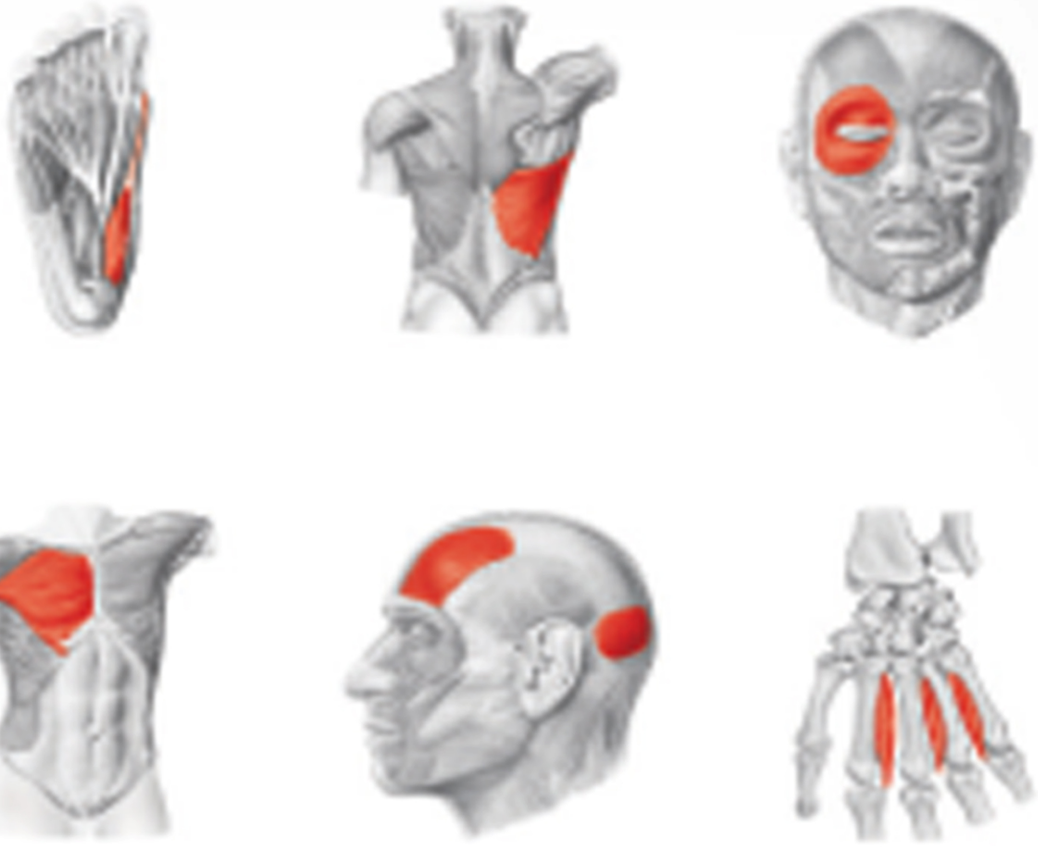


Sobotta

Atlas of Human Anatomy

Tables of Muscles, Joints, and Nerves

With English Nomenclature

1st Edition

URBAN & FISCHER

Sobotta

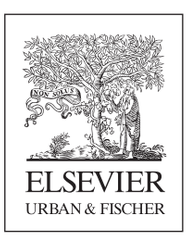
Atlas of Human Anatomy

Tables of Muscles, Joints, and Nerves

1st edition

Edited by F. Paulsen and J. Waschke

Translated by T. Klonisch and
S. Hombach-Klonisch, Winnipeg, Canada



URBAN & FISCHER
München

Sobotta

Atlas of Human Anatomy
Tables of Muscles, Joints, and Nerves
1st edition

Edited by F. Paulsen and J. Waschke

Translated by T. Klonisch and S. Hombach-Klonisch

This booklet is a supplement to Sobotta, Atlas of Anatomy, volumes 1 to 3, 15th edition. The cross-references refer to the figure numbers in the Atlas. Apart from this, the tables are also useful for an independent systematic learning and revision of subject matter.
Abbreviations: O = Origin; I = Insertion; F = Function

All business correspondence should be made with:
Elsevier GmbH, Urban & Fischer Verlag, Hackerbrücke 6, 80335 Munich, Germany, mail to: medizinstudium@elsevier.de

Addresses of the editors:
Professor Dr. med. Friedrich Paulsen
Institut für Anatomie II (Chairman)
Universität Erlangen-Nürnberg
Universitätsstraße 19
91054 Erlangen
Germany

Professor Dr. med. Jens Waschke
Institut für Anatomie I (Chairman)
Ludwig-Maximilians-Universität
Pettenkoferstraße 11
80333 München
Germany

Addresses of the translators:
Professor Dr. med. Sabine Hombach-Klonisch
Professor Dr. med. Thomas Klonisch
Faculty of Medicine
Department of Human Anatomy and Cell Science
University of Manitoba
745 Bannatyne Avenue
Winnipeg Manitoba R3E 0J9
Canada

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://www.d-nb.de.

15th Edition 2013

Urban & Fischer Verlag is an imprint of Elsevier GmbH.

13 14 15 16 17 5 4 3 2 1

Acquisition editor: Alexandra Frntic, Munich, Dr. Katja Weimann, Munich
Development editor: Dr. Andrea Beilmann, Munich
Editing: Ulrike Kriegel, buchundmehr, Munich
Production manager: Sibylle Hartl, Munich; Renate Hausdorf, buchundmehr, Gräfelfing
Composed by: abavo GmbH, Buchloe
Printed and bound by: Firmengruppe appl, Wemding
Cover illustration: Nicola Neubauer, Puchheim
Cover design: SpieszDesign, Neu-Ulm
Printed on 80g LuxoArt Silk

ISBN 978-0-7020-5254-5

Table of contents

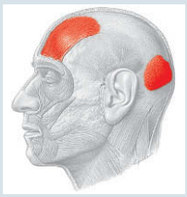
Tables of muscles, joints, and nerves

1 Facial muscles (→ Figs. 8.63–8.65, 11.2, 11.13)

The mimic muscles only partially originate from defined bony structures but all insert in the skin.

a Forehead, vertex, temple

Occipitofrontalis
Facial nerve [VII]
Occipitofrontalis and temporoparietalis are collectively named epicranius.

