial arch. The part of the perineum dorsal to a line connecting the tubera ischiadica is the anal triangle, surrounding the anal canal and closed by the pelvic diaphragm. The part of the perineum ventral to the line is the urogenital triangle, surrounding the urogenital tract and closed by the perineal membrane. A more restricted definition includes only the perineal body between the anus and the urogenital tract. The perineal region is the surface area over the perineum and adjacent parts. In the ox it is bounded dorsally by the root of the tail and ventrally by the attachment of the scrotum or udder. The lateral border is formed by the sacrosciatic ligament, tuber ischiadicum, and a line from the tuber to the scrotum or udder. The perineal region is divided into anal and urogenital regions by a line connecting the medial processes of the tubers. The urogenital region is greatly elongated in ruminants by the ventral position of the scrotum and udder.

b) The ANAL TRIANGLE. The pelvic diaphragm is composed of right and left coccygeus (2) and levator ani (3) muscles and the external anal sphincter (12), together with the deep fascia on their external and internal surfaces. Each half of the diaphragm is oblique, extending caudomedially from the origin of the muscles on the medi al surface of the sciatic spine, to the termination of the coccygeus on the caudal vertebrae and of the levator ani on the external anal sphincter. The perineal body [centrum tendineum perinei], is the fibromuscular mass between the anus and the urogenital tract.

c) The UROGENITAL TRIANGLE. The perineal membrane in the cow is a strong sheet of deep perineal fascia extending from the ischiial arch to the ventral and lateral walls of the vestibule, cranial to the constrictor vestibuli (13) and caudal to the major vestibular gland (10). Together with the urogenital muscles it closes the urogenital triangle, joining the pelvic diaphragm at the level of the perineal body and anchoring the general tract to the ischiial arch.

d) The ISCHIORECTAL FOSSA is a fat-filled, wedge-shaped space lateral to the anus. The laterodorsal wall is the sacrococcygeal lig., the caudal border of which, the sacrotuberous lig (1), is easily palpable. The lateroventral wall is the tuber ischiadicum and the obturator fascia. The medial wall is the deep fascia covering the coccygeus, levator ani, and constrictor vestibuli. In the ox, unlike the horse, the sacrotuberous lig. and tuber ischiadicum are subcutaneous (see p. 16).

e) NERVES AND VESSELS. For the intrapelvic origins of the perineal nerves and vessels, see pp. 84–85. The pudendal n. (9) gives off the proximal and distal cutaneous branches and the deep perineal n. (20), and continues caudally on the pelvic floor with the internal pudendal a. and v. (9), supplying the vestibule and the mammary br. (25) and terminating in the clitoris. In the bull, the pudendal n. gives off the preputial and scrotal br. and terminates as the dorsal n. of the penis. The deep perineal n. supplies the vagina, major vestibular gland, and perineal muscles, and ends in the labium and the skin lateral to the perineal body. The caudal rectal n. (17), which may be double, supplies branches to the rectum, coccygeus, levator ani, ext. anal sphincter, retractor clitoridis (penis), perineal body, constrictor vestibuli, roof of the vestibule, and labium. Anesthesia of the penis and paralysis of the retractor penis, or anesthesia of the vestibule and vulva can be produced by blocking bilaterally the pudendal and caudal rectal nn. and the communicating br. of the caud. cutaneous femoral n. (p. 84) inside the sacrosciatic lig.* The internal iliac a. (6), at the level of the sciatic spine, gives off the vaginal or prostatic a. (These arteries may originate from the internal pudendal a.). The internal iliac ends by dividing at the lesser sciatic foramen into the caudal gluteal a. and internal pudendal a. (9). The latter supplies the coccygeus, levator ani, ischiorectal fossa, vagina, urethra, vestibule, and major vestibular gl. The internal pudendal a. ends by dividing into the ventral perineal a. (23) and the a. of the clitoris (24). The ventral perineal a. usually gives off the mammary branch (25). In some cows the ventral perineal a. and mammary br. are supplied by the dorsal labial br. of the dorsal perineal a. The vaginal a. (7), after giving off the urogenital br., divides into the middle rectal a. and the dorsal perineal a. (8). The latter divides into the caudal rectal a. (21) and the dorsal labial br. (22), which gives off the perineal br. seen on the tuber ischiadicum, and runs ventrally in the labium. It may also supply the mammary br. and the ventral part of the perineum. The dorsal labial br. may be cut in episiotomy. In the male, the prostatic a. gives branches to the urethra, prostate, and bulbourethral gl., and may terminate as the dorsal perineal a., but the latter usually comes from the internal pudendal a.**

f) The TAIL contains 16–21 caudal vertebrae. The rectocaudalis is longitudinal smooth muscle from the wall of the rectum, attached to caud. vertebrae 2 and 3. The smooth muscle retractor clitoridis (penis) originates from caud. vertebrae 2 and 3 or 3 and 4. The caudal nerves in the cauda equina run in the vertebral canal. The median caudal a. and v. on the ventral surface are convenient for the veterinarian working behind stanched cows. The pulse is best palpated between the vertebral or about 18 cm from the root of the tail to avoid the hemal processes. Tail bleeding is done by raising the tail and puncturing the median caudal v. between hemal processes.

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* Larson, 1953
** Erasha, 1987
Perineal region

(Caudal aspect)

1 Sacrosciatic lig. (a)
2 Coccygeus (b)
3 Levator ani (c)
4 Supf. perineal n. (d)
5 Transversus perinei (e)

Anal triangle:
11 Rectocaudalis
12 Ext. anal sphincter

Urogenital triangle:
13 Constrictor vestibuli
14 Constrictor vulvae
15 Retractor clitoridis

Legend:

a Tuber coxae
b Tuber ischiatricum
c Gluteus medius
d Biceps femoris
e Semitendinosus
f Semimembranosus
g Gracilis
h Intertransversarii
i Sacrocaudalis dors. med.
j Sacrocaudalis dors. lat.
k Sacrocaudalis vent. lat.
l Sacrocaudalis vent. med.

Pelvic n.
6 Int. iliac a. and v.
7 Vaginal a. and v.
8 Dors. perineal a. and v.
9 Int. pudendal a. and v.
10 Major vestibular gl.

(See pp. 85, 91)

(Lateral aspect)

17 Caud. rectal nn. and brv. to coccygeus and levator ani
18 Prox. cut. br. of pudendal n.
19 Dist. cut. br. of pudendal n.
20 Deep perineal n.
21 Caud. rectal a. and v.
22 Dors. labial br. and v.
23 Vent. perineal a. and v.
24 A. and v. of clitoris and dorsal n. of clitoris
25 Mammary brr. of vent. perineal a. and pudendal n.; vent. labial v.
ANATOMICAL ASPECTS OF BOVINE SPONGIFORM ENCEPHALOPATHY (BSE)

NATURE OF THE DISEASE

The term spongiform encephalopathy refers to spongy changes in the brain. BSE is one of a group of diseases called transmissible spongiform encephalopathies (TSE), of which scrapie of sheep has been known for a long time, is widely distributed, and has been intensively investigated. The TSE are caused by prion proteins (PrP) – minute proteinaceous infectious particles 4–6 nm in diameter. They occur in normal and pathogenic forms on the surface of nerve cells and various cells of lymphatic tissue. In normal PrP the amino acid chains are predominantly wound up in alpha-helices. By unknown processes, often by mutation in the controlling gene, pathogenic PrP develop, whose amino acids in some regions of the molecule are refolded from alpha helices into beta-sheets layered antiparallel on each other. The misfolded, pathogenic PrP cause BSE by imposing their structure on normal PrP thereby multiplying the pathogen. They enter the lysosomes of nerve cells, where they are not decomposed, but accumulate in amyloid plaques and cause the death of the nerve cells.**

Models of prion proteins (purple = alpha-helix structure, blue = beta sheet structure)

SPECIES DISTRIBUTION OF PRION DISEASES

Prion diseases have been found in sheep, goats, cattle, zoo and wild ruminants, mint, great cats, and rhesus monkeys. Human prion diseases are Creutzfeldt-Jakob disease, Gerstmann-Sträussler syndrome, fatal familial insomnia, and kuru. BSE is of great importance because:

1. Its causative agent can overcome the species barrier and become very dangerous to man.
2. Cattle are significant sources of human food, and an undiagnosed BSE infection is a danger to man.

THE SIGNS OF BSE DISEASE

The average age of cattle affected with BSE is about 3 years, but the first signs may appear at 20 months. As a result of the brain disorder, the following signs appear: hypersensitivity to stimuli (e. g. noise), anxiety, aggression, and locomotor disturbance progressing to collapse. The terminal stage is prostration until death. There is no cure.

DIAGNOSIS OF BSE

A suspected clinical diagnosis is possible in the terminal stage, but a certain diagnosis can be made only after death. For the rapid test, parts of the brainstem are removed, homogenized, and digested by proteinases. After digestion, only the pathogenic PrP remain intact, and can be identified by a specific antibody. If the results are doubtful, further tests by immunohistological or cytological (E/M) methods are required.

POSSIBLE CAUSES FOR THE APPEARANCE OF NEW PRION DISEASES

The PrP of scrapie in sheep could have mutated in cattle to the PrP of BSE. Scrapie was widely distributed in Great Britain, and carcasses of affected sheep were reduced in rendering plants to fat and tankage in large autoclaves (tanks). The tankage (meat and bone meal) was a common source of protein in animal feed, including cattle feed. Transmission by feed was later made highly probable by the success of a ban on tankage in animal feed.***

In Germany BSE was probably spread by feeding calves a milk substitute made by replacing milk fat with tallow from adult bovine mesenteric and abdominal fat.

Failure to observe proper procedures in the operation of the tank (addition of lye and detergents and maintenance of heat at 130 °C for 20 min.) could have led to survival of pathogenic PrP.

PATHWAYS OF INFECTION

The probable mode of infection in sheep and cattle is intestinal. Precise information on infection of cattle is not available, but parallels can be drawn from experiments on rodents, which have a much shorter incubation period. Also, possible parallels can be drawn to scrapie in sheep.

TRANSPORT THROUGH THE AUTONOMIC SYSTEM

At least three routes to the CNS have been proposed on the basis of experiments on rodents: ***

1. The vagus conducts parasympathetic fibers that bypass the spinal cord. The vagal efferents have their nerve cell bodies in the dorsal motor nucleus in the obex region of the medulla. Vagal afferents have their nerve cell bodies in the proximal and distal vagal ganglia. They send their short axons to the obex region.
2. An alternative route goes from the enteric plexuses through prevertebral ganglia and the splanchnic nerves to the sympathetic trunk, thence through the communicating branches and spinal nerve roots to the tracts of the spinal cord leading to and from the brain.
3. A third possibility is passage from the sympathetic trunk through the cervicothoracic ganglion, ansa subclavia, and vagosympathetic trunk to the head.

** Borchers, 2002
*** McBride et al., 2001
** Hoernlimann et al., 2001
AREAS OF HIGHEST CONCENTRATION IN THE BRAIN

The primary site of pathogenic prions is the region of the obex between the medulla oblongata and the spinal cord. The dorsal vagal nucleus and other important nuclei here show typical spongiform changes. Other regions of the brainstem display lesions. Spongiform encephalopathy of the cerebellar cortex explains the locomotor disturbances and ataxia. Insoluble amyloid forms in the nerve cells, with high concentration of pathogenic prions and spongiform changes. Neighboring glia cells are also affected.


Nervous tissue of the region of the obex in BSE. Preparation: Prof. F. Ehrensperger, Inst. of Vet. Pathology, Zürich

Another TSE, chronic wasting disease (CWD) of North American deer and elk, discovered in Colorado in 1967, has been found in wild or farmed deer and elk in Wyoming, Nebraska, South Dakota, Oklahoma, Montana, Wisconsin, and one case in Illinois. (The North American elk, a misnomer, is Cervus canadensis, not Alces alces—the European Elch and the North American moose.) There is no evidence that other species, including man, are infected through contact with CWD. In experimental deer inoculated orally with infective deer brain, pathogenic PrP were first found in lymphoid tissues of the alimentary system and then in autonomic nerves leading from the gut to the brainstem, where they appeared first in the dorsal motor nucleus of the vagus. Other peripheral nerves, such as the brachial plexus and sciatic nerve, were tested and found negative.

The U. S. government has prohibited importation of live ruminants and most ruminant products from Europe and Canada. The U. S. Dept. of Agriculture has prohibited importation of all rendered animal products of any species. There is no evidence of BSE in the United States after a decade of testing for it.

Spinal cord and sympathetic trunk after removal of the left side of the vertebral arches and the musculature

Legend:

1. Dorsal horn
2. Ventral horn
3. Central canal
4. White matter
5. Dorsal root
6. Spinal ganglion
7. Ventral root
8. Dorsal br.
9. Ventral br.
10. Communicating br.
11. Ganglia of sympathetic trunk
12. Sympathetic trunk
14. Pia mater
15. Arachnoid
16. Dura mater

a. Psoas major
b. Psoas minor

REMOVAL OF THE BRAINSTEM FOR LABORATORY TESTS

After slaughter and decapitation, brainstem tissue can be removed with a curette through the foramen magnum. If the head is bisected, the meninges are separated from the more rostral parts of the brain (see p. 51, below) by a transverse cut through 13 and 14, and by cutting the roots of cranial nn. V-XII and the cerebellar peduncles to release the sample of the brainstem. The material of the obex region is used for the BSE rapid test. If the results are positive, histopathologic, immunohistochemical, and E/M investigations follow, for which more rostral parts of the brainstem are used.

TRANSMISSION OF BSE TO MAN

Human infection with the agent of BSE and consequent illness with the variant of Creutzfeld-Jacob disease (vCJD) is highly probable. In vCJD the multiplication of the agent also occurs outside the brain and spinal cord in the lymphatic organs (e.g., tonsils); whereas as in the sporadic (classical) CJD the pathological changes remain restricted to the CNS. The likelihood of transmission from BSE-infected cattle to man is supported by the fact that the agents of BSE and vCJD are biologically and biochemically identical. The connection of time and place between occurrences of BSE and vCJD in Great Britain supports this probability. Apparently a genetically determined susceptibility plays a role in transmission because, so far, only a few people have contracted vCJD, and only a few of the cattle in a herd contract BSE.

DANGERS OF EATING MEAT AND MEAT PRODUCTS FROM BSE-INFECTED CATTLE OR CATTLE SUSPECTED OF EXPOSURE TO BSE

The risks increase with the amount of infective material consumed and its concentration of pathogenic misfolded prions. Of the components of nervous tissue, the perikarya and therefore the ganglia and nuclei may present a greater danger than axons, and thus more than nerves and fiber tracts. The perikarya occupy a much larger volume and have a concentration of prions in the lysosomes, which are not present in the processes. The danger is increased, the nearer the ganglia lie to valuable cuts of meat; for example, the sympathetic trunk and ganglia are closely associated with the tenderloin (iliopsoas and psoas minor (see p. 81, upper fig.) The spinal ganglia lie in the intervertebral foramina and are included with the bone in steaks cut from the rib and loin regions (see text fig.). Regarding the concentration of pathogenic misfolded prions the following list presents the opinion of the European Union on the possible risk of infectivity in various tissues (including experiments with scrapie).

1. Highly infectious tissues: brain and spinal cord together with surrounding membranes, eyes, spinal ganglia.
2. Tissues of intermediate infectivity: intestine, tonsils, spleen, placenta, uterus, fetal tissue, cerebrospinal fluid, hypophysis, and adrenal gl.
3. Tissues of lower infectivity: liver, thymus, bone marrow, tubular bones, nasal mucosa, peripheral nerves.
4. Infectivity was not demonstrated in the following tissues and organs: skeletal muscle, heart, kidneys, milk, fat (except mesenteric fat), cartilage, blood, salivary gl., tests, and ovary.
## SPECIAL ANATOMY, TABULAR PART

### 1. MYOLOGY

#### MUSCLE / FIG. ORIGIN TERMINATION INNERVATION FUNCTION REMARKS

#### MEDIAL MUSCLES OF THE SHOULDER AND ARM (p. 4)

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>TERMINATION</th>
<th>INNERVATION</th>
<th>FUNCTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teres major</strong> (5.2)</td>
<td>Caudal border of scapula and subscapula</td>
<td>Teres major tuberosity of humerus</td>
<td>Axillary n.</td>
<td>Flexor of shoulder joint</td>
<td>Joined by terminal tendon of latissimus dorsi</td>
</tr>
<tr>
<td><strong>Subscapularis</strong> (5.4)</td>
<td>Subscapular fossa of scapula</td>
<td>Minor tubercle of humerus</td>
<td>Subscapular and axillary nn.</td>
<td>Mainly an extensor of shoulder jt.</td>
<td>3–4 distinct parts; tendon acts as med., collat. lig. of shoulder joint</td>
</tr>
<tr>
<td><strong>Coracobrachialis</strong> (5.16)</td>
<td>Coracoid process of scapula</td>
<td>Small part prox. and large part dist. to teres major tuberosity of humerus</td>
<td>Musculocutaneous n.</td>
<td>Extensor of shoulder joint and adductor and supinator of brachium</td>
<td>Two bellies; synovial bursa under tendon of origin</td>
</tr>
<tr>
<td><strong>Articularis humeri</strong></td>
<td>Inconstant in the ox.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Biceps brachii</strong> (5.26)</td>
<td>Supraglenoid tubercle of scapula</td>
<td>Radial tuberosity, cranial surface of radius, fleshy on med. collat. lig. of elbow joint</td>
<td>Musculocutaneous n.</td>
<td>Extensor of shoulder joint, flexor of elbow joint</td>
<td>Intertubercular bursa under tendon of origin; thin lacertus fibrosis to antebrachial fascia</td>
</tr>
<tr>
<td><strong>Brachialis</strong> (5.21)</td>
<td>Caud. surface of humerus, close to neck</td>
<td>Radial tuberosity and med. collat. lig. of elbow joint</td>
<td>Musculocutaneous n.; for distal parts, radial n.</td>
<td>Flexor of elbow joint</td>
<td>Spiral course in brachialis groove of humerus, added innervation from radial n. in 50 %</td>
</tr>
<tr>
<td><strong>Tensor fasciae antebrachii</strong> (5.22)</td>
<td>Caud. border of scapula, latissimus dorsi</td>
<td>Medially on olecranon and antebrachial fascia</td>
<td>Radial n.</td>
<td>Tensor of fascia of forearm and extensor of elbow joint</td>
<td></td>
</tr>
</tbody>
</table>

#### LATERAL MUSCLES OF SHOULDER AND ARM (p. 4)

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>TERMINATION</th>
<th>INNERVATION</th>
<th>FUNCTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deltoides</strong></td>
<td>Clavicular part (Cleidobrachialis) (5.23)</td>
<td>Clavicular intersection</td>
<td>Crest of humerus</td>
<td>Auxillary n.</td>
<td>Advances limb</td>
</tr>
<tr>
<td><strong>Scapular part</strong> (5.6)</td>
<td>Caud. border of scapula, aponeurosis from scapular spine</td>
<td>Deltoid tuberosity of humerus, fascia of triceps</td>
<td></td>
<td>Flexor of shoulder joint</td>
<td>Small flat muscle</td>
</tr>
<tr>
<td><strong>Acromial part</strong> (5.7)</td>
<td>Acromion</td>
<td>Deltoid tuberosity of humerus</td>
<td></td>
<td>Flexor of shoulder joint</td>
<td>Interspersed with tendinous strands</td>
</tr>
<tr>
<td><strong>Teres minor</strong> (5.12)</td>
<td>Distal half of cl. border of scapula</td>
<td>Prox. to deltid tuberosity of humerus on teres minor tuberosity</td>
<td>Axillary n.</td>
<td>Flexor of shoulder joint</td>
<td></td>
</tr>
<tr>
<td><strong>Supraspinatus</strong> (5.1)</td>
<td>Supraspinous fossa, cran. border of scapula</td>
<td>Major and minor tubercles of humerus</td>
<td>Suprascapular n.</td>
<td>Extensor and stabilizer of shoulder jt.; also flexor dependent on state of joint</td>
<td>Tendon of origin of biceps passes between the terminal tendons</td>
</tr>
<tr>
<td><strong>Infraspinatus</strong> (5.11)</td>
<td>Infraspinous fossa and spine of scapula</td>
<td>Deep part on prox. border and med. surface of major tubercle; supf. part distal to tubercle</td>
<td>Suprascapular n.</td>
<td>Abductor and lateral rotator of arm; acts as lat. collat. lig.</td>
<td>Largely tendinous, flat; supf. tendon passes over infraspinatus bursa</td>
</tr>
<tr>
<td><strong>Triceps brachii</strong></td>
<td>All heads together on olecranon</td>
<td></td>
<td>Radial n.</td>
<td>Extensor of elbow joint; long head also flexes shoulder joint; stabilizer of elbow</td>
<td>Relatively flat</td>
</tr>
<tr>
<td>Long head (5.18)</td>
<td>Caud. border of scapula</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lat. head (5.17)</td>
<td>Lateral on humerus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Med. head (5.19)</td>
<td>Medial on humerus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessory head</td>
<td>Caudal on humerus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Anconeus</strong> (5.25)</td>
<td>Borders of olecranon fossa</td>
<td>Lateral on olecranon</td>
<td>Radial n.</td>
<td>Extensor of elbow joint</td>
<td>Separable with difficulty from lat. head of triceps</td>
</tr>
</tbody>
</table>

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**Note:** The table provides a detailed overview of the muscles of the shoulder and arm, including their origins, insertions, innervations, functions, and remarks. Each entry in the table is a muscle, followed by its origin, termination, innervation, function, and any remarks highlighting specific aspects of anatomy or function.
### MUSCLE / FIG. ORIGIN TERMINATION INNERVATION FUNCTION REMARKS

### CRANIOLATERAL MUSCLES OF THE FOREARM
Generally extensors, which originate predominantly on the lateral epicondyle of the humerus (p. 4)

<table>
<thead>
<tr>
<th>Common digital extensor (5.40)</th>
<th>Radial n.</th>
<th>Extensor of the digits and carpus</th>
<th>Receives extensor branches of interosseus III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial head (Proper extensor of digit III, Med. digital extensor)</td>
<td>Lateral epicondyle of humerus</td>
<td>Middle and distal phalanges of digit III</td>
<td>Extensor of fetlock and pastern joints of digit III</td>
</tr>
<tr>
<td>Lateral head (Common extensor of digits III and IV)</td>
<td>Lateral epicondyle of humerus, head of ulna</td>
<td>Branches to extensor processes of dist. phalanges of digits III &amp; IV</td>
<td>Extensor of coffin joints</td>
</tr>
<tr>
<td>Lateral digital extensor (Proper extensor of digit IV) (5.41)</td>
<td>Proximal on radius and ulna</td>
<td>Middle and distal phalanges of digit IV</td>
<td>Extensor of fetlock and pastern joints of digit IV</td>
</tr>
<tr>
<td>Extensor carpi radialis (5.35)</td>
<td>Lat. supracondylar crest and radial fossa of humerus</td>
<td>Tuberosity of Mc III</td>
<td>Radial n.</td>
</tr>
<tr>
<td>Ulnaris lateralis (Extensor carpi ulnaris) (5.38)</td>
<td>Lateral epicondyle of humerus</td>
<td>Accessory carpal bone and Mc V</td>
<td>Radial n.</td>
</tr>
<tr>
<td>Ext. carpi obliquus (Abductor pollicis longus) (5.39)</td>
<td>Cranialat. in middle third of radius</td>
<td>Mc III</td>
<td>Radial n.</td>
</tr>
</tbody>
</table>

### CAUDOMEDIAL MUSCLES OF THE FOREARM
Generally FLEXORS, which originate predominantly on the medial epicondyle of the humerus (p. 4)

<table>
<thead>
<tr>
<th>Superficial digital flexor (5.36 and 5.37)</th>
<th>Med. epicondyle of humerus</th>
<th>Flexor tuberosities of middle phalanges</th>
<th>Ulnar n.</th>
<th>Flexor of the carpus and digits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Larger supf. belly supf. to flexor retinaculum; deep belly within carpal canal</td>
<td></td>
</tr>
<tr>
<td>MUSCLE / FIG.</td>
<td>ORIGIN</td>
<td>TERMINATION</td>
<td>INNERVATION</td>
<td>FUNCTION</td>
</tr>
<tr>
<td>--------------</td>
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</tr>
<tr>
<td>Deep digital flexor (5.34)</td>
<td>Med. epicondyle of humerus</td>
<td>Flexor tubercles of distal phalanges</td>
<td>Ulnar and median nn.</td>
<td>Flexor of coffin jts.; support of fetlock jts.</td>
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<tr>
<td>Humeran head</td>
<td>Med. epicondyle of humerus</td>
<td>Accessory carpal bone</td>
<td>Ulnar n.</td>
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<tr>
<td>Ulnar head</td>
<td>Medially on olecranon</td>
<td>Proximopalmar on Mc III</td>
<td>Median n.</td>
<td>Flexor of carpus</td>
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<tr>
<td>Pronator teres (5.27)</td>
<td>Medial epicondyle of humerus</td>
<td>Cranio medial on radius</td>
<td>Median n.</td>
<td>Pronator of forearm and manus</td>
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<tr>
<td>METACARPUS (p. 4 and 18)</td>
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<td></td>
<td>Auxiliary flexors of the digits</td>
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<tr>
<td>Interflexorii</td>
<td>Muscle fibers connecting the supf. and deep digital flexors as well as their tendons, in and near the carpal canal</td>
<td>Median n.</td>
<td>Support fetlock joints; oppose tension of deep flexor on distal phalanx</td>
<td>Predominantly tendinous in older cattle.</td>
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<tr>
<td>Interosseus III and Interosseus IV (p. 18)</td>
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<td>Prox. sesamoid bones; branches to proper extensor tendons; accessory lig. to supf. flexor</td>
<td>Palmar branch of ulnar n.</td>
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<tr>
<td>MUSCLES OF THE HIP JOINT (p. 16)</td>
<td>Tuber coxae</td>
<td>By the fascia lata on the patella, lateral patellar lig., and cran. border of tibia</td>
<td>Cran. gluteal n.</td>
<td>Flexor of hip joint, advances limb; extensor of stifle; tensor of fascia lata</td>
</tr>
<tr>
<td>Tensor fasciae latae (17.5)</td>
<td>Gluteal surface of ilium</td>
<td>Major trochanter of femur</td>
<td>Cran. gluteal n.</td>
<td>Extensor of hip joint; abductor of limb</td>
</tr>
<tr>
<td>Gluteus superficialis</td>
<td>Gluteal surface of ilium</td>
<td>Craniolat. on femur just distal to maj. trochanter</td>
<td>Cran. gluteal n.</td>
<td>Same as gluteus medius</td>
</tr>
<tr>
<td>Gluteus accessorius (17.3)</td>
<td>Sciatic spine, lat. on body of ischium, sacrosciatic lig.</td>
<td>Craniolat. on femur, distal to gluteus accessorius</td>
<td>Cran. gluteal n.</td>
<td>Abductor of limb</td>
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<tr>
<td><strong>CAUDAL THIGH MUSCLES (p. 16)</strong></td>
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<tr>
<td><strong>Gluteobiceps</strong> (Biceps femoris) (17.7)</td>
<td>Vertebral head: caud. part of median sacral crest and last transverse processes; sacrosciatic lig.; and <strong>tuber ischiadicum</strong></td>
<td>Patella; lat. patellar lig.; cran. border of tibia (by fascia cruris and fascia lata); common calcaneal tendon</td>
<td>Vert. head: caud. gluteal n. Pelvic head: tibial n.</td>
<td>Extensor of hip and stifle; with caud. part, flexor of stifle; adductor of limb; extensor of hock</td>
</tr>
<tr>
<td><strong>Semitendinosus</strong> (17.20)</td>
<td><strong>Tuber ischiadicum</strong></td>
<td>Cran. border of tibia, <strong>terminal aponeurosis of gracilis</strong>, common calcaneal tendon</td>
<td>Tibial n.</td>
<td>In supporting limb: extensor of hip, stifle and hock; in swinging limb: flexor of stifle; also adductor and retractor of limb</td>
</tr>
<tr>
<td><strong>Semimembranosus</strong> (17.18)</td>
<td><strong>Tuber ischiadicum</strong></td>
<td>Med. condyles of femur and tibia</td>
<td>Tibial n.</td>
<td>In supporting limb: extensor of hip and stifle; in swinging limb: retractor, adductor, and pronator of limb</td>
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<td><strong>DEEP MUSCLES OF THE HIP JOINT (p. 16, 18)</strong></td>
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<td><strong>Gemelli</strong> (17.25)</td>
<td>Lesser sciatic notch</td>
<td>Trochanteric fossa of femur</td>
<td>Muscular brr. of sciatic n.</td>
<td>Rotate thigh laterally</td>
</tr>
<tr>
<td><strong>Internal obturator is absent in the ox.</strong></td>
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<tr>
<td><strong>Quadratus femoris</strong> (17.26)</td>
<td>Ventral surface of ischium</td>
<td>Lat. surface of body of femur</td>
<td>Muscular brr. of sciatic n.</td>
<td>Supinator of thigh, auxiliary extensor of hip joint</td>
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<tr>
<td><strong>External obturator</strong> (19.7)</td>
<td>Outer and inner surface of ischium around obturator for.</td>
<td>Trochanteric fossa of femur</td>
<td>Obturator n.</td>
<td>Supinator of thigh; adductor of limb</td>
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<td><strong>MEDIAL THIGH MUSCLES: Adductors (p. 18)</strong></td>
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<tr>
<td><strong>Gracilis</strong> (19.10)</td>
<td>Prepubic tendon; by symphysial tendon from pelvic symphysis</td>
<td>Fascia cruris</td>
<td>Obturator and saphenous nn.</td>
<td>Adductor (and extensor of stifle jt.)</td>
</tr>
<tr>
<td><strong>Adductor magnus</strong> (et brevis) (19.9)</td>
<td>Symphysial tendon; ventrally on pubis</td>
<td>Facies aspera of femur</td>
<td>Obturator n.</td>
<td>Adductor and retractor of the limb</td>
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<tr>
<td><strong>Pectineus</strong> (et adductor longus) (19.8)</td>
<td>Contralateral pubis: iliopubic eminence; ilium up to tubercle of psoas minor</td>
<td>Caudomedial on femur</td>
<td>Adductor part: obturator n.; pectineus part: saphenous n.</td>
<td>Adductor of limb, flexor of hip</td>
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<td><strong>EXTENSORS OF THE STIFLE (p. 18)</strong></td>
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<td><strong>Sartorius</strong> (19.3)</td>
<td>Cranial: iliac fascia and tendon of psoas minor; caudal: iliopubic eminence and adjacent ilium</td>
<td>Fascia cruris</td>
<td>Saphenous n.</td>
<td>Flexor of hip joint; protractor and adductor of limb; extensor of stifle</td>
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<tr>
<td><strong>Quadriceps femoris</strong></td>
<td>By middle patellar lig., on the tibial tuberosity</td>
<td>Femoral n.</td>
<td>Flexor of the hip joint (rectus); extensor and stabilizer of the stifle</td>
<td>Very large and clearly four heads</td>
</tr>
<tr>
<td><strong>Rectus femoris</strong> (19.1)</td>
<td>Ilium: main tendon from med. fossa cran. to acetabulum; small tendon from lat. area near acetab.</td>
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<tr>
<td><strong>Vastus lateralis</strong> (17.29)</td>
<td>Proximolateral on femur</td>
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<tr>
<td><strong>Vastus medialis</strong> (19.2)</td>
<td>Proximomedial on femur</td>
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<tr>
<td><strong>Vastus intermedius</strong></td>
<td>Proximocranial on femur</td>
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<td><strong>SPECIAL FLEXOR OF THE STIFLE: Caudal to the stifle (p. 18)</strong></td>
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<td>Popliteus (29.4)</td>
<td>Lateral femoral condyle</td>
<td>Proximomedial on caud. surface of tibia</td>
<td>Tibial n.</td>
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<td><strong>EXTENSORS OF THE HOCK AND FLEXORS OF THE DIGITS: Caudal on the crus (p. 18)</strong></td>
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<tr>
<td>Gastrocnemius (19.11)</td>
<td>On both sides of supracondylar fossa of the femur</td>
<td>By the common calcanean tendon on calcanean tuber</td>
<td>Tibial n.</td>
<td>Extensor of the hock, flexor of the stifle</td>
</tr>
<tr>
<td>Lateral head</td>
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<td></td>
<td></td>
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<tr>
<td>Medial head</td>
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<tr>
<td>Soleus (17.31)</td>
<td>Prox. rudiment of the fibula</td>
<td>Joins common calcanean tendon</td>
<td>Tibial n.</td>
<td>Auxiliary extensor of the hock</td>
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<tr>
<td>Supf. digital flexor (19.22)</td>
<td>Supracondylar fossa of femur</td>
<td>Flexor tuberosities of middle phalanges</td>
<td>Tibial n.</td>
<td>Extensor of hock; digital flexor; and flexor of the stifle</td>
</tr>
<tr>
<td>Deep digital flexors</td>
<td>Distal phalanges</td>
<td>Tibial n.</td>
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<td>Flexors of coffin joints; support of hock and fetlock joints</td>
</tr>
<tr>
<td>Lat. digital flexor (17.32)</td>
<td>Lat. condyle and caud. surface of tibia</td>
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<tr>
<td>Caudal tibial m. (17.33)</td>
<td>Lat. condyle of tibia</td>
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<td></td>
<td></td>
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<tr>
<td>Med. digital flexor (19.5)</td>
<td>Lat. condyle of tibia</td>
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<tr>
<td><strong>FLEXORS OF THE HOCK AND EXTENSORS OF THE DIGITS: Craniolateral on the crus (p. 16)</strong></td>
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<tr>
<td>Tibialis cranialis (17.8)</td>
<td>Cran. border and proximolateral surface of tibia; prox. rudiment of fibula and replacement ligament</td>
<td>T I, proximomedial on Mt III and Mt IV</td>
<td>Deep peroneal n.</td>
<td>Flexor of hock</td>
</tr>
<tr>
<td>Peroneus tertius (17.10)</td>
<td>Extensor fossa of femur</td>
<td>Prox. on Mt III and Mt IV; T II and T III</td>
<td>Deep peroneal n.</td>
<td>Flexor of hock</td>
</tr>
<tr>
<td>Long digital extensor (17.13)</td>
<td>Extensor fossa of femur</td>
<td>Deep peroneal n.</td>
<td></td>
<td>Extensor of digits and flexor of hock</td>
</tr>
<tr>
<td>Medial head</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(Proper extensor of digit III, Med. digital extensor)</td>
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</tr>
<tr>
<td>Lateral head</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(Extensor of digits III and IV)</td>
<td></td>
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### MUSCLE / FIG.