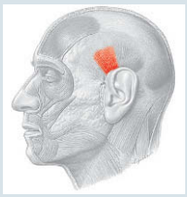


O: frontal belly: skin of the forehead
occipital belly: highest nuchal line

I: epicranial aponeurosis

F: forehead
frontal belly: wrinkling of the forehead (expression of surprise)
occipital belly: smoothens wrinkles of the forehead

Temporoparietalis
Facial nerve [VII]



O: skin of the temple, temporal fascia

I: epicranial aponeurosis

F: moves the skin of the head downwards

b Auricle

Auricularis anterior
Facial nerve [VII]

O: temporal fascia

I: anterior to the auricle

F: moves the auricle in a superior and anterior direction

Auricularis superior
Facial nerve [VII]

O: epicranial aponeurosis

I: superior to the auricle

F: moves the auricle in a superior and posterior direction

Auricularis posterior
Facial nerve [VII]

O: mastoid process

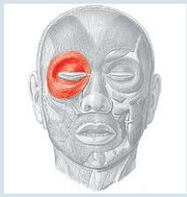
I: posterior to the auricle

F: moves the auricle in a posterior direction

1 Facial muscles (continued)

c Palpebral fissure

Orbicularis oculi (surrounds the orbital opening like a sphincter)
Facial nerve [VII]

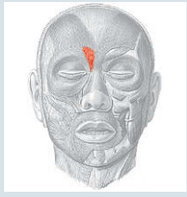


O: orbital part: nasal part of the frontal bone, frontal process of the maxilla, lacrimal bone, medial palpebral ligament
palpebral part: medial palpebral ligament, lacrimal sac
lacrimal part: posterior lacrimal crest of the lacrimal bone, lacrimal sac

I: orbital part: lateral palpebral ligament
palpebral part: lateral palpebral ligament
lacrimal part: lacrimal duct, palpebral fissure

F: closes the eyelids, compresses the lacrimal sac

Depressor supercilii (separation of the orbital part of the orbicularis oculi)
Facial nerve [VII]



O: nasal part of the frontal bone, dorsum of the nose

I: medial third of the skin of the eyebrow

F: depresses the skin of the eyebrow

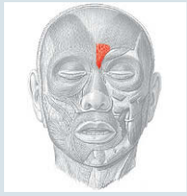
Corrugator supercilii
Facial nerve [VII]

O: nasal part of the frontal bone

I: middle third of the skin of the eyebrow

F: pulls the skin of the forehead and eyebrows towards the root of the nose, creates a vertical fold above the root of the nose (anger, thinking)

Procerus
Facial nerve [VII]



O: nasal bone

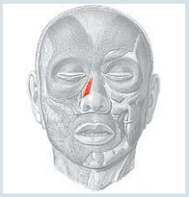
I: skin of the glabella

F: horizontal folds on the dorsum of the nose (wrinkling of the nose)

1 Facial muscles (continued)

d Nose

Nasalis
Facial nerve [VII]

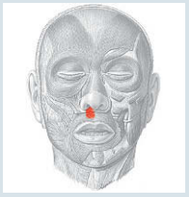


O: alar part: maxilla at the level of the lateral incisor
transverse part: maxilla at the level of the canine

I: alar part: nasal wing, rim of the nasal opening
transverse part: tendinous plate of the dorsum of the nose

F: moves the nasal wings and the nose
alar part: dilates the nasal opening
transverse part: narrows the nasal opening

Depressor septi nasi
Facial nerve [VII]



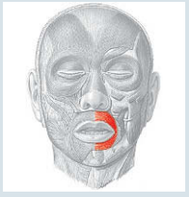
O: maxilla at the level of the medial incisor

I: septal nasal cartilage

F: moves the nose downwards

e Mouth

Orbicularis oris
Facial nerve [VII]

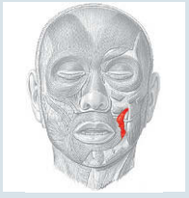


O: marginal part and **labial part:** lateral of the angle of mouth

I: skin of the lip

F: closes lips, pursing lips

Buccinator
Facial nerve [VII]

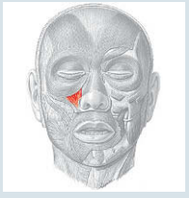


O: maxilla, pterygomandibular raphe, mandible

I: angle of mouth

F: puts tension on the lips, increases pressure within the mouth cavity, e.g. during blowing and chewing

Levator labii superioris
Facial nerve [VII]



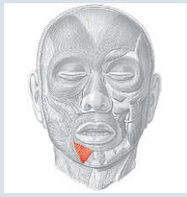
O: maxilla superior to the infra-orbital foramen

I: upper lip

F: pulls the upper lip sideways and upwards

1 Facial muscles (continued)

Depressor labii inferioris
Facial nerve [VII]

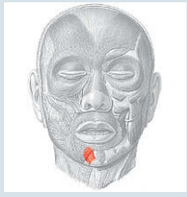


O: mandible inferior to the mental foramen

I: lower lip

F: pulls the lower lip sideways and downwards

Mentalis
Facial nerve [VII]

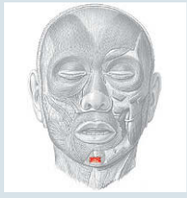


O: mandible, at the level of the lower lateral incisor

I: skin of the chin

F: creates the groove of the chin, everts and protrudes the lower lip (together with the orbicularis oris; to pout or pull a face)

Transversus menti
Facial nerve [VII]

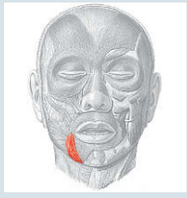


O: transverse separation from the mentalis

I: skin of the mental protuberance

F: moves the skin of the chin

Depressor anguli oris
Facial nerve [VII]

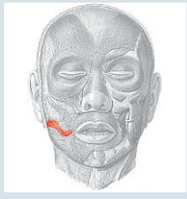


O: lower margin of the mandible

I: angle of mouth

F: moves the angle of the mouth downwards

Risorius
Facial nerve [VII]



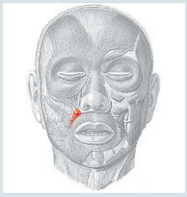
O: parotid fascia, masseteric fascia

I: angle of mouth

F: broadens the mouth (grin), creates dimples

1 Facial muscles (continued)

Levator anguli oris
Facial nerve [VII]

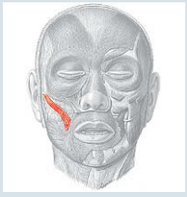


O: canine fossa of the maxilla

I: angle of mouth

F: pulls the angle of the mouth to the medial side and upwards

Zygomaticus major
Facial nerve [VII]

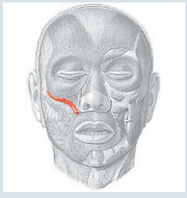


O: zygomatic bone

I: angle of mouth

F: pulls the angle of the mouth to the lateral side and upwards

Zygomaticus minor
Facial nerve [VII]

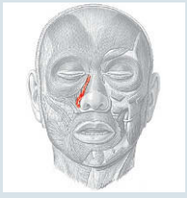


O: zygomatic bone

I: angle of mouth

F: pulls the angle of the mouth to the lateral side and upwards

Levator labii superioris alaeque nasi
Facial nerve [VII]



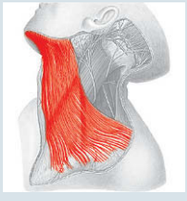
O: frontal process of the maxilla (medial orbital wall)

I: nasal wing, upper lip

F: lifts the lips and the nasal wing

f Neck (→ Fig. 11.2)