<table>
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<tr>
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<td>Lat. collateral lig. of stifle; lat. condyle of tibia</td>
<td>Middle and distal phalanges of digit IV</td>
<td>Deep peroneal n.</td>
<td>Extensor of digit IV and flexor of hock</td>
<td>Relatively large and pennate; receives extensor branches from interosseus IV</td>
</tr>
<tr>
<td>Extensor digitalis brevis (17.15)</td>
<td>Ligamentous mass on dorsal surface of tarsus</td>
<td>Joins tendon of long digital extensor</td>
<td>Deep peroneal n.</td>
<td>Digital extensor</td>
<td>Small</td>
</tr>
<tr>
<td>Peroneus longus (17.11)</td>
<td>Lat. condyle of tibia, rudiment of fibula</td>
<td>Tendon crosses lat. surface of hock and tendon of lat. dig. ext. and plantar surface of hock to T I</td>
<td>Deep peroneal n.</td>
<td>Flexor of hock</td>
<td>Small, with long thin tendon</td>
</tr>
</tbody>
</table>

### METATARSUS:

Interossei III and IV: (see Muscle tables, p. 100 and p. 18)

### MUSCLES INNERVATED BY THE FACIAL NERVE (p. 36 and 37)

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<tr>
<td>Cervicoauricularis superficialis</td>
<td>Nuchal lig.</td>
<td>Dorso-lat. surface of auricle</td>
<td>Caud. auricular n.</td>
<td>Raises auricle</td>
<td></td>
</tr>
<tr>
<td>Cervicoauricularis profundus and medius</td>
<td>Nuchal lig. and cervical fascia</td>
<td>Caudo-lat. and caud. surface of auricle</td>
<td>Caud. auricular n.</td>
<td>Turn intertragic notch laterally</td>
<td></td>
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<tr>
<td>Cervicoauricularis (37.2)</td>
<td>Nuchal lig., parietal bone caud. to intercornual protuberance</td>
<td>Caud. border of scutiform cartilage</td>
<td>Caud. auricular n. from nerve</td>
<td>Raises auricle and tenses scutiform cartilage</td>
<td>Broad muscle plate</td>
</tr>
<tr>
<td>Intercutularis (37.3)</td>
<td>Cornual proc., temporal line</td>
<td>Medially on scutiform cartilage</td>
<td>Rostral auric. br. of auriculopalpebral n. from facial n.</td>
<td>Tensor of scutiform cartilage</td>
<td>Has no connection to contralateral muscle</td>
</tr>
<tr>
<td>Frontoscutularis</td>
<td>Temporal line and zygomatic proc. of frontal bone</td>
<td>Scutiform cartilage</td>
<td>Rostral auric. br. of auriculopalpebral n. from facial n.</td>
<td>Tensor of scutiform cartilage</td>
<td>Two distinct parts according to origin</td>
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<tr>
<td>Zygomaticoscutularis (37.B)</td>
<td>Zygomatic arch</td>
<td>Rostrally on scutiform cartilage</td>
<td>Rostral auric. br. of auriculopalpebral n. from facial n.</td>
<td>Tensor of scutiform cartilage</td>
<td></td>
</tr>
<tr>
<td>Scutulosaauricularis superficialis et profundus (37.D, E)</td>
<td>Scutiform cartilage</td>
<td>Rostromedial on auricle</td>
<td>Rostral auric. br. of auriculopalpebral n. from facial n.</td>
<td>Levator and protractor of auricle</td>
<td>Two muscles crossed on scutiform cartilage</td>
</tr>
<tr>
<td>Zygomaticosauricularis (37.12)</td>
<td>Zygomatic arch</td>
<td>Auricular concha, at intertragic notch</td>
<td>Rostral auric. br. of auriculopalpebral n. from facial n.</td>
<td>Turns intertragic notch rostrally</td>
<td></td>
</tr>
<tr>
<td>Parotidoauricularis (37.13)</td>
<td>Parotid fascia</td>
<td>Auricular concha, at intertragic notch</td>
<td>Auriculopalpebral n.</td>
<td>Depressor and retractor of auricle</td>
<td></td>
</tr>
<tr>
<td>Styloauricularis (37.23)</td>
<td>Cartilage of acoustic meatus</td>
<td>Rostromedial border of auricle</td>
<td>Caud. auricular n.</td>
<td>Muscle of the acoustic meatus</td>
<td>May be absent</td>
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### MUSCLES OF THE LIPS AND CHEEKS (p. 36)

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<tbody>
<tr>
<td>Orbicularis oris (37.10)</td>
<td>Surrounds the opening of the mouth, except the middle of the upper lip</td>
<td>Buccal brr. of facial nerve</td>
<td>Closes rima oris</td>
<td>Contralat. fibers do not join in the upper lip</td>
</tr>
<tr>
<td>Buccinator (37.26)</td>
<td>Between coronoid process of mandible and angle of the mouth</td>
<td>Buccal brr. of facial nerve</td>
<td>Muscular substance of cheek; presses food from vestibule into oral cavity proper</td>
<td>Separable into a molar part with rostroventral fiber course, and buccal part with dorsoventral fiber course</td>
</tr>
<tr>
<td>Zygomaticus (37.11)</td>
<td>Parotidomasseteric fascia</td>
<td>In orbicularis oris at angle of mouth</td>
<td>Auriculopalpebral n. from facial n.</td>
<td>Retractor of angle of mouth</td>
</tr>
<tr>
<td>Caninus (37.23)</td>
<td>Rostrally on facial tuber</td>
<td>With 3 tendons on lat. rim of nostril</td>
<td>Buccal brr. of facial nerve</td>
<td>Dilates nostril and raises upper lip</td>
</tr>
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<tr>
<td>Levator labii superioris (37.22)</td>
<td>Facial tuber</td>
<td>Planum nasolabiale dors. and med. to nostril</td>
<td>Buccal br. of facial nerve</td>
<td>Levator and retractor of upper lip and planum nasolabiale</td>
</tr>
<tr>
<td>Depressor labii superioris (37.24)</td>
<td>Rostrally on facial tuber</td>
<td>Upper lip and planum nasolabiale</td>
<td>Buccal br. of facial nerve</td>
<td>Depressor of upper lip and planum nasolabiale</td>
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<tr>
<td>Depressor labii inferioris (37.25)</td>
<td>Caudal alveolar border of mandible</td>
<td>Lower lip</td>
<td>Buccal br. of facial nerve</td>
<td>Depressor and retractor of lower lip</td>
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**MUSCLES OF THE EYELIDS AND NOSE (p. 36)**

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<tr>
<td>Orbicularis oculi (37.4)</td>
<td>The muscular ring around the eye in the eyelids</td>
<td>Auriculopalpebral n. from facial n.</td>
<td>Narrowing and closure of the palpebral fissure</td>
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<tr>
<td>Levator nasolabialis (37.5)</td>
<td>Frontal bone</td>
<td>Deep part on nasal proc. of incisive bone and lat. nasal cartilages; supf. part between nostril and upper lip</td>
<td>Auriculopalpebral n. from facial n.</td>
<td>Levator of upper lip, dilator of nostril</td>
<td>Broad and thin; levator labii superioris and caninus pass between supf. and deep parts</td>
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<tr>
<td>Malaris (37.20)</td>
<td>Lacrimal bone and parotidomasseteric fascia</td>
<td>Cheek; orbicularis oculi near medial angle of eye</td>
<td>Buccal br. of facial n.</td>
<td>Levator of the cheek</td>
<td>Can be divided into rostral and caudal parts</td>
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<tr>
<td>Frontalis (37.1)</td>
<td>Base of born and intercornual protuberance</td>
<td>Upper eyelid and frontal region</td>
<td>Auriculopalpebral n. from facial n.</td>
<td>Levator of upper eyelid and medial angle of eye</td>
<td>Much reduced in other domestic mammals</td>
</tr>
</tbody>
</table>

*The retractor anguli oculi lat. is absent and the levator anguli oculi med. is replaced in the ox by the frontalis.*

**MUSCLES INNERVATED BY THE MANDIBULAR NERVE (p. 38)**

**SUPERFICIAL MUSCLES OF THE INTERMANDIBULAR REGION**

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<tr>
<td>Digastricus (39.31)</td>
<td>Tendinous on paracoridylar process</td>
<td>Medially on vent. border of mandible rostral to vascular groove</td>
<td>Caud. belly; digastric br. of facial n.; rostral belly; mylohyoid n. from mandib. n.</td>
<td>Opens the mouth</td>
<td>Two bellies not distinctly divided; connected to contralat. m. by fibers on lingual proc. of hyoid bone</td>
</tr>
<tr>
<td>Mylohyoideus (39.25)</td>
<td>Rostr al part from angel of chin to first cheek tooth; caud. part from 3rd to beyond last cheek tooth</td>
<td>Lingual proc. of hyoid bone</td>
<td>Mylohyoid n. from mandib. nerve</td>
<td>Raises the floor of the mouth and elevates the tongue against the palate</td>
<td>The two parts have different fiber directions</td>
</tr>
</tbody>
</table>

**LATERAL MUSCLES OF MASTICATION**

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>TERMINATION</th>
<th>INNERVATION</th>
<th>FUNCTION</th>
<th>REMARKS</th>
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</thead>
<tbody>
<tr>
<td>Temporalis (39.17)</td>
<td>Temporal fossa</td>
<td>Coronoid proc. of mandible</td>
<td>Deep temporal nn. from masticatory n. from mandibular n.</td>
<td>Masticatory m.; raises and presses mandible to maxilla, closing the mouth</td>
<td>Relatively poorly developed</td>
</tr>
<tr>
<td>Masseter (39.13)</td>
<td>Facial tuber</td>
<td>Angle and caud. border of mandible</td>
<td>Masseteric n. from masticatory n. from mandibular n.</td>
<td>Masticatory m.; raises and presses mandible to maxilla; closes the mouth; unilat. contraction pulls mandible laterally</td>
<td>Very tendinous</td>
</tr>
<tr>
<td>Supf. Part</td>
<td>Facial crest; zygomatic arch</td>
<td>Lat. surface of ramus of mandible</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Deep part</td>
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**MEDIAL MUSCLES OF MASTICATION**

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>TERMINATION</th>
<th>INNERVATION</th>
<th>FUNCTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pterygoideus (39.22)</td>
<td>Pterygoid bone and surroundings</td>
<td>Pterygoid fossa medial on ramus of mandible; condylar proc. of mandible</td>
<td>Pterygoid nn. from mandibular n.</td>
<td>Synergists of masseter; unilateral contraction pulls mandible laterally</td>
<td>Br. of mandibular n. pass between pterygoid mm.</td>
</tr>
<tr>
<td>—medialis</td>
<td></td>
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</tr>
<tr>
<td>—lateralis</td>
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</tr>
<tr>
<td>MUSCLE / FIG.</td>
<td>ORIGIN</td>
<td>TERMINATION</td>
<td>INNERVATION</td>
<td>FUNCTION</td>
<td>REMARKS</td>
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<tr>
<td><strong>EYE MUSCLES:</strong> (See pp. 40, 41)</td>
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</tr>
<tr>
<td><strong>PHARYNGEAL MUSCLES (p. 46)</strong></td>
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</tr>
<tr>
<td>Stylopharyngeus caudalis (47.15)</td>
<td>Medially on prox. half of stylohyoid</td>
<td>Mainly on thyroid cart.; dorsolat. wall of pharynx</td>
<td>Glossopharyngeal n.</td>
<td>Only dilator of pharynx; elevator of larynx</td>
<td></td>
</tr>
<tr>
<td><strong>MUSCLES OF THE SOFT PALATE (p. 46)</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Tensor veli palatini (47.11)</td>
<td>Muscular proc. of tympanic part of temporal bone, hamulus of pterygoid bone</td>
<td>Tendinous on soft palate, laterally on auditory tube</td>
<td>Mandibular n.</td>
<td>Tensor of soft palate, dilator of auditory tube</td>
<td></td>
</tr>
<tr>
<td>Levator veli palatini (47.12)</td>
<td>Muscular proc. of tympanic part of temporal bone; laterally on auditory tube</td>
<td>Soft palate</td>
<td>Pharyngeal plexus (IX, X)</td>
<td>Levator of soft palate</td>
<td></td>
</tr>
<tr>
<td>Palatinus</td>
<td>Choanal border of palatine bones</td>
<td>Soft palate</td>
<td>Pharyngeal plexus (IX, X)</td>
<td>Shortens the soft palate</td>
<td>A small strand of muscle (m. uvulae) is present near the palatine arch</td>
</tr>
<tr>
<td><strong>ROSTRAL PHARYNGEAL CONSTRUCTORS (p. 46)</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Stylopharyngeus rostralis</td>
<td>Mediodistal half of stylohyoid</td>
<td>Pharyngeal raphe</td>
<td>Pharyngeal plexus (IX, X)</td>
<td>Constrictor of pharynx</td>
<td>Regularly present</td>
</tr>
<tr>
<td>Pterygopharyngeus (47.13)</td>
<td>Pterygoid bone and palate aponeurosis</td>
<td>Pharyngeal raphe</td>
<td>Pharyngeal plexus (IX, X)</td>
<td>Constrictor and protractor of pharynx</td>
<td></td>
</tr>
<tr>
<td><strong>MIDDLE PHARYNGEAL CONSTRUCTOR (p. 46)</strong></td>
<td></td>
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<tr>
<td>Hyopharyngeus (47.16)</td>
<td>Thyrohyoid, ceratobryoid, and stylohyoid</td>
<td>Pharyngeal raphe</td>
<td>Pharyngeal plexus (IX, X)</td>
<td>Constrictor of pharynx</td>
<td></td>
</tr>
<tr>
<td><strong>CAUDAL PHARYNGEAL CONSTRUCTORS (p. 46)</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Thyropharyngeus (47.17)</td>
<td>Thyroid cartilage</td>
<td>Pharyngeal raphe</td>
<td>Pharyngeal plexus (IX, X)</td>
<td>Constrictor of pharynx</td>
<td></td>
</tr>
<tr>
<td>Cricopharyngeus (47.18)</td>
<td>Cricoid cartilage</td>
<td>Pharyngeal raphe</td>
<td>Pharyngeal plexus (IX, X)</td>
<td>Constrictor of pharynx</td>
<td></td>
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<tr>
<td><strong>LARYNGEAL MUSCLES (Intrinsic muscles of the larynx, p. 46)</strong></td>
<td></td>
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</tr>
<tr>
<td>Cricothyroides</td>
<td>Ventrolaterally on cricoid arch</td>
<td>Caudally on thyroid cartilage</td>
<td>Cran. laryngeal n. (X)</td>
<td>Narrows rima glottidis, tenses vocal cords</td>
<td></td>
</tr>
<tr>
<td>Cricoarytenoideus dorsalis (47.9)</td>
<td>Dorsolaterally on cricoid lamina</td>
<td>Muscular proc. of arytenoid cartilage</td>
<td>Caud. laryngeal n. (X)</td>
<td>Widens rima glottidis</td>
<td></td>
</tr>
<tr>
<td>Cricoarytenoideus lateralis (47.7)</td>
<td>Cranilaterally on cricoid arch</td>
<td>Muscular proc. of arytenoid cartilage</td>
<td>Caud. laryngeal n. (X)</td>
<td>Narrows rima glottidis</td>
<td></td>
</tr>
<tr>
<td>Arytenoideus transversus (47.6)</td>
<td>Arcuate crest rostral to muscular proc. of both arytenoid cartilages</td>
<td></td>
<td>Caud. laryngeal n. (X)</td>
<td>Narrows cartilaginous rima glottidis</td>
<td>Unpaired muscle with a dorsomedian raphe</td>
</tr>
<tr>
<td>Thyroarytenoideus (47.8)</td>
<td>Thyroid cart., base of epiglottis, cricothyroid lig.</td>
<td>Muscular and vocal proc. of arytenoid cartilage</td>
<td>Caud. Laryngeal n. (X)</td>
<td>Narrows rima glottidis</td>
<td>Not divided into ventricularis and vocalis</td>
</tr>
<tr>
<td><strong>MUSCLES OF THE TONGUE AND HYOID (radiate from the basihyoid into the tongue, p. 45)</strong></td>
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<tr>
<td>Lingualis proprius (45.1)</td>
<td>Intrinsic muscle of tongue</td>
<td>Hypoglossal n.</td>
<td>Changes shape of tongue</td>
<td>Longitudinal, transverse, and perpendicular fibers</td>
<td></td>
</tr>
<tr>
<td>MUSCLE / FIG.</td>
<td>ORIGIN</td>
<td>TERMINATION</td>
<td>INNERVATION</td>
<td>FUNCTION</td>
<td>REMARKS</td>
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</tr>
<tr>
<td><strong>EXTRINSIC MUSCLES OF TONGUE (pp. 45, 47)</strong></td>
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<tr>
<td>Styloglossus (47.n)</td>
<td>Stylohyoid</td>
<td>Apex of tongue (streaming in from each side)</td>
<td>Hypoglossal n.</td>
<td>Draws tongue caudodorsally; Unilat. contraction draws it lat.</td>
<td></td>
</tr>
<tr>
<td>Hyoglossus (47.n)</td>
<td>Basihyoid, lingual proc., thyrohyoid</td>
<td>Tongue, dorso-median to apex</td>
<td>Hypoglossal n.</td>
<td>Draws tongue caudoventrally</td>
<td></td>
</tr>
<tr>
<td>Genioglossus</td>
<td>Medially on mandible in angle of chin</td>
<td>Tongue, back to hyoid bone</td>
<td>Hypoglossal n.</td>
<td>Draws tongue rostroventrally</td>
<td>Lingual septum divides right and left mm.</td>
</tr>
<tr>
<td><strong>MUSCLES OF HYOID APPARATUS</strong></td>
<td></td>
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</tr>
<tr>
<td>M. geniohyoideus</td>
<td>Incisive part of mandible</td>
<td>Lingual process of basihyoid</td>
<td>Hypoglossal n.</td>
<td>Draws hyoid apparatus (and tongue) rostrally</td>
<td></td>
</tr>
<tr>
<td>M. thyrohyoideus</td>
<td>Thyroid cartilage</td>
<td>Thyrohyoid bone</td>
<td>Hypoglossal n.</td>
<td>Draws larynx and thyrohyoid toward each other</td>
<td></td>
</tr>
<tr>
<td>Mylohyoideus</td>
<td>Tendinous, from angle of stylohyoid</td>
<td>Fleshy on thyrohyoid</td>
<td>Facial n.</td>
<td>Draws hyoid bone and larynx caudodorsally</td>
<td>The termination is not perforated by digastricus</td>
</tr>
<tr>
<td>Occipitisohyoides</td>
<td>Paracodylar process</td>
<td>Caudodorsal end of stylohyoid</td>
<td>Facial n.</td>
<td>Lowers root of tongue and larynx</td>
<td></td>
</tr>
<tr>
<td>Hyoideus transversus</td>
<td>Ceratohyoid</td>
<td>On median raphe, joined to contralateral muscle</td>
<td>Glossopharyngeal n.</td>
<td>Levator of root of tongue</td>
<td></td>
</tr>
<tr>
<td>Ceratothyoideus</td>
<td>Ceratohyoid, epiphyoid, and vent. end of stylohyoid</td>
<td>Thyrohyoid</td>
<td>Glossopharyngeal n.</td>
<td>Raises thyrohyoid, drawing larynx rostroventrally</td>
<td>Fills triangle between cerato- and thyrohyoid</td>
</tr>
<tr>
<td>Hyoepiglotticus (45.o)</td>
<td>Basihyoid</td>
<td>Rostral surface of base of epiglottis</td>
<td>Hypoglossal n.</td>
<td>Draws epiglottis rostroventrally</td>
<td></td>
</tr>
<tr>
<td><strong>LONG HYOID MUSCLES (p. 60)</strong></td>
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<td></td>
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<tr>
<td>Sternothyroideus (61.15)</td>
<td>Manubrium sterni</td>
<td>Laterally on thyroid cartilage</td>
<td>Medial br. of vent. br. of C1</td>
<td>Synergist of sternothyroideus and retracts thyroid cart.</td>
<td>Sternothyroideus and -hyoideus have no tendinous intersection, unlike the horse, but are joined in the middle of the neck</td>
</tr>
<tr>
<td>Sternohyoideus (61.14)</td>
<td>Manubrium sterni</td>
<td>Basihyoid</td>
<td>Medial br. of vent. br. of C1</td>
<td>Retractor of hyoid bone and tongue</td>
<td>Thin in the ox; fused with sternothyroideus deep to mandibular gland</td>
</tr>
<tr>
<td>Omohyoideus (61.13)</td>
<td>Indirectly by deep cervical fascia from 3rd (4th) cervical vertebra</td>
<td>Basihyoid</td>
<td>Medial br. of vent. br. of C1</td>
<td>Synergist of sternothyroideus</td>
<td></td>
</tr>
<tr>
<td><strong>CUTANEOUS MUSCLES (pp. 37, 60, 66)</strong></td>
<td></td>
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<tr>
<td>Platysma:</td>
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</tr>
<tr>
<td>Cutaneus faciei (37.A)</td>
<td>From supf. fascia of laryngeal region</td>
<td>Angle of mouth</td>
<td>Auriculopalpebral n. (VII)</td>
<td>Tenses and moves skin of face; retracts angle of mouth</td>
<td></td>
</tr>
<tr>
<td>Cutaneus coli</td>
<td>Ventrally on supf. fascia of the neck</td>
<td>Directed cranially to skin</td>
<td>Auriculopalpebral n. (VII)</td>
<td>Tenses and moves skin of ventral neck</td>
<td>Thin and often not demonstrable in the ox</td>
</tr>
<tr>
<td>MUSCLE / FIG.</td>
<td>ORIGIN</td>
<td>TERMINATION</td>
<td>INNERVATION</td>
<td>FUNCTION</td>
<td>REMARKS</td>
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</tr>
<tr>
<td>Cutaneus trunci</td>
<td>Supr. fascia of trunk and thigh on a line from withers to fold of flank; minor tubercle of humerus</td>
<td>Skin over ribs, hypochondrium, and lower flank</td>
<td>Lat. thoracic n.</td>
<td>Tenses and moves skin of the trunk</td>
<td>Joined to omohyoid muscle along a line from fold of flank to dorsal third of last rib. Vent. border covers milk vein</td>
</tr>
<tr>
<td>Cutaneus omobrachialis</td>
<td>Supr. fascia of scapular and brachial regions</td>
<td>Skin of scapular and brachial regions</td>
<td>Lat. thoracic n.</td>
<td>Tenses and moves skin of scapular and brachial regions</td>
<td>Thin; partly without connection to cutaneus trunci</td>
</tr>
<tr>
<td>Preputialis cranialis</td>
<td>Xiphoid proc. with a portion from ventral border of cutaneus trunci</td>
<td>On the prepuce</td>
<td>Vent. brr. of last thoracic and 1st lumbar nn.</td>
<td>Protractor of the prepuce</td>
<td>Paired; forms with contralat. m. a loop around caud. border of preputial orifice</td>
</tr>
<tr>
<td>Preputialis caudalis</td>
<td>Fascia lateral and medial to vaginal tunic</td>
<td>On the internal lamina of the prepuce</td>
<td>Vent. brr. of last thoracic and 1st lumbar nn.</td>
<td>Retractor of internal lamina of prepuce</td>
<td>Paired; absent in polled breeds</td>
</tr>
</tbody>
</table>

**VERTEBRAL COLUMN MUSCULATURE:**

(A) Dorsal (epaxial) vertebral column muscles (pp. 61, 63, 87)

<table>
<thead>
<tr>
<th>Spleenius (61.k)</th>
<th>Spinosus proc. of T1–T3 (4); thoraco-lumbar fascia</th>
<th>Dorsal brr. of corresponding spinal nn.</th>
<th>Extension, elevation, and lat. flexion of head and neck</th>
</tr>
</thead>
<tbody>
<tr>
<td>—capitis</td>
<td>Dorsolat. on occipital bone</td>
<td>Fixation of loin and ribs; extends vert. column and bends it laterally; assists in expiration</td>
<td></td>
</tr>
<tr>
<td>—cervicis</td>
<td>Wing of atlas and transverse proc. of axis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Iliocostalis | Fixation and extension of vert. column; raises cranial part of trunk; raises neck and head; unilat. contraction bends neck |
| --- | --- | --- | --- |
| —cervicis (61.o) | Ends as continuation of iliocostalis thoracis on transverse process of C7 | Dorsal brr. of corresponding spinal nn. |
| —thoracis (61.o') | Transv. proc. of L1–L4, mainly on L3. | Angles of ribs and transverse proc. of thoracic vertebrae |
| —lumborum (61.o'') | Tendinous from iliac crest | Caud. border of last rib and transverse proc. of thoracic vertebrae |

| M. longissimus | Fixation and extension of vert. column; raises cranial part of trunk; raises neck and head; unilat. contraction bends neck |
| --- | --- | --- | --- |
| —atlantis et capitis (61.n) | Artic. proc. of C3–T2 | Wing of atlas, mastoid proc. of temporal bone, temporal line |
| —cervicis (61.n') | Transv. proc. of first 6–7 thor. vertt. | Transv. proc. of last 4 cervical vertebrae |
| —thoracis (61.n’’') | Spinosus proc. of last thor. vertt. | Transv. proc. of C7 (6); vert. ends of ribs; transv. proc. of thor. and lumbar vertt.; articular and mamillary proc. of lumbar vertebrae |
| —lumborum (61.n’’’') | Lumbar, and sacral vertt.; iliac crest, and tuber coxae |

<table>
<thead>
<tr>
<th>Semispinalis capitis (61.l)</th>
<th>Transv. proc. of T1–T8 (9); artic. proc. of C3–C7; lig. nuchae</th>
<th>Occipital bone; laterally on lig. nuchae</th>
<th>Dorsal brr. of corresponding spinal nerves</th>
<th>Lifting and lat. bending of head and neck. Has great active role in the horn thrust</th>
</tr>
</thead>
<tbody>
<tr>
<td>—capitis</td>
<td>Ligament of nuchae</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**NOTES:**

- The text refers to various muscles and their functions, origins, and terminations in relation to the vertebral column and other anatomical structures.
- The remarks section provides additional context and observations about the muscles, such as their involvement in specific movements or their relationship to other muscles and anatomical features.
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<tr>
<th>MUSCLE / FIG.</th>
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<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinalis et semi-spinalis thoracis et cervicis (61.m)</td>
<td>Spino. procc. of L1 and T (10) 11–T13; supraspinous lig.; transp. procc. of T9–T12 (semi-spinalis part); spinous procc. of T1</td>
<td>Spino. procc. of T1–T6 and C4–C7</td>
<td>Dorsal brr. of corresponding spinal nerves</td>
<td>Fixation of back and neck; raising and lat. bending of neck; synergist of longissimus</td>
<td>Fleshly semi-spinalis part is present; it lies on longissimus thoracis from T5–T13 like a cap</td>
</tr>
<tr>
<td>Multifidus</td>
<td>—cervicis</td>
<td>Artic. procc. of C(3) 4–C7</td>
<td>Spino. procc. of the more cran. vertebrae, including axis</td>
<td>Dorsal brr. of corresponding spinal nerves</td>
<td>Fixes and rotates vert. column; raises neck and bends it laterally</td>
</tr>
<tr>
<td></td>
<td>—thoracis</td>
<td>Transv. prod. of T1; mamillary and artic. procc. of last thoracic and lumbar vert.</td>
<td></td>
<td></td>
<td>The fiber bundles cross over as many as 5 vertebrae</td>
</tr>
<tr>
<td></td>
<td>—lumborum</td>
<td>Sacrum; Cd1</td>
<td>L5 and L6</td>
<td></td>
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<tr>
<td><em>Interspinales</em>: In the ox they are muscular only in the neck. In thoracic and lumbar regions they are replaced by interspinal ligaments.</td>
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<tr>
<td>Intertransversarii (87.h)</td>
<td>Artic. procc. of C3–C7 and cran. artic. proc. of T1; transv. procc. of all lumbar and caud. vertebrae</td>
<td>Transv. procc. of C2–C7; transverse procc. and costal tubercles of preceding segments; lumbar segments end on prox. end of last rib; caud. segments on caud. transv. processes</td>
<td>Dorsal and ventral brr. of corresponding spinal nn.</td>
<td>Fixation and lateral bending of vertebral column</td>
<td>Ventrolat. bundles in neck form intertransversarius longus cervicis, dorsolat. to longus capitis and ending on wing of atlas</td>
</tr>
<tr>
<td>Sacrocaudalis</td>
<td>Between spinous and mamillary procc. of 2–3 last sacral and first caudal vertebrae</td>
<td>Dorsal brr. of corresponding spinal nerves</td>
<td>Raises tail and bends it laterally</td>
<td></td>
<td>Considered the caudal continuation of the multifidus</td>
</tr>
<tr>
<td><em>—coccygeus</em> dorsalis medialis (87.e)</td>
<td>Laterally on the sacrum and transv. procc. of 1st caudal vertebrae</td>
<td>Tendinous on 5th to last caudal vertebrae</td>
<td>Dorsal brr. of corresponding spinal nerves</td>
<td>Raises tail and bends it laterally</td>
<td>Caudal continuation of longissimus</td>
</tr>
<tr>
<td><em>—coccygeus</em> dorsalis lateralis (87.f)</td>
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</tbody>
</table>