Platysma
Facial nerve [VII]



O: base of mandible, parotid fascia

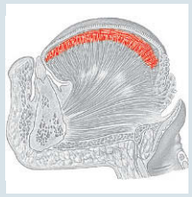
I: skin below the clavicle, pectoral fascia

F: tenses the skin of the neck, generates longitudinal folds

2 Muscles of the tongue (→ Figs. 8.139, 8.141, 8.147–8.150)

a Intrinsic muscles of the tongue

Superior longitudinal muscle
Hypoglossal nerve [XII]



O: root of tongue

I: apex of tongue

F: shortens and broadens the tongue, elevates the tip of the tongue

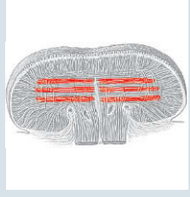
Inferior longitudinal muscle
Hypoglossal nerve [XII]

O: root of tongue

I: apex of tongue

F: shortens and broadens the tongue, depresses the tip of the tongue

Transverse muscle
Hypoglossal nerve [XII]

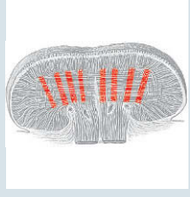


O: lateral margin of the tongue, lingual septum

I: lateral margin of the tongue, lingual aponeurosis

F: narrows the tongue and, in association with the vertical muscle, extends the tongue

Vertical muscle
Hypoglossal nerve [XII]



O: root of tongue

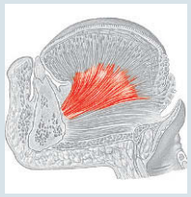
I: lingual aponeurosis

F: broadens the tongue

2 Muscles of the tongue (continued)

b Extrinsic muscles of the tongue

Genioglossus
Hypoglossal nerve [XII]

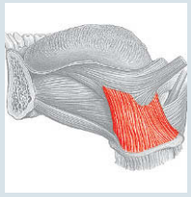


O: mental spine of the mandible

I: lingual aponeurosis

F: moves the tongue in an anterior and inferior direction

Hyoglossus
Hypoglossal nerve [XII]

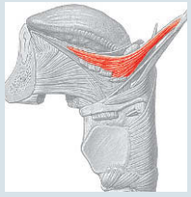


O: greater horn and body of hyoid bone

I: lingual aponeurosis

F: moves the tongue in a posterior and inferior direction

Styloglossus
Hypoglossal nerve [XII]



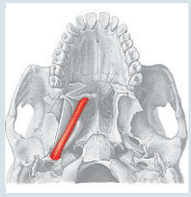
O: styloid process of the temporal bone

I: lingual aponeurosis

F: moves the tongue in a posterior and superior direction

3 Muscles of the palate (→ Fig. 8.133)

Levator veli palatini
Pharyngeal branches of the glossopharyngeal nerve [IX] and the vagus nerve [X] (= pharyngeal plexus)

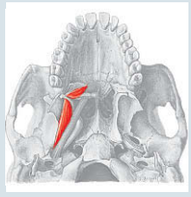


O: inferior surface of the petrous part of the temporal bone, cartilage of auditory tube

I: palatine aponeurosis

F: elevates the soft palate, widens the lumen of the auditory tube

Tensor veli palatini (is looped around the pterygoid hamulus which acts as a hypomochlion)
Nerve to tensor veli palatini of the mandibular nerve [V/3]

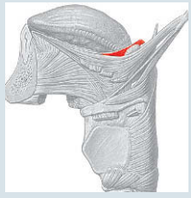


O: scaphoid fossa at the pterygoid process, membranous part and cartilage of the auditory tube

I: palatine aponeurosis

F: tenses the soft palate and widens the lumen of the auditory tube

Palatoglossus
Glossopharyngeal nerve [IX]



O: palatine aponeurosis

I: projects into the intrinsic muscles of the tongue

F: depresses the soft palate, simultaneously elevates the root of the tongue and thereby narrows the isthmus of fauces

Musculus uvulae (unpaired muscle)
Pharyngeal branches of the glossopharyngeal nerve [IX] and the vagus nerve [X] (= pharyngeal plexus)

O: palatine aponeurosis

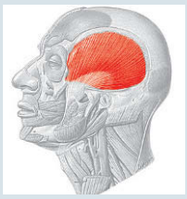
I: stroma of the uvula

F: shortens the uvula, thereby thickening it

4 Masticatory muscles (→ Figs. 8.62, 8.64–8.67, 8.69)

The masseter is easily palpated through the skin along its course from the mandibular angle to the zygomatic arch. When clenching the teeth the belly of the temporalis becomes noticeable at the temple. The medial pterygoid is located at the inside of the mandible. The lateral pterygoid projects from the temporomandibular joint anteriorly.

Temporalis
Deep temporal nerves (mandibular nerve [V/3])

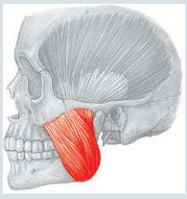


O: temporal bone inferior to the inferior temporal line, deep lamina of the temporal fascia

I: coronoid process of the mandible

F: closes the jaw (strongest masticatory muscle)
anterior portion: pulls the mandible forward (= protrusion)
posterior portion: pulls the mandible backward (= retrusion)

Masseter
Masseteric nerve (mandibular nerve [V/3])

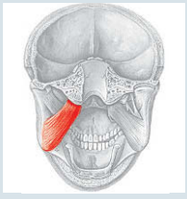


O: superficial part: inferior margin of the zygomatic arch
deep part: inner surface of the zygomatic arch

I: superficial part: angle of mandible (masseteric tuberosity)
deep part: inferior margin of the mandible

F: closes the jaw
superficial part: pulls the mandible forward (= protrusion)

Medial pterygoid
Nerve to medial pterygoid (mandibular nerve [V/3])

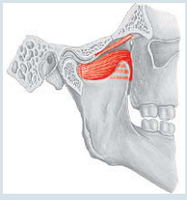


O: pterygoid fossa

I: inferior margin of the mandible (pterygoid tuberosity)

F: closes the jaw, pulls the mandible forward (= protrusion)

Lateral pterygoid
Nerve to lateral pterygoid (mandibular nerve [V/3])



O: upper head: infratemporal crest of the sphenoid
lower head: lateral plate of the pterygoid process

I: upper head: disc and capsule of the temporomandibular joint
lower head: condylar process of mandible (pterygoid fovea)

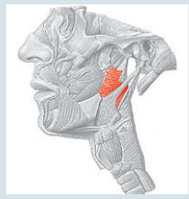
F: upper head: initiates jaw opening by pulling the articular disc forward
lower head: pulls the mandible forward (= protrusion)
unilateral action: contralateral excursion

5 Muscles of the pharynx (→ Figs. 8.150, 11.12, 11.13, 11.21)

The pharyngeal muscles are divided into constrictor muscles (superior, middle, and inferior constrictor) and levator muscles (stylopharyngeus, salpingopharyngeus, and palatopharyngeus).

a Pharyngeal constrictor muscles

Superior constrictor
Pharyngeal branches of the glossopharyngeal nerve [IX] (= pharyngeal plexus)

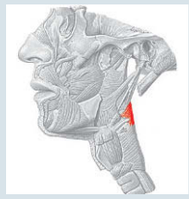


O: pterygopharyngeal part: medial lamina of the pterygoid process, pterygoid hamulus
buccopharyngeal part: pterygomandibular raphe
mylopharyngeal part: mylohyoid line of the mandible
glossopharyngeal part: transverse muscle

I: pharyngobasilar membrane, pharyngeal raphe

F: narrows the pharyngeal space (PASSAVANT's ridge), separates the epipharynx from the mesopharynx

Middle constrictor
Pharyngeal branches of the glossopharyngeal nerve [IX] and the vagus nerve [X] (= pharyngeal plexus)

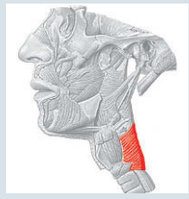


O: chondropharyngeal part: lesser horn of hyoid bone
ceratopharyngeal part: greater horn of hyoid bone

I: pharyngeal raphe

F: narrows the pharyngeal space from behind, promotes wave-like downward contractions to support the transport of ingested food into the esophagus (peristalsis)

Inferior constrictor
Pharyngeal branches of the vagus nerve [X] (= pharyngeal plexus)



O: thyropharyngeal part: thyroid cartilage
cricopharyngeal part: lateral side of the cricoid cartilage

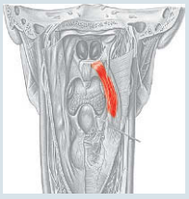
I: pharyngeal raphe

F: closes the laryngeal inlet by elevating the larynx, narrows the pharyngeal space from behind, promotes wave-like downward contractions to support the transport of ingested food into the esophagus (peristalsis)

5 Muscles of the pharynx (continued)

b Pharyngeal levator muscles

Palatopharyngeus (functionally also belonging to the palatine muscles)
Pharyngeal branches of the glossopharyngeal nerve [IX] (= pharyngeal plexus)

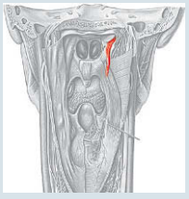


O: palatine aponeurosis

I: thyroid cartilage, projects into the lateral and posterior wall of the pharynx

F: narrows the isthmus of fauces, depresses the soft palate, elevates the pharyngeal wall towards the soft palate

Salpingopharyngeus
Pharyngeal branches of the glossopharyngeal nerve [IX] (= pharyngeal plexus)

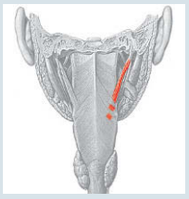


O: cartilage of tube

I: projects into the lateral wall of the pharynx

F: elevates the pharynx

Stylopharyngeus
Stylopharyngeal branch of the glossopharyngeal nerve [IX]



O: styloid process of the temporal bone

I: thyroid cartilage, projects into the lateral wall of the pharynx

F: elevates the pharynx

6 Muscles of the larynx (→ Figs. 11.34, 11.36, 11.39)

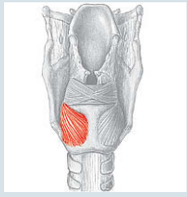
Cricothyroid (straight part: superficial, oblique part: deep)
External branch of the superior laryngeal nerve of the vagus nerve [X]

O: external surface of the arch of cricoid cartilage

I: inferior rim of the lamina of the thyroid cartilage

F: puts tension on the vocal ligaments by tilting the cricoid cartilage (strongest tensor muscle of the vocal ligaments)

Posterior crico-arytenoid
Recurrent laryngeal nerve of the vagus nerve [X]



O: posterior lamina of the cricoid cartilage

I: muscular process of the arytenoid cartilage

F: widens the glottis by lateral movement of the vocal process of the arytenoid cartilage and lateral tilt of the arytenoid cartilage

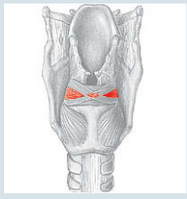
Lateral crico-arytenoid
Recurrent laryngeal nerve of the vagus nerve [X]

O: lateral upper rim of the arch of the cricoid cartilage

I: muscular process of the arytenoid cartilage

F: closes the intermembranous part of the glottis by inward rotation of the arytenoid cartilage

Transverse arytenoid
Recurrent laryngeal nerve of the vagus nerve [X]

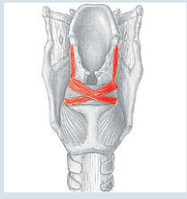


O: lateral rim and posterior surface of the arytenoid cartilage

I: lateral rim and posterior surface of the opposite arytenoid cartilage

F: closes the intercartilaginous part of the glottis by converging both arytenoid cartilages

Oblique arytenoid
Recurrent laryngeal nerve of the vagus nerve [X]



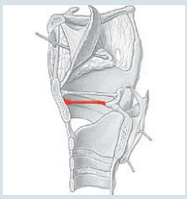
O: base of the posterior surface of the arytenoid cartilage
ary-epiglottic part: tip of the arytenoid cartilage

I: tip of the arytenoid cartilage
ary-epiglottic part: lateral rim of the epiglottic cartilage

F: pulls the arytenoid cartilage medially and, thus, narrows the intercartilaginous part of the glottis, narrows the entrance to the larynx

6 Muscles of the larynx (continued)

Vocalis
Recurrent laryngeal nerve of the vagus nerve [X]

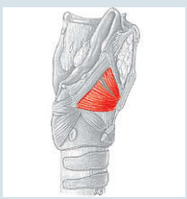


O: inner side of the thyroid cartilage

I: vocal process of the arytenoid cartilage lateral of the vocal ligaments

F: closes the glottis completely, responsible for the fine-tuning of the tension in the vocal ligaments

Thyroarytenoid
Recurrent laryngeal nerve of the vagus nerve [X]



O: inner surface of the lamina of the thyroid cartilage

I: muscular process and anterior surface of the arytenoid cartilage
thyro-epiglottic part: lateral rim of the epiglottic cartilage

F: narrows the intermembraneous part of the glottis
thyro-epiglottic part: narrows the entrance to the larynx

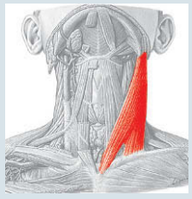
7 Branches and innervation areas of the cervical plexus (→ Figs. 11.61, 11. 62, 11.65–11.69)

	motor function	sensory function
(Deep) Ansa cervicalis superior root (= anterior root) inferior root (= posterior root)	infrahyoid muscles	
Muscular branches	longus colli, longus capitis, rectus capitis anterior and lateralis, intertransversarii anteriores cervicis, trapezius, levator scapulae, scalene muscles, geniohyoid	
Branches of the punctum nervosum (ERB's point)		
great auricular nerve		skin of the upper neck region, at the mandibular angle, anterior and posterior to the auricle, the major part of the auricle
transverse cervical nerve		skin in the upper anterior neck region
lesser occipital nerve		skin in the occipital region
medial, intermediate, and lateral supraclavicular nerves		skin in a stripe inferior to the clavicle
Phrenic nerve	diaphragm	parietal pleura, pericardium, peritoneum

8 Lateral muscles of the neck (→ Figs. 11.3, 11.5)

The sternocleidomastoid derives from the same primordium as the trapezius (same innervation). The sternocleidomastoid has its origin at the mastoid process and courses to the anteromedial side in an oblique downward direction. It is integrated in the superficial lamina of the cervical fascia.