**B) Ventral vertebral column muscles (pp. 47, 61, 87)**

### Scaleni

<p>| Scalenes dorsalis (61.p) | Ribs (2) 3–4 | Transv. procc. of C4–C6 | Ventral brr. of spinal nn. | When neck is fixed, levator of first ribs; when ribs are fixed, draws neck ventrally or bends it laterally | More supf. than dorsal; absent in horse |
| Scalenus medius | Cran. border of first rib | Transv. procc. of C4–C7 | Draws neck laterally | Dorsal to brachial plexus |
| Scalenus ventralis (61.p) | Cran. border of first rib | Transv. procc. of C3–C7 | Bends neck laterally | Ventral to brachial plexus; is very robust |
| Longus capitis (61.h) | Transv. procc. of C2–C6 | Muscular tubercle on base of skull | Ventral brr. of spinal nn. | Flexes head and neck and bends them laterally | Thin triangular muscle |
| Longus colli | Cervical part: transv. procc. and bodies of C3–C7. Thoracic part: bodies and transv. procc. of C6–C7; bodies of T1–T6 | Ventral crest of more cran. vertebrae and vent. tubercle of atlas | Ventral brr. of spinal nn. | Flexor of the neck | Relatively thick; fiber bundles often cross over one segment |</p>
<table>
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<tr>
<th>MUSCLE / FIG.</th>
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<tbody>
<tr>
<td>Sacrocaudalis [—coccygeus] ventralis</td>
<td>Last sacral segment to end of tail (ventral on caud. vertebrae)</td>
<td>Second following hemal proc.</td>
<td>Ventral br. of spinal nn.</td>
<td>Draws tail ventrally; unilateral action draws tail lat.</td>
<td>Connected with terminal tendons of sacrocaudalis vent. lateralis</td>
</tr>
<tr>
<td>—medialis (95.l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Thicker than the med. muscle</td>
</tr>
<tr>
<td>—lateralis (95.k)</td>
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<td></td>
</tr>
<tr>
<td>Rectus capitis ventralis</td>
<td>Ventral arch of atlas</td>
<td>Base of skull, caud. to longus capitis</td>
<td>Ventral br. of 1st spinal n.</td>
<td>Flexor of the atlanto-occipital joint</td>
<td>More robust than in other domestic animals</td>
</tr>
<tr>
<td>Rectus capitis lateralis</td>
<td>Ventral arch and vent. surf. of wing of atlas</td>
<td>Paracondylar process</td>
<td>Ventral br. of 1st spinal n.</td>
<td>Flexor of the atlanto-occipital joint; rotates head</td>
<td>Relatively weak and covered by rectus capitis ventralis</td>
</tr>
</tbody>
</table>

**C) DORSAL MUSCLES ACTING ON THE HEAD**

| Rectus capitis dorsalis major | Spinal process of axis | Occipital bone, medial to obliquus cap. cran. | Dorsal br. of C1 | Levator of the head |
| Rectus capitis dorsalis minor | Dorsal arch of atlas | Occipital bone dorsal to foramen magnum | Dorsal br. of C1 | Levator of the head | More robust than in carniveres |
| Obliquus capitis cranialis | Cran. border of wing of atlas and atlantal fossa | Occipital squama, base of jugular proc. | Dorsal br. of C1 | Extensor and rotator of head |
| Obliquus capitis caudalis | Spinal process and cd. artic. proc. of axis | Cran. border of wing of atlas | Dorsal br. of C2 | Rotator of atlas around dens of axis | Very robust |

**DORSAL TRUNK-LIMB MUSCLES (p. 60)**

| Trapezius | Dorsally on funiculus nuchae and supraspinous lig. from C1–T12 | Spine of scapula | Dorsal br. of accessory n. | Fixation of scapula, protractor and abductor of limb | Well developed; cervical and thoracic parts separated by tendinous strip on scapular spine |
| Omotransversarius (61.8) | Acromion; brachial fascia | Wing of atlas (partly also transverse proc. of axis) | Medial br. of vent. brr. of cervical nn. | Flexor of limb and lat. flexor of neck | Sufp. cervical ln. lies deep to omotransversarius and cleido-brachialis |
| Rhomboideus —cervicis (61.28) | Dorsomedian on funiculus nuchae and supraspinous lig. from C2–T8 | Medially on scapular cartilage | Med. br. of vent. brr. of cervical nn. of thoracic nn. | Fixes, raises, and retracts the limb; raises neck | The rhomboideus capitis is absent as in the horse |
| —thoracis (61.28') | | | | | |
| Latissimus dorsi (61.12) | Thoracolumbar fascia; ribs 11 and 12 | Teres major tuberosity and deep pectoral, coracobrachialis, and long head of triceps | Thoracodorsal nerve | Retractor of limb, flexor of shoulder joint, protractor of trunk when limb is fixed | Relatively thin; course over the caud. angle of scapula fixes scapula on thoracic wall |

**VENTRAL TRUNK-LIMB MUSCLES (p. 60)**

<p>| Pectorales superficialis | Cran. and caud. pectoral nerves | Connect limb to trunk; adductors, protractors, and retractors of limb | | Thinner than in horse; the two muscles are less distinct |
| Pectoralis transversus (61.25') | 1st to 6th costal cartilage; ventrally on sternum | Antebrachial fascia, humerus | | |
| Pectoralis descendens (61.25) | Manubrium sterni | Crest of major tubercle of humerus and brachial fascia | | |</p>
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<tr>
<td>Pectoralis profundus [Pectoralis ascendens] (61.26)</td>
<td>Sternum from 2nd rib caudally and sternal costal cartilages; tunica flava</td>
<td>Major and minor tubercles of humerus; coracoid proc. of scapula</td>
<td>Cran. and caud. pectoral nerves</td>
<td>Supports trunk; retracts limb; fixes shoulder joint</td>
<td>Unified; no accessory part like that of the dog; gives a flat muscular strap to the supraspinatus</td>
</tr>
<tr>
<td>Subclavius (61.26')</td>
<td>Cartilage of 1st rib</td>
<td>Clavicular intersection on deep surface of brachiocephalicus</td>
<td>Cran. pectoral nerves</td>
<td>Rudimentary</td>
<td></td>
</tr>
<tr>
<td>Serratus ventralis</td>
<td>—cervicis (61.27)</td>
<td>Transverse proc. of C3/4–C7</td>
<td>Cranially on facies serrata of scapula</td>
<td>Med. brr. of vent. brr. of cervical nn.</td>
<td>Most important supporter of trunk, raises neck when limb is fixed, auxiliary inspiratory muscle</td>
</tr>
<tr>
<td></td>
<td>—thoracis (61.27')</td>
<td>Ribs 1 to 7, 8, or 9</td>
<td>Caudally on facies serrata; subscapular fossa</td>
<td>Long thoracic nerve</td>
<td>Digitations of origin markedly tendinous</td>
</tr>
<tr>
<td>Sternomandibularis</td>
<td>Manubrium sterni and 1st rib</td>
<td>Rostral border of masseter, mandible, and depressor labii inferioris</td>
<td>Ventral br. of accessory n.</td>
<td>Opens mouth; fixes mandible and pharynx in swallowing</td>
<td></td>
</tr>
<tr>
<td>Sterno-mastoideus (61.5)</td>
<td>Manubrium sterni</td>
<td>Mastoid proc. of temporal bone; with cleidomastoideus and longus capitis, on muscular tubercle of occipital bone</td>
<td>Ventral br. of accessory n.</td>
<td>Fixes and draws head and neck ventrally</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sterno-mastoideus (61.4)</td>
<td>Manubrium sterni</td>
<td>Mastoid proc. of temporal bone; and, with sternomastoideus and longus capitis, on muscular tubercle of occipital bone</td>
<td>Ventral br. of accessory n.</td>
<td>Protractor of limb; draws head ventrally or laterally</td>
</tr>
<tr>
<td></td>
<td>Cleido-occipitalis (61.6)</td>
<td>Clavicular intersection</td>
<td>Mastoid proc. of temporal bone; and, with sternomastoideus and longus capitis, on muscular tubercle of occipital bone</td>
<td>Ventral br. of accessory n.</td>
<td>Joins cleidooccipitalis in the middle of neck to form cleidocephalicus which joins the cleidobrachialis (p. 4)</td>
</tr>
<tr>
<td></td>
<td>Cleido-occipitalis (61.7)</td>
<td>Clavicular intersection</td>
<td>Funiculus nuchae and occipital bone</td>
<td>Dorsal br. of accessory n.</td>
<td>Protractor of limb, raises head</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Adjoins cranial border of trapezius</td>
</tr>
</tbody>
</table>

**EXPIRATORY MUSCLES (pp. 61, 63, 67)**
Compress thorax by drawing ribs mediocaudally

| Serratus dorsalis caudalis (61.r') | Thoracolumbar fascia | Caud. border of ribs 10–13 | Intercostal nerves | Expirator | Interdigitates with ext. abd. obl. and ext. intercostal mm. |
| Intercostales interni (67.d) | Fiber bundles run cranioventrally in intercostal spaces | Caudal border of ribs 10-13 | Intercostal nerves | Expirators |
| Retractor costae | Transverse processes of L1–L3 | Caud. border of last rib | Intercostal nerves | Expirator |
| Transversus thoracis (63.v) | Costal cartilages 2–7 | Sternebrae 2–7; 8th costal cartilage | Intercostal nerves | Expirator | Right and left halves separated on median line |

**INSPIRATORY MUSCLES (pp. 61, 63, 67)**
Expand thorax by drawing ribs cranio laterally

<p>| Serratus dorsalis cranialis (61.t) | Supraspinous ligament | Cran. border of ribs 5–9 | Intercostal nerves | Inspirator | Weak |
| Rectus thoracis (67.e) | First rib | Costal cartilages 2–4 (6) | Intercostal nerves | Inspirator |</p>
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<tbody>
<tr>
<td><strong>Intercostales externi</strong> (61.e)</td>
<td>Fiber bundles run caudoventrally in intercostal spaces</td>
<td></td>
<td>Intercostal nerves</td>
<td>Inspirators</td>
<td>Very tendinous fiber tracts; pass into ext. abd. obl. near the last ribs</td>
</tr>
<tr>
<td><strong>Levatores costarum</strong> (63.2–63.5)</td>
<td>Transverse and mamillary proc. of T1–T12</td>
<td>Cran. border of next rib</td>
<td>Dorsal brr. of thoracic nn.</td>
<td>Inspirators</td>
<td>10–12 muscles; same fiber direction as ext. intercostals</td>
</tr>
<tr>
<td><strong>Diaphragm</strong></td>
<td></td>
<td></td>
<td>Phrenic n.</td>
<td>Inspirator; main respiratory muscle</td>
<td></td>
</tr>
<tr>
<td>Costal part (63.3)</td>
<td>From knee of 8th rib, across the middle of 11th to ventral end of 12th rib</td>
<td></td>
<td>Tendinous center</td>
<td></td>
<td>More steeply inclined than in other dom. Mammals</td>
</tr>
<tr>
<td>Sternal part</td>
<td>Xiphoid process</td>
<td></td>
<td>Tendinous center</td>
<td></td>
<td>Clearly divided from the costal part</td>
</tr>
<tr>
<td>Lumbar part (63.2)</td>
<td>Ventral surfaces of L1–3 (4)</td>
<td></td>
<td>Tendinous center</td>
<td></td>
<td>Forms right and left crura of diaphragm</td>
</tr>
</tbody>
</table>

*The subcostales are not present in the ox.*

**ABDOMINAL MUSCLES** (p. 66)

| External abdominal oblique (67.2) | Costal part: ribs (4) 5–13 along vent. border of latissimus dorsi. | Abdominal tendon: linea alba and prepubic tendon. Pelvic tendon: tuber coxae, inguinal lig., and prepubic tendon | Vent. brr. of corresponding intercostal and lumbar nn. | As a whole: contractile sling adaptable to weight and volume of abd. organs; reinforced by strong tunica flava of abdomen | Inguinal canal: abd. and pelvic tendons bound ext. ing. ring; pelvic tend. is caud. border of deep ring Sheath of rectus: abdominal tendon is in ext. lamina |

| Internal abdominal oblique (67.10) | Thoracolumbar fascia; transverse proc. of lumbar vertebrae, tuber coxae, inguinal ligament | Linea alba and last rib | Vent. brr. of corresponding intercostal and lumbar nn. | Abd. press in urination, defecation, and parturition, with inspiratory position of diaphragm fixed by closed glottis. Flexion of vert. column by rectus abdominis. Auxillary exspirators; straight strapping: rectus and transversus; oblique strapping: ext. and int. abd. obl. | Inguinal canal: cran. border of deep ring; Sheath of rectus: aponoeurous is only in ext. lamina. Costochoondral crus is caudovent. border of paralumbar fossa Sheath of rectus: int. lamina is formed by transversus alone |

| Transversus abdominis (67.7) | Costal part: last 7–8 costal cartilages; Lumbar part: transverse process of lumbar vertebrae | Linea alba | Vent. brr. of corresponding intercostal and lumbar nn. | | |

| Rectus abdominis (67.6) | Fourth to ninth costal cartilages | Prepubic tendon, symphyseal tendon and symphyseal crest | Vent. brr. of corresponding intercostal and lumbar nn. | | Has 5 tendinous intersections; near the 2nd is the "milk well" where the subcutaneous abd. v. perforates the abd. wall to int. thoracic v. |