Sternocleidomastoid
Accessory nerve [XI]; cervical plexus



O: sternal head: ventral aspect of the sternum
clavicular head: sternal third of the clavicle

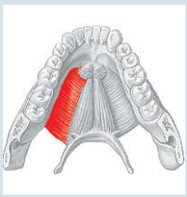
I: mastoid process, lateral superior nuchal line

F: unilaterally active: turns the head to the contralateral side and bends the head to the same side,
bilaterally active: erects the head, bends the cervical vertebral column, auxiliary breathing muscle when the head is in a fixed position

9 Suprahyoid muscles (→ Figs. 8.145–8.148, 11.3, 11.5)

The suprahyoid muscles create the floor of the oral cavity and are counteracting the infrahyoid muscles. The anterior belly of the digastric lies superficially. Shaped as a broad muscular plate, the mylohyoid forms the floor of the oral cavity. On its inner aspect lies the round-shaped geniohyoid. The posterior belly of the digastric and the stylohyoid position dorsally.

Mylohyoid (Together, the right and left parts of the muscle form a muscular plate that provides the caudal seal of the oral cavity.)
Nerve to mylohyoid (mandibular nerve [V/3])



O: mylohyoid line of the mandible

I: mylohyoid raphe, body of hyoid bone

F: lifts the floor of the oral cavity (opens mouth), depresses the mandible, lifts the hyoid bone during swallowing

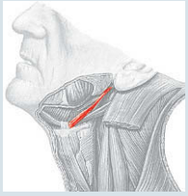
Digastric (Posterior belly and anterior belly are connected by an intermediate round tendon, which is fixed at the lesser horn of the hyoid bone.)
Anterior belly: *nerve to mylohyoid (mandibular nerve [V/3])*
Posterior belly: *digastric branch (facial nerve [VII])*

O: mastoid notch of the temporal bone

I: digastric fossa of the mandible

F: supports the mylohyoid

Stylohyoid
Stylohyoid branch (facial nerve [VII])

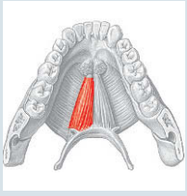


O: styloid process of the temporal bone

I: body of hyoid bone with two muscular bundles which encompass the intermediate tendon of the digastric

F: lifts the hyoid bone during swallowing

Geniohyoid (The right and left parts of the muscle lie close to each other – only separated by a thin septum of connective tissue.)
Ventral branches of C1–C2



O: mental spine of the mandible

I: body of hyoid bone

F: supports the mylohyoid

10 Infrahyoid muscles (→ Figs. 11.3, 11.5)

The infrahyoid muscles are counteracting the suprahyoid muscles. Located beneath the superficial sternohyoid are the sternothyroid and the thyrohyoid. The omohyoid is positioned farthest to the lateral side.

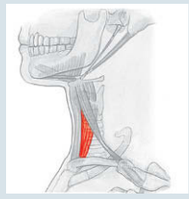
Sternohyoid
Ansa cervicalis (cervical plexus)

O: inner surface of the manubrium of sternum

I: body of hyoid bone

F: pulls the hyoid bone caudally

Sternothyroid
Ansa cervicalis (cervical plexus)

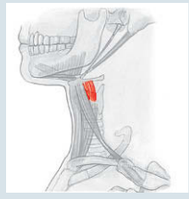


O: inner surface of the manubrium of sternum

I: oblique line of the lamina of the thyroid cartilage

F: pulls the larynx caudally

Thyrohyoid
Ansa cervicalis (cervical plexus)

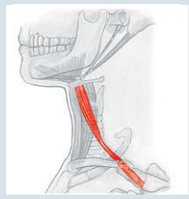


O: outer surface of the lamina of the thyroid cartilage

I: body of hyoid bone

F: approximates the hyoid bone and the larynx nearer to each other

Omohyoid (Inferior belly and superior belly are connected by an intermediate tendon which is attached to the carotid sheath.)
Ansa cervicalis (cervical plexus)



O: inferior belly: superior border of the scapula

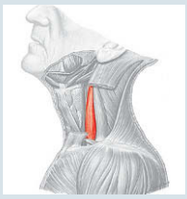
I: superior belly: body of hyoid bone

F: stretches the fascia of the neck since the intermediate tendon is attached to the carotid sheath, prevents the lumen of the internal jugular vein from collapsing, pulls the hyoid bone caudally

11 Scalene muscles (→ Figs. 2.89, 11.3, 11.5, 11.6)

The three scalene muscles, scalenus anterior, scalenus medius, and scalenus posterior course to the upper ribs and form a triangular muscular plate at the lateral aspect of the cervical vertebral column. The brachial plexus and the subclavian artery pass through the scalene triangle delineated by the scalenus anterior and scalenus medius.

Scalenus anterior
Direct branches of the cervical plexus and brachial plexus

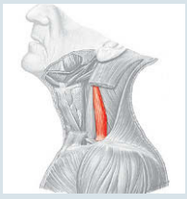


O: anterior tubercles of the transverse processes of the 3rd–6th cervical vertebrae

I: scalene tubercle of rib I

F: vertebral column: bends the cervical part of the vertebral column sideways
thorax: lifts rib I and thus the thorax (breathing muscle: inspiration)

Scalenus medius
Direct branches of the cervical plexus and brachial plexus

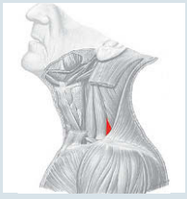


O: tubercles of the transverse processes of the 3rd–7th cervical vertebrae

I: rib I posterior to the groove for subclavian artery

F: vertebral column: bends the cervical vertebral column sideways
thorax: lifts rib I and thus the thorax (breathing muscle: inspiration)

Scalenus posterior
Direct branches of the cervical plexus and brachial plexus



O: posterior tubercles of the transverse processes of the 5th–6th cervical vertebrae

I: rib II

F: vertebral column: bends the cervical part of the vertebral column sideways
thorax: lifts rib II and thus the thorax (breathing muscle: inspiration)

12 Prevertebral muscles (→ Figs. 2.89, 11.6)

The prevertebral muscles are located to the right and left sides of the vertebral bodies of the cervical and upper thoracic vertebral column and are covered by the prevertebral lamina of the cervical fascia. The rectus capitis anterior and rectus capitis lateralis connect the anterior and lateral parts of the atlas and axis.

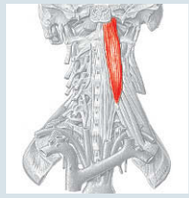
Rectus capitis anterior and **rectus capitis lateralis**
Direct branches of the cervical plexus

O: transverse process and lateral mass of the atlas

I: basilar part of the occipital bone

F: bend the head to the ventrolateral side, turn the head to the ipsilateral side

Longus capitis
Direct branches of the cervical plexus



O: anterior tubercles of the transverse processes of the 3rd–6th cervical vertebrae

I: basilar part of the occipital bone

F: bends the head ventrally, turns the head to the ipsilateral side

Longus colli
Direct branches of the cervical plexus

O: body of the 5th cervical to 3rd thoracic vertebrae, anterior tubercles of the transverse processes of the 2nd–5th cervical vertebrae

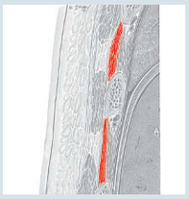
I: transverse processes of the 5th–6th cervical vertebrae, body of the 2nd–4th cervical vertebrae, anterior tubercle of the atlas

F: bends the head ventrally, turns the head to the ipsilateral side

13 Muscles of the thoracic wall (→ Figs. 2.87–2.93)

The pectoralis major shapes the surface relief of the anterior upper thoracic wall. Beneath this muscle lies the pectoralis minor. These two muscles, together with the subclavius, belong to the group of ventral muscles of the shoulder girdle (→ Table 24).
The external intercostal muscle and internal intercostal muscle fill the intercostal spaces. The subcostales and the transversus thoracis position on the inner side of the thoracic wall.

External intercostal muscle
Intercostal nerves (thoracic nerves)

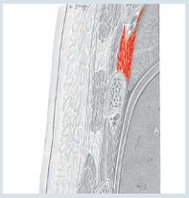


O: inferior costal rim from the tubercle to the bone-cartilage line of the ribs

I: superior rim of the next deeper rib

F: lifts the ribs, inspiration

Internal intercostal muscle (The innermost intercostal muscle is delineated on its inner side by the posterior intercostal vessels and the intercostal nerve.)
Intercostal nerves (thoracic nerves)



O: superior costal rim ventral to the costal angle

I: inferior rim of the next higher rib

F: depresses the ribs, expiration

Subcostales (inconsistent muscle)
Intercostal nerves (thoracic nerves)

O: superior rim of the lower ribs between tubercle and angle of rib

I: inferior rim of the lower ribs, skipping one rib

F: depresses the ribs, expiration

Transversus thoracis
Intercostal nerves (thoracic nerves)

O: dorsally at the body of sternum and xiphoid process

I: costal cartilage of ribs II–VI

F: braces the thoracic wall, expiration

14 Ventral muscles of the abdominal wall (→ Figs. 2.91–2.93, 2.98)

The muscles of the anterior abdominal wall, the rectus abdominis and the pyramidalis, are located within the rectus sheath.

Rectus abdominis
Intercostal nerves (thoracic nerves)

O: outer surface of the costal cartilage of ribs V–VII, costoxiphoid ligaments

I: pubic symphysis

F: bends the torso, abdominal press, expiration (diaphragmatic/abdominal breathing type)

Pyramidalis (inconsistent muscle)
Caudal intercostal nerves (thoracic nerves)

O: pubic symphysis ventral to the rectus abdominis

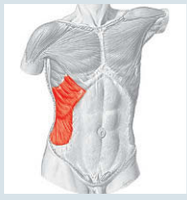
I: linea alba

F: "tenses" the linea alba

15 Lateral muscles of the abdominal wall (→ Figs. 2.85–2.87, 2.91–2.93, 2.96, 2.98, 2.99)

The external oblique, the internal oblique, and the transversus abdominis are collectively named the lateral muscles of the abdominal wall. Their tendinous plates form the rectus sheath. In men and women, the cremaster separates from the internal oblique and the transversus.

External oblique
Caudal intercostal nerves (thoracic nerves)



O: outer surface of ribs V–XII

I: outer lip of the iliac crest, inguinal ligament, participates in the formation of the anterior lamina of the rectus sheath

F: unilaterally active: rotates the thorax to the contralateral side, bends the vertebral column to the ipsilateral side;
bilaterally active: bends the torso, abdominal press, expiration (diaphragmatic breathing type)

Internal oblique
Caudal intercostal nerves (thoracic nerves); iliohypogastric nerve; ilioinguinal nerve (lumbar plexus)

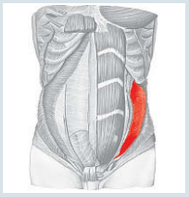
O: thoracolumbar fascia (deep layer), intermediate zone of the iliac crest, inguinal ligament

I: inferior rim of the costal cartilage of ribs IX–XII, contributes to the anterior and posterior laminae of the rectus sheath above the arcuate line, below thereof all tendinous fibers project into the anterior lamina

F: unilaterally active: rotates the thorax to the ipsilateral side, bends the vertebral column to the ipsilateral side;
bilaterally active: bends the torso, abdominal press, expiration (diaphragmatic breathing type)

15 Lateral muscles of the abdominal wall (continued)

Transversus abdominis
Caudal intercostal nerves (thoracic nerves); iliohypogastric nerve; ilioinguinal nerve (lumbar plexus); genitofemoral nerve



O: inner surface of the costal cartilage of ribs VII–XII, thoracolumbar fascia (deep layer), inner lip of the iliac crest, inguinal ligament

I: contributes to the posterior lamina of the rectus sheath above the arcuate line, below thereof it contributes to the formation of the anterior lamina

F: abdominal press, expiration (diaphragmatic breathing type)

Cremaster
Genitofemoral nerve

O: separation of the internal oblique and the transversus abdominis

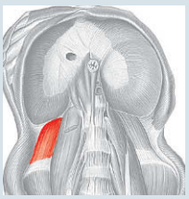
I: surrounds the spermatic cord, in women the round ligament of uterus

F: lifts the testis

16 Dorsal muscles of the abdominal wall (→ Figs. 2.96, 2.99)

The quadratus lumborum forms the muscular basis of the posterior abdominal wall. Medially thereof follows the psoas major.

Quadratus lumborum
Caudal intercostal nerves; muscular branches (lumbar plexus)



O: inner lip of the iliac crest

I: rib XII, costal process of the 4^{th}–1^{st} lumbar vertebrae

F: bends the vertebral column to the ipsilateral side

17 Spinocostal muscles (→ Fig. 2.75)

The spinocostal muscles, serratus posterior superior, and serratus posterior inferior, are thin muscles of minor functional relevance and are located on top of the autochthonous muscles of the back.