**INTERNAL LUMBAR MUSCLES** (p. 81)

<p>| Quadratus lumborum (81.g) | Proxovoentral on last rib; T10–T13 and transv. proc. of lumbar vertebrae | Ventrally on wing of sacrum | Vent. brr. of intercostal and lumbar nn.; lumbar plexus | Stiffens lumbar vert. column and arches it dorsally | All 4 internal lumbar mm. show about the same relations as in horse; very tendinous |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Psoas major (81.e)</td>
<td>Fleshy on cran. border of last rib; body and transverse processes of all lumbar vertebrae</td>
<td>The iliacus and psoas major end together as the iliopsoas on minor trochanter of femur</td>
<td>Vent. br. of intercostal and lumbar nn.; lumbar plexus</td>
<td>Protractor of pelvic limb; flexor and supinator of hip joint; stabilizer of vertebral column when limb is fixed</td>
<td>The iliopsoas and psoas minor form the tendon in (filet)</td>
</tr>
<tr>
<td>Iliacus (81.f)</td>
<td>Ventrally from body of L6; ventral surface of wing of ilium; wing of sacrum; tendon of psoas minor</td>
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<tr>
<td>Psoas minor (81.d)</td>
<td>T12–T13, L1, and crura of diaphragm</td>
<td>Psoas minor tubercle of ilium</td>
<td>Vent. br. of intercostal and lumbar nn.; lumbar plexus</td>
<td>Rotates pelvis forward at sacroiliac joint when vert. col. is fixed; stabilizes and arches lumbar vertebral column when pelvis is fixed</td>
<td>Strong tendon at termination</td>
</tr>
<tr>
<td>PERINEAL MUSCLES (p. 94)</td>
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<tr>
<td>Levator ani (95.3)</td>
<td>Spine of ischium and med. surface of sacrotrochlear lig.</td>
<td>External anal sphincter, caudal fascia</td>
<td>Pudendal and caud. rectal nn. from vent. br. of sacral nerves</td>
<td>Holds anus against contraction of rectum; aids coccygeus</td>
<td></td>
</tr>
<tr>
<td>Coccygeus (95.2)</td>
<td>Spine of ischium and med. surface of sacrotrochlear lig.</td>
<td>Transv. proc. of first 3 caud. vertebrae</td>
<td>Pudendal and caud. rectal nn. from vent. br. of sacral nerves</td>
<td>Unilat. contr. draws tail laterally; bilat. contr. draws tail ventrally</td>
<td></td>
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<tr>
<td>Muscles of anal region</td>
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<tr>
<td>External anal sphincter (95.12)</td>
<td>Fiber bundles completely encircle anus, cross ventral to anus in perineal body, and continue in constrictor vulvae</td>
<td></td>
<td>Pudendal and caud. rectal nn. from vent. br. of sacral nerves</td>
<td>Closes the anus</td>
<td>Voluntary striated muscle</td>
</tr>
<tr>
<td>Internal anal sphincter</td>
<td>Thickened annular muscle layer of rectum</td>
<td>Caud. rectal nn.</td>
<td></td>
<td>Closes the anus</td>
<td>Involuntary smooth muscle</td>
</tr>
<tr>
<td>Rectococcygeus (95.11)</td>
<td>Continuation of dorsal longitudinal muscle of rectum</td>
<td>Ventromedian on caudal vertebrae 1–3</td>
<td>Caud. rectal nn. from vent. br. of sacral nn.</td>
<td>Supports and stabilizes anal canal and rectum</td>
<td>Smooth muscle. Ventral fibers of rectum cross in the perineal body and enter the labia and vestibule</td>
</tr>
<tr>
<td>Urogenital muscles (bull, p. 92; cow, p. 87)</td>
<td></td>
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</tr>
<tr>
<td>Bulbospongiosus (93.6)</td>
<td>Continuation of urethralis caud. to urogenital membrane; dorsal raphe</td>
<td>Tunica albuginea on sides of bulb of penis</td>
<td>Deep perineal n. from pudendal n. (S2–S4)</td>
<td>Forces the flow of urine, semen, and blood</td>
<td>Very thick; ca. 17 cm long from bulbourethral gll. to junction of crura penis</td>
</tr>
<tr>
<td>Constrictor vestibuli (87.m)</td>
<td>Vent. border of levator ani and fascia on levator</td>
<td>Tendons of rt. and left muscles join vent. to vestibule</td>
<td>Pudendal and caud. rectal nn. from vent. br. of sacral nerves</td>
<td>Narrows the vestibule of the vagina</td>
<td>Bilateral, embracing the vestibule</td>
</tr>
<tr>
<td>Constrictor vulvae (87.n)</td>
<td>External anal sphincter in perineal body</td>
<td>Subcut. in labia; fascia of semimembranosus</td>
<td>Caud. rectal nn. from vent. br. of S4–S5</td>
<td>Constricts vulva</td>
<td>Striated muscle of labia vulvae</td>
</tr>
<tr>
<td>Retractor penis (93.8)</td>
<td>Caud. vertebrae 1 and 2; rectum, ext. anal sphincter, levator ani</td>
<td>1. distal bend of sigmoid flexure 2. on tunica albuginea 15–20 cm. prox. to glans</td>
<td>Deep perineal n. and dorsal n. of penis from pudendal n.; caud. rectal n. from vent. br. of sacral nerves</td>
<td>Retracts penis by folding sigmoid flexure</td>
<td>Smooth muscle, paired</td>
</tr>
<tr>
<td>Retractor clitoridis (87.o)</td>
<td>Caud. vertebrae 2 and 3 or 3 and 4; rectum, ext. anal sphincter, levator ani</td>
<td>Body of clitoris, vestibule, fascia of semimembranosus</td>
<td>Pudendal and caud. rectal nn. from vent. br. of sacral nn.</td>
<td>Retracts clitoris</td>
<td>Smooth muscle, paired</td>
</tr>
<tr>
<td>Ischiocavernosus (93.7)</td>
<td>Medial surface of tuber ischiadicum</td>
<td>Body of penis or clitoris at junction of crura</td>
<td>Deep perineal n. from pudendal n. (vent. br. of S2–S4)</td>
<td>Rhythmic pumping of blood into corpus cavernosum in erection</td>
<td>Broad, paired muscle covering crura; rudimentary in the cow</td>
</tr>
</tbody>
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## 2. LYMPHATIC SYSTEM

### LYMPHOCENTER LOCATION AFFERENTS FROM EFFERENTS TO REMARKS

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<th>EFFERENTS TO</th>
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<tr>
<td>Parotid ln. (39.12)</td>
<td>Ventrolat. to temporoman-dib. jt.; between rostral border of parotid gl. and masseter</td>
<td>Skin and mm. of whole dors. part of head, skull bones, parotid gl.; ext. ear, eyelids, lacrimal app., rostral half of nasal cavity, hard palate, chin</td>
<td>Lat. retropharyngeal ln.</td>
<td>6–9 cm long. Regularly incised in meat inspection</td>
</tr>
<tr>
<td><strong>MANDIBULAR LYMPHOCENTER</strong> (p. 38)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mandibular ln. (39.10)</td>
<td>Ventr. to mandible midway between rostr. border of masseter and angle of mandible; covered by sternomandibularis</td>
<td>Skin of head, facial and masticatory mm., rostr. nasal cavity, oral and nasal mucosa, paranasal sinuses, tongue mm., pharynx, larynx, salivary gl.</td>
<td>Lat. retropharyngeal ln.</td>
<td>3–4.5 cm long, palpable. Regularly incised in meat inspection</td>
</tr>
<tr>
<td>Pterygoid ln.</td>
<td>On rostral border of ramus of mandible; med. to med. pterygoid m.</td>
<td>Hard palate</td>
<td>Mandibular ln.</td>
<td>Inconstant</td>
</tr>
<tr>
<td><strong>RETROPHARYNGEAL LYMPHOCENTER</strong> (p. 38)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lat. retropharyngeal ln. (39.11)</td>
<td>Under the wing of atlas; covered by dorsal end of mandib. gland</td>
<td>Skin of head-neck union, lips, salivary gl., buccal mucosa, mandib. mucosa in diastema, masticatory mm., tongue and parts of hyoid mm., mandible, part of thymus, nearby neck mm., ear mm.</td>
<td>The efferents join to form tracheal trunk</td>
<td>4–5 cm long, smooth, oval; palpable if enlarged; may be associated with 1–3 small ln. Regularly incised in meat inspection</td>
</tr>
<tr>
<td>Med. retropharyngeal ln. (49.a)</td>
<td>Between caudodors. wall of pharynx and longus capitis; med. to stylo-hyoides</td>
<td>Tongue, hyoid mm., oral mucosa, palate, tonsils, maxillary and palatine sinuses, mandible, caudal half of nasal cavity, larynx and pharynx, mandibular and sublingual gl., longus capitis</td>
<td>Lat. retropharyngeal ln.</td>
<td>3–6 cm long, oval, surrounded by fat; rarely double; palpable from pharynx. Regularly incised in meat inspection</td>
</tr>
<tr>
<td>Rostral hyoid ln.</td>
<td>Lat. to thyrohyoid</td>
<td>Apex of tongue</td>
<td>Lat. and med. retropharyngeal ln.</td>
<td>Inconstant; 1–1.5 cm in diameter</td>
</tr>
<tr>
<td>Caud. hyoid ln.</td>
<td>Lat. to angle of stylohyoid</td>
<td>Mandible</td>
<td>Lat. retropharyngeal ln.</td>
<td>Inconstant; 1–1.5 cm in diameter</td>
</tr>
<tr>
<td><strong>SUPERFICIAL CERVICAL LYMPHOCENTER</strong> (p. 60)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supf. cervical ln. (61.9 and 67.a)</td>
<td>In the groove cranial to supraspinatus above shoulder jt., covered by omotransversarius and clido-occipitalis</td>
<td>Skin of neck, thoracic limb, thoracic wall back to level of 12th rib. Shoulder girdle mm. and mm. dors. to scapula, antebrachial fasciae, manus</td>
<td>Left side: thoracic duct or left tracheal trunk. Rt. side: rt. tracheal trunk</td>
<td>7–9 cm long, 1–2 cm thick, palpable; Examined in suspected cases in meat inspection</td>
</tr>
<tr>
<td><strong>DEEP CERVICAL LYMPHOCENTER</strong> (p. 60)</td>
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</tr>
<tr>
<td>Deep cervical lnn.:</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cran. deep cerv. ln. (61.22)</td>
<td>From thyroid gl. to 7th tracheal ring</td>
<td>Ventr. cervical mm., flexors of neck, thyroid gl., larynx and pharynx, cervical trachea and esophagus, cervical thymus</td>
<td>Left side: thoracic duct or end of tracheal trunk, may go directly to angle between bifugular trunk and subclavian v. Right side: caud. part of right tracheal trunk</td>
<td>To be considered in suspected cases in meat inspection. 4–6 lnn., 1–2.5 cm each; rarely absent</td>
</tr>
<tr>
<td>Middle deep cerv. ln. (61.23)</td>
<td>In the middle 1/3 of neck, on the right of the trachea and on the left of esophagus</td>
<td></td>
<td></td>
<td>1–7 lnn., 0.5–3 cm long</td>
</tr>
<tr>
<td>Caud. deep cerv. ln. (61.24)</td>
<td>On the trachea just cran. to the 1st rib</td>
<td></td>
<td></td>
<td>2–4 separate lnn.</td>
</tr>
<tr>
<td>LYMPHOCENTER LOCATION AFFERENTS FROM EFFERENTS TO REMARKS</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-----------------------------------------------------------</td>
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</tr>
<tr>
<td>Costocervical ln. Cran. to costocerv. trunk craniomed. to 1st rib</td>
<td>Supraspinatus, infraspinatus, dors. shoulder girdle mm. extendors of neck and back, flexors of neck, omohyoides, pleura, trachea</td>
<td>Left side: thoracic duct and caud. deep cerv. ln. or cran. mediastinal ln. or angle between bif Jugular tr. and subclavian v. Right side: rt. tracheal trunk or vas efferens of supf. cerv. ln.</td>
<td>1.5–3 cm long, often merged with caud. deep cerv. ln. Adjoins common carotid a. ventrally, esophagus and trachea medially. To be considered in suspected cases in meat inspection</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AXILLARY LYMPHOCENTER (p. 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proper axillary ln. 6–10 cm caud. to shoulder jt. at level of 2nd intercostal space, med. to teres major</td>
</tr>
<tr>
<td>Axillary ln. of 1st rib On the lat. surface of the rib and 1st intercostal space; covered by the lat. part of deep pectoral m.</td>
</tr>
<tr>
<td>Accessory axillary ln. At the level of the 4th rib</td>
</tr>
<tr>
<td>Infraspinatus ln. On the caudal border of that m., covered by the cran. border of latissimus dorsi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DORSAL THORACIC LYMPHOCENTER (p. 62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic aortic lnn. (63.11) Dorsolat. to sorta and med. to sympathetic trunk. Right side: dorsal to thoracic duct. Left side: ventr. to left azygos v. (p. 65)</td>
</tr>
<tr>
<td>Intercostal lnn. (63.10) Subpleural at level of heads of the ribs, lat. to sympathetic trunk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VENTRAL THORACIC LYMPHOCENTER (p. 62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cran. sternal ln. (63.17) Dors. to manubrium sterni, ventr. to int. thoracic a. and v. at 1st IC space</td>
</tr>
<tr>
<td>Caud. sternal ln. Ventr. to transversus thoracis along int. thoracic a. and v. other ln. dors. to transversus thor. just cran. to attachment of diaphragm</td>
</tr>
<tr>
<td>LYMPHOCENTER LOCATION</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>MEDIASTINAL LYMPHOCENTER (p. 62)</td>
</tr>
<tr>
<td>Cranial mediastinal ln. (63.14)</td>
</tr>
<tr>
<td>Middle mediastinal ln. (63.12)</td>
</tr>
<tr>
<td>Caudal mediastinal ln. (63.13)</td>
</tr>
<tr>
<td>Phrenic ln.</td>
</tr>
</tbody>
</table>

<p>| BRONCHIAL LYMPHOCENTER (p. 62) | | | |
| Left tracheobronchial ln. (63.24) | Caud. to lig. arteriosum, between arch of aorta and left pulmonary a. | Thoracic esophagus, bifurcation of trachea, heart | Caud. and cran. mediastinal ln., thoracic duct | 2.5–3.5 cm long. Regularly incised in meat inspection |
| Right tracheobronchial ln. (63.25) | Between apical and middle lobes on lat. surface of rt. main bronchus | Lung; pulmonary ln. | Middle mediastinal ln. | 1–3 cm long. Present in 75 % of cattle. Regularly incised in meat inspection (supervisor’s node) |
| Middle tracheobronchial ln. (63.27) | Dorsal to the bifurcation of the trachea | Lung | Right tracheobronchial ln. | 0.75–1 cm long; present in 50 % of cattle. Regularly incised in meat inspection |
| Cran. tracheobronchial ln. (63.21) | On right side of trachea, cran. to origin of tracheal bronchus | Lung; pulmonary ln. | Cran. mediastinal ln. | 2–5 cm long. Regularly incised in meat inspection |
| Pulmonary ln. (63.28) | Around both main bronchi, covered by lung tissue | Lung, except right apical lobe | Right and left tracheobronchial ln., more rarely, caud. mediastinal ln. | 1 or 2 ln., 0.5–1.5 cm in size; present in 50 % of cattle |</p>
<table>
<thead>
<tr>
<th>LYMPHOCENTER LOCATION AFFERENTS FROM EFFERENTS TO REMARKS</th>
</tr>
</thead>
</table>

### LUMBAR LYMPHOCENTER (p. 82)

- **Aortic lumbar lnn. (83.8)**
  - Location: Dors. and ventr. to aorta and caud. vena cava, ventr. to lumbar vert.
  - Afferents: Hypaxial lumbar mm., extensors of the back, thoracolumbar fascia, lumbar vertebræ, peritoneum, kidneys, adrenal gl.
  - Efferents to: Lumbar trunk
  - Remarks: 12–15 small lnn. to be considered in suspected cases in meat inspection

- **Proper lumbar lnn. (76.G)**
  - Location: Near the intervent. foramina of lumbar vertebræ
  - Afferents: Extensors of back, (latissimus dorsi), abdominal mm.
  - Efferents to: Aortic lumbar lnn.
  - Remarks: Separate, about 0.5 cm; on one side or bilateral or absent

- **Renal lnn. (83.9)**
  - Location: Close to renal a. and v.
  - Afferents: Kidneys, adrenal gl.
  - Efferents to: Cysterna chyli
  - Remarks: Not sharply distinct from aortic lumbar lnn. Regularly examined in meat inspection

### CELIAC LYMPHOCENTER (p. 72, 74)

- **Celiac lnn. (77.A)**
  - Location: On celiac a.
  - Afferents: Spleen
  - Efferents to: Visceral trunk or directly into cisterna chyli
  - Remarks: Cannot be sharply delimited from nearby lnn.

- **Splenial (or atrial) lnn. (73.E)**
  - Location: Between atrium ruminis and left crus of diaphragm, dorsocranial to the spleen
  - Afferents: Spleen, rumen, reticulum; lymph from all other gastric lnn.
  - Efferents to: Variable, usually gastric trunk
  - Remarks: 1–7 lnn. Regularly examined in meat inspection

- **Right ruminal lnn. (73.D)**
  - Location: Subserous, in right longitudinal groove of rumen
  - Afferents: Rumen
  - Efferents to: Splenic lnn. or gastric trunk
  - Remarks: 1–4 more lnn. in the cran. groove of rumen

- **Left ruminal lnn. (73.C)**
  - Location: Subserous in left longitudinal groove
  - Afferents: Rumen
  - Efferents to: Cran. ruminal lnn., partly to right ruminal lnn.
  - Remarks: 1–2 inconstant, 1–2 cm long lnn.