Serratus posterior superior
Cranial intercostal nerves (thoracic nerves)

O: spinous process of the 6^{th}, 7^{th} cervical vertebrae and the 1^{st}, 2^{nd} thoracic vertebrae

I: ribs II–V lateral to the angle of rib

F: elevates the ribs, inspiration

Serratus posterior inferior
Caudal intercostal nerves (thoracic nerves)

O: spinous process of the 11^{th}, 12^{th} thoracic vertebrae and the 1^{st}, 2^{nd} lumbar vertebrae

I: caudal margin of ribs IX–XII

F: depresses ribs IX–XII, as an antagonist to the diaphragm also active during forced inspiration

18 Autochthonous muscles of the back (→ Figs. 2.76–2.79, 2.81–2.84, 2.96)

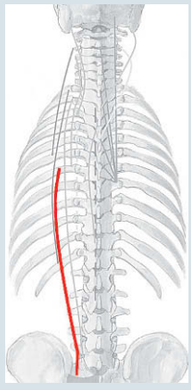
I Lateral tract

The lateral tract of the autochthonous muscles of the back covers the medial tract in the cervical and lumbar regions. Hence, it is also referred to as the superficial part of the autochthonous muscles of the back. The iliocostalis, the longissimus, and the intertransversarii constitute the group of straight muscles. Diverging cranially in an oblique angle (spinotransversal) are the splenius muscles. The levatores costarum course in an oblique laterocaudal direction to the ribs.

a) Sacrospinal system

Iliocostalis lumborum

Posterior branches of the lumbar nerves



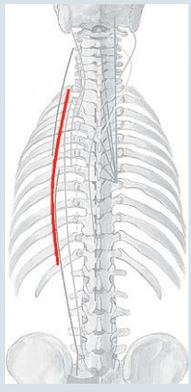
O: together with the longissimus thoracis from:
spinous processes of the lumbar vertebrae,
dorsal surface of the sacrum,
dorsal third of the iliac crest,
thoracolumbar fascia

I: angle of ribs XII–V

F: unilaterally active: lateroflexion; bilaterally active: extension

Iliocostalis thoracis

Posterior branches of the thoracic nerves



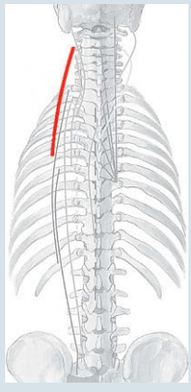
O: ribs XII–VII medial to the costal angle

I: angle of ribs (VI) VII–I

F: unilaterally active: lateroflexion; bilaterally active: extension

Iliocostalis cervicis

Posterior branches of the cervical nerves



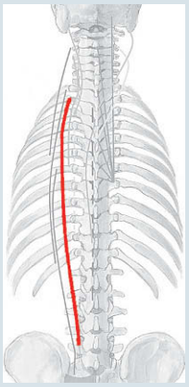
O: ribs VII–(IV) III medial to the costal angle

I: posterior tubercle of the transverse process of the 6^{th}–(4^{th}) 3^{rd} cervical vertebrae

F: unilaterally active: lateroflexion; bilaterally active: extension

18 Autochthonous muscles of the back (continued)

Longissimus thoracis
Posterior branches of the spinal nerves

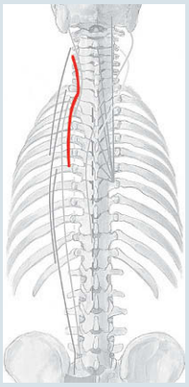


O: spinous processes of the lumbar vertebrae,
dorsal surface of the sacrum,
frequently from the mamillary process of the 2nd and 1st lumbar vertebrae and from the transverse process of the 12th–6th thoracic vertebrae

A: medial part: mamillary process of the 5th lumbar vertebra,
accessory process of the 4th–1st lumbar vertebrae,
transverse processes of the thoracic vertebrae;
lateral part: costal process of the 4th–1st lumbar vertebrae,
deep lamina of the thoracolumbar fascia,
ribs XII–II medial to the costal angle

F: unilaterally active: lateroflexion;
bilaterally active: extension

Longissimus cervicis
Posterior branches of the spinal nerves

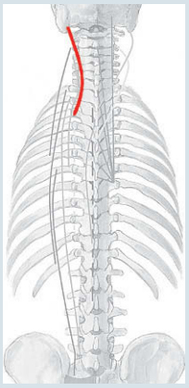


O: transverse process of the 6th–1st thoracic and 7th–3rd cervical vertebrae

I: posterior tubercle of the transverse process of the 5th–2nd cervical vertebrae

F: unilaterally active: lateroflexion;
bilaterally active: extension

Longissimus capitis
Posterior branches of the spinal nerves



O: transverse process of the 3rd thoracic to the 3rd cervical vertebrae

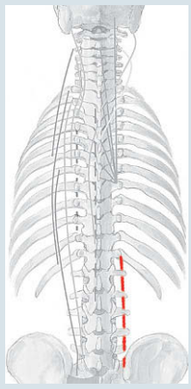
I: posterior margin of the mastoid process

F: unilaterally active: lateroflexion;
bilaterally active: extension

18 Autochthonous muscles of the back (continued)

b) Intertransversal system

Intertransversarii laterales lumborum (These are not autochthonous muscles in the true sense but they are of ventral origin.)
Anterior branches of the spinal nerves

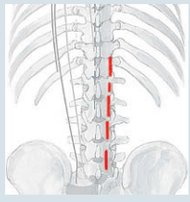


O: iliac tuberosity, costal process and accessory processs of the 5th–1st lumbar vertebrae, transverse process of the 12th thoracic vertebra

I: costal process of the 5th–1st lumbar vertebrae, iliac tuberosity

F: unilaterally active: lateroflexion; bilaterally active: extension

Intertransversarii mediales lumborum
Posterior branches of the spinal nerves

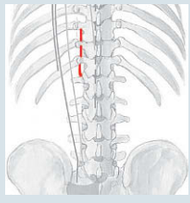


O: accessory process of the 4th–1st lumbar vertebrae

I: mamillary process of the 5th–2nd lumbar vertebrae

F: unilaterally active: lateroflexion; bilaterally active: extension

Intertransversarii thoracis
Posterior branches of the spinal nerves

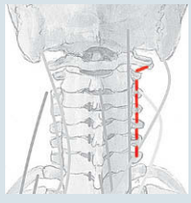


O: transverse process of the 12th–10th thoracic vertebrae

I: accessory process and mamillary process of the 1st lumbar vertebra up to the transverse process of the 11th thoracic vertebra

F: unilaterally active: lateroflexion; bilaterally active: extension

Intertransversarii posteriores cervicis
Posterior branches of the spinal nerves

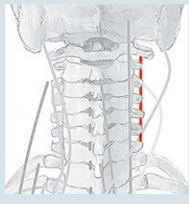


O: posterior tubercle of the transverse process of the 6th–1st cervical vertebrae