- **Cran. ruminal lnn. (73.F)**
  - Location: In the cran. groove of rumen
  - Afferents: Rumen
  - Efferents to: Right ruminal lnn., splenic lnn.
  - Remarks: 2–8 lnn., 0.5–1.5 cm each

- **Reticular lnn. (73.F)**
  - Location: On the diaphragmatic and visceral surfaces of the reticulum
  - Afferents: Reticulum
  - Efferents to: Splenic lnn., rarely directly into the gastric trunk
  - Remarks: 1–7 small, 0.5–1.5 cm lnn.

- **Omasal lnn. (73.B)**
  - Location: On the visceral surface of the omasum
  - Afferents: Omasum
  - Efferents to: Splenic lnn.
  - Remarks: 6–12 lnn., 0.5–4 cm each

- **Ruminoabomasal lnn. (73.A)**
  - Location: On the left, cranially on rumen and greater curvature of abomasum
  - Afferents: Rumen, omasum, abomasum
  - Efferents to: Reticuloabomasal lnn. or reticular lnn.
  - Remarks: 2–7 lnn., 0.5–4 cm long

- **Reticuloabomasal lnn. (73.A)**
  - Location: On the left, between reticulum, abomasum, and atrium ruminis
  - Afferents: Rumen, reticulum, and abomasum
  - Efferents to: Reticular lnn.
  - Remarks: 2–8 lnn., 0.5–4 cm long

- **Dors. abomasal lnn. (73.G)**
  - Location: Near the lesser curvature of abomasum
  - Afferents: Duodenum, omasum, abomasum
  - Efferents to: Hepatic lnn.
  - Remarks: 3–6 lnn., 0.5–4 cm each

- **Ventr. abomasal lnn. (73.H)**
  - Location: Near the greater curvature of the abomasum, in the greater omentum
  - Afferents: Duodenum, abomasum
  - Efferents to: Hepatic lnn.
  - Remarks: 1–4 lnn., inconstant

- **Hepatic lnn. (75.23)**
  - Location: Porta hepatis
  - Afferents: Liver, pancreas, duodenum
  - Efferents to: Hepatic trunk
  - Remarks: 6–15 lnn., 1–7 cm long. Regularly incised in meat inspection

- **Accessory hepatic lnn. (74.29)**
  - Location: On dors. border of liver, near the caud. vena cava
  - Afferents: Liver
  - Efferents to: Hepatic trunk
  - Remarks: Several small lnn.
<table>
<thead>
<tr>
<th>LYMPHOCENTER LOCATION</th>
<th>LOCATION</th>
<th>AFFERENTS FROM</th>
<th>EFFERENTS TO</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pancreaticoduodenal ln.</td>
<td>On visceral surf. of pancreas near portal v., between panc. and duod., and between panc. and transverse colon</td>
<td>Pancreas, duodenum, nearby parts of colon</td>
<td>Intestinal trunk</td>
<td>Varying number of small ln. Regularly incised in meat inspection</td>
</tr>
</tbody>
</table>

**CRANIAL MESENTERIC LYMPHOCENTER (p. 76)**

| Cran. mesenteric ln. (77.A) | At the origin of cran. mesenteric a. | Spleen | Visceral trunk or directly into cisterna chyli | Not clearly separate from celiac and nearby ln. |
| Jejunal ln. (77.E) | In the mesojejunum along the collateral br. of cran. mesenteric a., near jejunum, outside spiral colon | Jejunum, ileum | Intestinal trunk and colic ln. | 10–50 ln., each 0.5–12 cm long. Regularly considered in meat inspection |
| Cecal ln. (77.D) | In ileocecal fold | Ileum, cecum | Colic ln. or directly to the intestinal trunk | 1–3 ln., 0.5–2 cm long, inconstant. Regularly examined in meat inspection |

**CAUDAL MESENTERIC LYMPHOCENTER (p. 76)**

| Caud. Mesenteric ln. (77.B) | On the sides of the descending colon | Descending colon | Lumbar trunk | Routinely examined in meat inspection |

**ILIOSACRAL LYMPHOCENTER (p. 82)**

| Medial iliac ln. (83.4) | At the termination of aorta and origin of deep circumflex iliac a. | Hip jt., hypaxial lumbar mm., pelvic and femoral mm., testis and spermatic cord; or ovary, uterine tube, uterus, bladder, kidneys, female urethra | Lumbar trunk | 1–4 ln., 0.5–5 cm long. Considered in suspected cases in meat inspection |
| Lat. iliac ln. (83.12) | At the bifurcation of deep circumflex iliac a. and v. | Pelvic bones, fascia lata, abd. mm., deep gluteal m., peritoneum; subiliac and coxal ln. | Lumbar trunk, med. iliac ln., in part iliofemoral ln. | 1–2 ln., 1.25–2.5 cm long, may be absent. Considered in suspected cases in meat inspection |
| Sacral ln. (83.5) | In the angle between right and left int. iliac aa. | Iliopsoas, gluteal mm., and mm. of tail, intrapelvic urogenital organs, including their mm. | Med. iliac ln., iliofemoral ln. or directly into lumbar trunk | A second, inconstant group lies on the internal surf. of the sacrosciatic lig. at the level of the lesser sciatic foramens |
| Anorectal ln. (76.K) | On the anus and rectum | Descending colon, rectum, anus | Med. iliac ln. | 12–17 ln. 0.5–3 cm long |

**ILIOFEMORAL LYMPHOCENTER (p. 20 and 82)**

<p>| Iliofemoral ln. (83.5) | In the angle between ext. iliac and deep circumflex iliac vessels | Femoral and crural mm., abd. mm., bones and joints of pelvis and pelvic limb down to the hock, intra-abdominal urogenital organs | Med. iliac ln., lumbar trunk | 3.5–9.5 cm long. Considered in suspected cases in meat inspection |</p>
<table>
<thead>
<tr>
<th>LYMPHOCENTER LOCATION</th>
<th>AFFERENTS FROM</th>
<th>EFFERENTS TO</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUPERFICIAL INGUINAL LYMPHOCENTER (p. 90 and 92)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supf. inguinal ln.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Scrotal ln. (93.9)</td>
<td>Caud. to spermatic cord, dorsolat. to penis at level of pecten pubis</td>
<td>Scrotum, prepuce, penis, skin of thigh, crus, and stifle</td>
<td>Iliofemoral ln.</td>
</tr>
<tr>
<td>Mammary ln. (91.B)</td>
<td>Med. to caud. border of lat. laminae of suspensory apparatus of udder</td>
<td>Udder, vulva, vestibule, clitoris, skin of thigh, crus, and stifle</td>
<td></td>
</tr>
<tr>
<td>Subiliac ln. (67.5)</td>
<td>At cran. border of tensor fasciae latae above the level of the stifle</td>
<td>Skin of abd. wall, pelvis and hind limb, prepuce</td>
<td>Iliofemoral ln., med. iliac ln., in part, coxal ln.</td>
</tr>
<tr>
<td>Coxal ln.</td>
<td>Med. to tensor fasciae latae at the tuber coxae</td>
<td>Fascia lata, quadriceps femoris</td>
<td>Lat. iliac ln. or med. iliac ln.</td>
</tr>
<tr>
<td><strong>SCIATIC LYMPHOCENTER (p. 20)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sciatic ln. (17.B)</td>
<td>On the sacrosciatic lig., dors. to lesser sciatic for. or in the foramen</td>
<td>Skin of the pelvic region and tail, gluteal mm., hip jt., rectum, anus, urogenital organs at pelvic outlet</td>
<td>Sacral ln.</td>
</tr>
<tr>
<td>Gluteal ln. (17.A)</td>
<td>On the sacrosciatic lig. at the greater sciatic foramen</td>
<td>Pelvic bones, hip jt., deep gluteal m., thoracolumbar fascia</td>
<td>Sacral ln.</td>
</tr>
<tr>
<td>Tuberal ln. (19.B)</td>
<td>On the med. surface of the tuber ischiadicum and on the attachment of the sacrosciatic lig.</td>
<td>Skin of pelvic region and tail, gluteobiceps</td>
<td>Sciatic ln., rarely sacral ln.</td>
</tr>
<tr>
<td><strong>POPLITEAL LYMPHOCENTER (p. 20)</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Deep popliteal ln. (17.C)</td>
<td>In the space between gluteobiceps and semitendinosus and the heads of the gastrocnemius</td>
<td>Pes, crus, and caud. thigh mm.</td>
<td>Iliofemoral and sacral ln.</td>
</tr>
</tbody>
</table>
### 3. PERIPHERAL NERVOUS SYSTEM

#### NERVE INNervation REMARKS

<table>
<thead>
<tr>
<th>SPINAL NERVE</th>
<th>INNERVATION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal branch (nd)</td>
<td>Skin of dors. third of lat. surf. of trunk</td>
<td>Leaves the vertebral canal through an intervertebral for. (exceptions C1; C2; S1–S5)</td>
</tr>
<tr>
<td>Lateral branch (ndl)</td>
<td>Sensory; except cervical nn.: motor</td>
<td></td>
</tr>
<tr>
<td>Medial branch (ndm)</td>
<td>Motor; except cervical nn.: sensory</td>
<td></td>
</tr>
<tr>
<td>Ventral branch (nv)</td>
<td>Except nerves of plexuses</td>
<td></td>
</tr>
<tr>
<td>Lateral branch (nvl)</td>
<td>Except nerves of plexuses</td>
<td></td>
</tr>
<tr>
<td>Medial branch (nvm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### I. CERVICAL NERVES: C1–C8 (p. 57, 61)

| • Dorsal branches | Cervical part of the dorsal mm. of the trunk |
| • Lateral branches | Motor |
| • Medial branches | Sensory; C2dm, as the major occipital n., innervates the skin of the nape |
| • Ventral branches | |
| • Lateral branches | Skin of lat. and ventr. cervical region; mm. cutanei colli, facies et laborum |
| • Medial branches | C2v, as the transverse cervical n. innervates the cutaneous mm. on the head and neck, and as the great auricular n. supplies sensation to lat. parts of the auricle; brnr. of C5v as the supracleavicular n. innervate the skin over the cranial thorax and shoulder joint |
| • Medial branches | Long hyoid mm. and hypaxial mm. |
| • Lateral branches | C4 and C5 form the ventr. cervical plexus; brnr. of C5v to C7v course through the thoracic inlet as the phrenic n. to the diaphragm; C6v, C7v, and C8v, together with T1v and T2v form the brachial plexus |

#### II. THORACIC NERVES: T1–T13 (p. 61, 67)

| • Dorsal branches | Skin over the dorsal thoracic wall down to parts of the lateral thoracic and abdominal wall |
| • Lateral branches | Also known as the first cutaneous branch |
| • Medial branches | Thoracic part of the epaxial muscles of the trunk |
| • Ventral branches | See Muscle Tables (Vertebral column Musculature: epaxial muscles) |
| • Lateral branches | Course ventrally under the pleura (except for the last n.) as intercostal nn. in the costal groove |
| • Lateral branches | Musculature of the lateral thoracic and abdominal wall |
| • Lateral cutaneous branches | Second cutaneous br.; lat. cut. brnr. of T1v–T3v and a brnr. of lat. thoracic n. form the intercostobrachial n. It innervates the cutaneous omobrachialis and skin over the triceps. |
| • Medial branches | In the region of the sternal ribs they innervate the internal intercostal mm. and transversus thoracis; in the region of the asternal ribs, the ext. and int. oblique, rectus, and transversus abd. mm. T13v, as the costoabdominal n., innervates parts of the psoas mm. and the quadratus lumborum |
| • Ventral cutaneous branches | Skin lat. and ventr. to the sternum, and of the abdomen to the udder or prepuce |
| • Medial branches | Also known as the third cutaneous branch |
### NERVE INNERRATION

#### III. LUMBAR NERVES: L1–L6 (p. 85)
- **Dorsal branches**
- **Lateral branches**
  - **Lat. and med. cutaneous branches** Skin on the lat. abd. wall down to the level of the patella; and lumbar and cran. gluteal regions
  - **Medial branches** Lumbar part of the epaxial mm.
- **Ventral branches**
- **Lateral branches** Skin and muscles of the lateral and ventral abdominal wall and pelvic limb

#### IV. SACRAL NERVES: S1–S5 (p. 85)
- **Dorsal branches**
  - Skin of caud. gluteal region and thigh
- **Lateral branches** Caud. parts of multifidus and dorsal muscles of the tail
- **Medial branches** Muscles of the pelvic limb
- **Ventral branches**
  - Skin of the lateral and ventral abdominal wall and pelvic limb

#### V. CAUDAL [COCCYGEAL] NERVES: Cd1–Cd5
- **Dorsal branches** Dorsal sacrocaudal mm., intertransversarii; skin of dorsal surface of tail
- **Ventral branches** Med. and lat. ventral sacrocaudal mm. and intertransversarii; skin of ventral surface of tail

#### BRACHIAL PLEXUS

- **Ventr. brs. of the 6th to 8th cervical nn. and the 1st and 2nd thoracic nn. form the roots of the plexus, which pass between the scalenus mm. to the cranio medial side of the shoulder joint. Supplies the thoracic limb, parts of the shoulder girdle mm., and the thoracic wall.**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Branches</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Suprascapular nn. 5.8</strong></td>
<td>Supraspinatus and infraspinatus</td>
<td>Fibers from C6v and C7v; it passes directly over the cran. border of the scapula from med. to lat.</td>
</tr>
<tr>
<td><strong>Subscapular n. 5.4</strong></td>
<td>Subscapularis</td>
<td>Fibers mostly from C7v, additionally from C8v</td>
</tr>
<tr>
<td><strong>Axillary n. 5.13</strong></td>
<td>Shoulder joint; caud. parts of the subscapularis; teres major, teres minor, deltoideus</td>
<td>Fibers mostly from C7v and C8v; main parts pass between subscapularis and teres major to the lat. side of the thoracic limb</td>
</tr>
<tr>
<td><strong>Muscular branches</strong></td>
<td>Shoulder joint; caud. parts of the subscapularis; teres major, teres minor, deltoideus</td>
<td></td>
</tr>
<tr>
<td><strong>Cran. cutaneous antebrachial n.</strong></td>
<td>Skin over the shoulder to the cranio lateral surface of the middle of the antebrachium</td>
<td></td>
</tr>
<tr>
<td>NERVE</td>
<td>INNERVATION</td>
<td>REMARKS</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Musculocutaneous nerve (5.9)</td>
<td>Fibers from C6v–C8v; forms the ansa axillaris with the median n.</td>
<td></td>
</tr>
<tr>
<td>• Proximal muscular br. (5.b)</td>
<td>Coracobrachialis and biceps brachii</td>
<td>Crosses deep to coracobrachialis en route to biceps</td>
</tr>
<tr>
<td>• Distal muscular branch (5.d)</td>
<td>Brachialis</td>
<td></td>
</tr>
<tr>
<td>• Med. cutaneus antebrachial n. (5.31)</td>
<td>Skin on the med. side of the forearm; cran. surface of elbow joint capsule</td>
<td>Communicates prox. to carpus with supf. br. of radial n.</td>
</tr>
<tr>
<td><strong>Radial nerve (5.15)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Muscular branches</td>
<td>Triceps brachii, tensor fasciae antebrachii, anconeus; distal parts of brachialis</td>
<td></td>
</tr>
<tr>
<td>• Caud. lat. cutaneus brachial n.</td>
<td>Lat. parts of brachial skin</td>
<td></td>
</tr>
<tr>
<td>• Deep branch (5.20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>•• Muscular branches</td>
<td>Extensor carpi radialis, ext. carpi ulnaris, ext. digitalis communis, ext. digitalis lat., ext. carpi obliquus</td>
<td></td>
</tr>
<tr>
<td>• Superficial branch (5.32)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>•• Lat. cut. antebrachial nerve (5.33)</td>
<td>Skin on lat. side of forearm almost down to carpus</td>
<td></td>
</tr>
<tr>
<td>•• Dorsal common digital n. II (7.34)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>••• Axial dors. digital n. II</td>
<td>Dorso-medial region of med. dewclaw</td>
<td>The nerve may be connected at the level of the fetlock jt. with the corresponding palmar nerve</td>
</tr>
<tr>
<td>••• Abaxial dors. digital n. III</td>
<td>Skin of digit III to dorso-medial bulbar and coronary regions; digital joints</td>
<td></td>
</tr>
<tr>
<td>••• Dorsal common digital n. III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>••• Axial dors. digital nn. III and IV</td>
<td>Skin of digits III and IV in the dorso-medial regions; digital joints</td>
<td>Each n. receives an interdigital communicating br. from the corresponding palmar nn.</td>
</tr>
<tr>
<td><strong>Median nerve (7.29)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Muscular branches</td>
<td>Pronator teres, flexor carpi radialis, humeral and radial heads of deep digital flexor, interflexorii</td>
<td></td>
</tr>
<tr>
<td>• Palmar common digital n. II (7.18)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>•• Axial palmar digital n. II</td>
<td>Medio-palmar region of med. dewclaw</td>
<td>The nerve may be connected at the level of the fetlock jt. with the corresponding dorsal nerve</td>
</tr>
<tr>
<td>•• Abaxial palmar digital n. III</td>
<td>Skin of digit III on medio-palmar bulbar and coronary regions to the apex of the digit; digital joints</td>
<td></td>
</tr>
<tr>
<td>• Communicating branch (7.4)</td>
<td>To palmar common digital n. IV, of the ulnar n.</td>
<td></td>
</tr>
<tr>
<td>• Palmar common digital n. III (7.17)</td>
<td>Usually double; the brz. may unite at the beginning of the interdigital space to form a common trunk (see p. 10)</td>
<td></td>
</tr>
<tr>
<td>•• Axial palmar digital nn. III and IV</td>
<td>Skin of the axial palmar digital regions of digits III and IV to the apices of the digits; digital joints</td>
<td>Each n. gives off an interdigital communicating br. to the corresponding dorsal nerve</td>
</tr>
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<td>-------</td>
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<td>---------</td>
</tr>
<tr>
<td>Ulnar nerve (5.10)</td>
<td>Fibers from C8v–T2v; runs caud. to brachial a. and v., medially on the brachium over the med. head of the triceps (covered by the tensor fasciae antebrachii) to the caud. surface of the elbow jt. and into the groove between the ulnaris lat. and flexor carpi ulnaris; gives off sensory fibers to elbow and carpal joints</td>
<td></td>
</tr>
<tr>
<td>• Caud. cut. antebrachial nerve (5.24)</td>
<td>Skin on the caudomed. and caudolat. sides of the forearm and carpus</td>
<td></td>
</tr>
<tr>
<td>• Muscular branches</td>
<td>Flexor carpi ulnaris, supf. digital flexor, humeral and ulnar heads of deep digital flexor</td>
<td></td>
</tr>
<tr>
<td>• Dorsal branch (5.43)</td>
<td>Passes laterally over the carpus and in the metacarpus becomes the dorsal common digital n. IV</td>
<td></td>
</tr>
<tr>
<td>•• Dorsal common digital n. IV</td>
<td>Laterodorsal region of lat. dewclaw</td>
<td></td>
</tr>
<tr>
<td>•• Axial dors. digital n. V</td>
<td>Laterodorsal region of lat. dewclaw</td>
<td>At the level of the fetlock jt. the n. may be connected to the corresponding palmar n.</td>
</tr>
<tr>
<td>•• Abaxial dors. digital n. IV</td>
<td>Skin of digit IV to the laterodorsal coronary and bulbar regions; digital joints</td>
<td></td>
</tr>
<tr>
<td>• Palmar branch (7.14)</td>
<td>Passes over the carpus lateral to the tendons of the supf. digital flexor</td>
<td></td>
</tr>
<tr>
<td>•• Deep branch</td>
<td>Interosseus III and IV</td>
<td>The deep branch is given off from the palmar br. distal to the carpus</td>
</tr>
<tr>
<td>•• Superficial branch</td>
<td></td>
<td>Passes distally lat. to the flexor tendons, receives the communicating br. from the median n., and becomes palmar common digital n. IV</td>
</tr>
<tr>
<td>••• Palmar common digital n. IV</td>
<td>Has a short course.</td>
<td></td>
</tr>
<tr>
<td>•••• Axial palmar digital n. V (9.22)</td>
<td>Lateropalmar region of the lat. dewclaw</td>
<td>At the level of the fetlock jt. the n. may be connected to the corresponding dorsal n.</td>
</tr>
<tr>
<td>•••• Abaxial palmar digital n. IV (9.24)</td>
<td>Skin of digit IV on the lateropalmar coronary and bulbar regions to the apex of the digit; digital joints</td>
<td></td>
</tr>
<tr>
<td>Cran. and caud. pectoral nerves (61.t and 61.u)</td>
<td>Supf. and deep pectoral mm. and subclavius</td>
<td>Fibers from the cran. roots of the plexus</td>
</tr>
<tr>
<td>Long thoracic nerve (61.v)</td>
<td>Serratus ventralis thoracis</td>
<td>Fibers mainly from C7v and C8v</td>
</tr>
<tr>
<td>Lateral thoracic nerve (61.w)</td>
<td>Cutaneus trunci and, together with intercostal nn., skin on ventral thorax and abdomen</td>
<td>Fibers from C8v–T2v; see also intercostobrachial n. under THORACIC NN. (p. 119)</td>
</tr>
<tr>
<td>Thoracodorsal nerve (5.3)</td>
<td>Latissimus dorsi</td>
<td>Fibers from C7v and mainly from C8v</td>
</tr>
<tr>
<td>Iliohypogastric nerve (67.8)</td>
<td>Ventral br. of L2–L6 form the roots of the plexus</td>
<td>Forms, with the sacral plexus, the lumbosacral plexus</td>
</tr>
<tr>
<td>• Lateral ventral branch</td>
<td>Ext. and int. abdominal oblique mm., transversus abdominis</td>
<td>Fibers from L1v; no communication with other spinal nn., therefore not a plexus n.</td>
</tr>
<tr>
<td>•• Lateral cutaneous br.</td>
<td>Skin of the flank back to the craniolateral surface of stifte</td>
<td></td>
</tr>
<tr>
<td>•• Ventral cutaneous br.</td>
<td>Skin on the ventr. abdominal wall, prepuse or udder, skin on medial surface of thigh</td>
<td></td>
</tr>
<tr>
<td>• Medial ventral br.</td>
<td>Caud. parts of all abd. mm.; peritoneum cran. to inguinal region</td>
<td>Courses subperitoneally to the vicinity of the internal inguinal ring</td>
</tr>
</tbody>
</table>
NERVE INNERVATION

**Nerve** (67.9)

- **Ilioinguinal nerve** (67.9)
  - **Lateral ventral branch**
    - See also iliohypogastric n.
  - **Lateral cutaneous branch**
    - Skin of paralumbar fossa, over the cran. surface of thigh to lat. surface of stifle
  - **Ventral cutaneous branch**
    - See iliohypogastric n.
  - **Medial ventral branch**
    - Peritoneum of the inguinal region, skin of the prepuce or udder

- **Genitofemoral nerve** (91.c)
  - **Genital branch** (81.11 and 81.19)
    - Cremaster, tunica vaginalis, skin of the prepuce or udder
  - **Femoral branch**
    - Skin on the med. surface of thigh and the prepuce or udder

- **Lateral cutaneous femoral nerve** (67.11)
  - Psoas major, skin of the fold of the flank, cranial, and in part medial, surfaces of thigh; stifle joint

- **Femoral nerve** (21.f)
  - **Muscular branches**
    - Sartorius, quadriceps femoris
  - **Saphenous nerve** (21.11)
    - Sartorius, pectineus (et adductor longus), gracilis; sensory to stifle joint

- **Obturator nerve** (21.n)
  - Pectineus (et adductor longus), gracilis, adductor magnus (et brevis); obturator externus (with intrapelvic part)

**SACRAL PLEXUS**

- **Cranial gluteal nerve** (17.2)
  - Middle, deep, and accessory gluteal mm., tensor fasciae latae

- **Caudal gluteal nerve** (17.16)
  - Gluteobiceps

- **Caudal cutaneous femoral nerve** (21.i)
  - Skin on the gluteal region and caudal thigh

- **Caudal clunial nerves**
  - Skin of the gluteal region

- **Sciatic nerve** (17.17)
  - **Muscular branches**
    - Deep gluteal, gemelli, quadratus femoris

**Remarks**

- Fibers from L2v and L3v
- Perforates the abdominal wall
- The field of innervation adjoins that of the iliohypogastric n. caudally
- Perforates transversus, rectus, and aponeuroses of oblique abd. muscles
- Fibers from L2v–L4v, crosses the deep circumflex iliac a. and v. Extremely variable
- Passes through the caudomedial angle of the supf. inguinal ring with the ext. pudendal a. and v.
- Passes through the lacuna vasorum
- Fibers from L3v and L4v; accompanies caud. branch of deep circumflex iliac a. and v.; after perforating the abd. wall runs at first medial, then cranialat. on the thigh down to the stifle
- Fibers from L4v–L6v; passes through psoas minor and cran. head of sartorius and iliopectineus through lacuna musculorum; gives off saphenous n. here
- Runs with femoral a. and v. in the femoral triangle; sensory to stifle jt.; supplies the pectineus part of the pectineus (et adductor longus)
- Fibers from L4v–L6v, but also from S1; runs in obturator groove to obturator for.; supplies adductor longus part of pectineus (et adductor longus)
- Roots from sacral nerves
- Fibers from L6v–S2v; branches off cranially from lumbosacral trunk
- Fibers from L6v–S2v; branches off caudally from lumbosacral trunk
- Fibers from S1v and S2v; arises from lumbosacral tr. caud. to caud. gluteal n.; runs outside sacrosciatic lig. and divides at minor sciatic for.; med. br. enters for. and joins pudendal n; lat. (cutaneous) br. may be absent
- May be replaced by the prox. and dist. br. of the pudendal n.
- Fibers from L5v–S2v; direct continuation of lumbosacral trunk; emerges through major sciatic for. to lat. surface of sacrosciatic lig., passes over the deep gluteal, then between the sciatic spine and major trochanter over the hip joint
NERVE INNervation

**Common peroneal n. (17.6)**

- **Lat. cutaneous sural n. (17.21)** Skin lat. to the stifle and crus
- **Supf. peroneal n. (17.14)** Originates from the common peroneal n. in the middle of the crus
- **Cutaneous branches** Skin on the dorsolat. surface of the metatarsus
- **Dorsal common dig. n. IV (23.6)**
- **Axial dors. dig. n. V (23.14) and Abaxial dors. dig. n. IV (23.15)** Distributed like corresponding nn. on the manus which originate from the ulnar n. (see p. 9)
- **Dorsal common dig. n. II (23.4)** Smaller terminal br. of supf. peroneal n.; divides distal to prox. third of metatarsus
- **Axial dors. dig. n. II (23.12) and Abax. dors. dig. n. III (23.13)** Distributed like corresponding nn. on the manus which originate from the radial n. (see p. 9)
- **Dorsal common dig. n. III (23.7)** Larger terminal br. of supf. peroneal n. in prox. third of metatarsal; runs to the interdigital space; exchanges communicating brr. with dors. metatarsal n. III (see. p. 11)
- **Axial dors. dig. nn. III (23.21) and IV (23.22)** Origin from com. peroneal n. in middle of crus; runs on lat. border of extensor digit. Iongus, deep to the extensor retinacula, to the flexion surface of the tarsus
- **Deep peroneal n. (17.9)**
- **Muscular brr.** Tibialis cran., long, lat., and short extensors, peroneus tertius, peroneus longus
- **Dorsal metatarsal n. III (23.1)** Runs on the metatarsus with vessels of the same name in the dors. mtt. groove to the interdigital space; after exchanging communicating brr. with dors. com. dig. n. III, ends in communicating brr. to each plantar axial digital n.
- **Tibial nerve (17.19)**
- **Prox. muscular brr.** Semitendinosus and semimembranosus and ischial head of biceps femoris
- **Caud. cutaneous sural n. (17.19’)** Skin on caudolat. surface of crus down to hock
- **Dist. muscular brr.** Popliteus, extensors of the hock, and flexors of the digits
- **Medial plantar n. (19.14)** Runs with supf. brr. of the med. plantar a. and v. on the med. border of the deep flexor tendon to the distal third of the metatarsus, where it divides
- **Plantar common digital n. II (23.9)**
- **Axial plant. dig. n. II (23.11) and Abax. plant. dig. n. III (23.17)** Distributed like the corresponding palmar nn. on the manus which come from the median n. (see p. 9)
- **Plantar common digital n. III (23.8)** Runs over the med. br. of the supf. dig. flexor tendon to the interdigital space; may be double or divide and reunite
- **Axial plant. dig. nn. III (23.20) and IV (23.19)** Like the corresponding palmar nn. on the manus, except that each receives a communicating br. from the union of the supf. and deep dors. nn. (see. p. 11)
- **Lateral plantar n. (19.13)** Crosses deep to the long plantar lig. of the tarsus to the lat. border of the interosseus
<table>
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<th>NERVE</th>
<th>INNERVERVATION</th>
<th>REMARKS</th>
</tr>
</thead>
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<tr>
<td>••• Deep branch</td>
<td>Intersos III and IV</td>
<td></td>
</tr>
<tr>
<td>••• Plant. common dig. n. IV</td>
<td></td>
<td>Like the corresponding palmar nn. of the manus which come from the ulnar n.</td>
</tr>
<tr>
<td>•••• Axial plant. dig. n. V and Abax. plant. dig. n. IV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch to coccygeus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch to levator ani (95.17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pudendal nerve (95.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Proximal cutaneous branch</td>
<td>Corresponding muscles</td>
<td>Fibers from S3 and S4, possibly also from the pudendal n. or caudal rectal nerves</td>
</tr>
<tr>
<td>• Distal cutaneous branch</td>
<td>Rectum, internal and external genital organs</td>
<td>S2–S4; accompanies int. pudendal a. and v. caudally on pelvic floor and over ischial arch</td>
</tr>
<tr>
<td>• Supf. perineal br.</td>
<td>Skin on semitendinosus</td>
<td>Emerges through biceps just cran. to dors. process of tuber ischiadicum or through sacrotuberous lig.</td>
</tr>
<tr>
<td>•• Dorsal scrotal nn. or dors. labial nn.</td>
<td>Scrotum or labia and skin of caud. surface of udder</td>
<td></td>
</tr>
<tr>
<td>• Deep perineal n.</td>
<td>Perineal muscles, vagina, vulva, major vestibular gl., skin of perineum</td>
<td>Communicating br. with caud. rectal nn.</td>
</tr>
<tr>
<td>• Dorsal n. of penis or clitoris</td>
<td>Penis or clitoris</td>
<td></td>
</tr>
<tr>
<td>• Preputial and scrotal branch or mammary branch</td>
<td>Prepuce and scrotum or udder</td>
<td>The mammary br. is closely associated with the convoluted ventral labial v.</td>
</tr>
<tr>
<td>Caudal rectal nerves (97.17)</td>
<td></td>
<td>Fibers from S4, S5; communicate with deep perineal n.</td>
</tr>
<tr>
<td>• Muscular branches</td>
<td>Caudal part of rectum, ext. anal sphincter, retractor penis (clitorids), coccygeus, levator ani, constrictor vestibuli</td>
<td></td>
</tr>
<tr>
<td>• Cutaneous branches</td>
<td>Skin of anal region</td>
<td></td>
</tr>
</tbody>
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