I: posterior tubercle of the transverse process of the 7th–2nd cervical vertebrae

F: unilaterally active: lateroflexion; bilaterally active: extension

Intertransversarii anteriores cervicis (These are not autochthonous muscles in the true sense but they are of ventral origin.)
Anterior branches of the spinal nerves



O: anterior tubercle of the transverse process of the 6th–1st cervical vertebrae

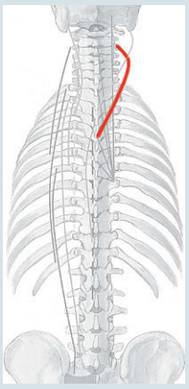
I: anterior tubercle of the transverse process of the 7th–2nd cervical vertebrae

F: unilaterally active: lateroflexion; bilaterally active: extension

18 Autochthonous muscles of the back (continued)

c) Spinotransversal system

Splenius cervicis
Posterior branches of the cervical nerves

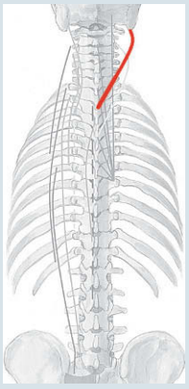


O: spinous process of the 3rd thoracic to the 6th cervical vertebrae, supraspinal ligament

I: posterior tubercle of the transverse process of the (3rd) 2nd–1st cervical vertebrae

F: unilaterally active: lateroflexion, rotation of the cervical part of the vertebral column and of the head to the ipsilateral side;
bilaterally active: extension of the cervical part of the vertebral column

Splenius capitis
Posterior branches of the cervical nerves



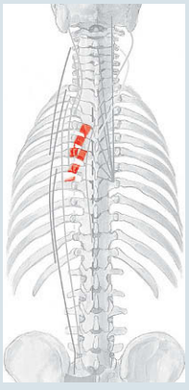
O: spinous process of the 3rd–7th cervical vertebrae, ligamentum nuchae

I: mastoid process, (superior nuchal line)

F: unilaterally active: lateroflexion, rotation of the cervical part of the vertebral column and of the head to the ipsilateral side;
bilaterally active: extension of the cervical part of the vertebral column

d) Levatores costarum

Levatores costarum (The levatores costarum longi skip a rib at a time, the levatores costarum breves course to the next caudal rib.)
Posterior branches of the cervical nerve [C8] and of the thoracic nerves [T1–T10]



O: transverse process of the 11th thoracic to 7th cervical vertebrae

I: ribs XII–I each lateral of the costal angle

F: lift the ribs, lateroflexion and rotation of the vertebral column

18 Autochthonous muscles of the back (continued)

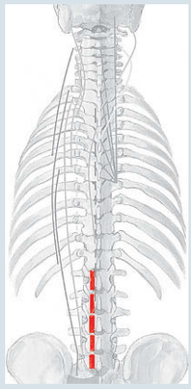
II Medial tract

The medial tract of the autochthonous muscles of the back is located beneath the lateral tract in the cervical and lumbar regions. Hence, it is also referred to as the deep part of the autochthonous muscles of the back. The interspinales and the spinalis constitute the group of straight muscles. The rotatores, the multifidi, and the semispinalis converge in a craniomedial direction (transversospinal).

a) Spinal system

Interspinales lumborum

Posterior branches of the spinal nerves



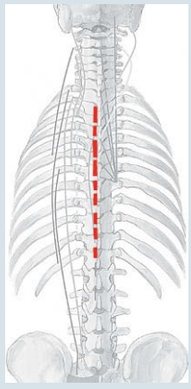
O: spinous process of the 5th–1st lumbar vertebrae

I: superior rim of the median sacral crest, spinous process of the 5th–2nd lumbar vertebrae

F: segmental extension

Interspinales thoracis

Posterior branches of the spinal nerves



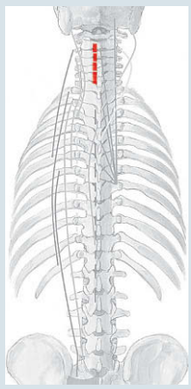
O: spinous process of the (12th) 11th–2nd (1st) thoracic vertebrae

I: spinous process of the (1st lumbar) 12th–3rd (2nd) thoracic vertebrae

F: segmental extension

Interspinales cervicis

Posterior branches of the spinal nerves



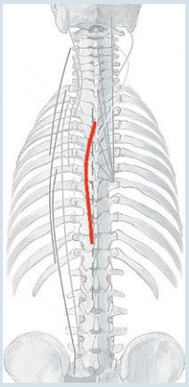
O: spinous process of the 7th–2nd cervical vertebrae

I: spinous process of the 1st thoracic to 3rd cervical vertebrae

F: segmental extension

18 Autochthonous muscles of the back (continued)

Spinalis thoracis (At its origin and insertion, this muscle has close connections with the longissimus thoracis and the multifidi, respectively.)
Posterior branches of the spinal nerves

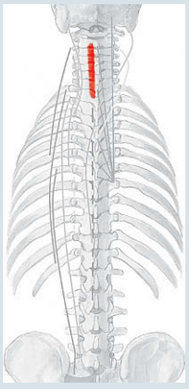


O: spinous process of the (3rd) 2nd, 1st lumbar and 12th–10th thoracic vertebrae

I: spinous process of the (10th) 9th–2nd thoracic vertebrae

F: unilaterally active: lateroflexion; bilaterally active: extension

Spinalis cervicis
Posterior branches of the spinal nerves

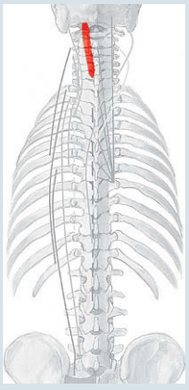


O: spinous process of the (4th) 3rd–1st thoracic and 7th–6th cervical vertebrae

I: spinous process of the (6th) 5th–2nd cervical vertebrae

F: unilaterally active: lateroflexion; bilaterally active: extension

Spinalis capitis (Inconsistent muscle, which, at its insertion point, is closely associated with the semispinalis capitis.)
Posterior branches of the spinal nerves



O: spinous process of the 3rd–1st thoracic and 7th–6th cervical vertebrae

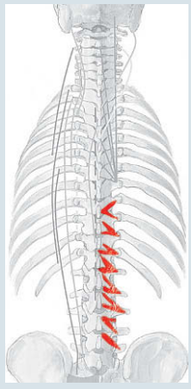
I: squamous part of occipital bone between highest nuchal line and superior nuchal line near the external occipital protuberance

F: unilaterally active: lateroflexion; bilaterally active: extension

18 Autochthonous muscles of the back (continued)

b) Transversospinal system

Rotatores (They are subdivided into the rotatores cervicis, rotatores thoracis, and the inconsistent rotatores lumborum. The rotatores breves course to the adjacent upper vertebra, whereas the rotatores longi skip one vertebra at a time.)
Posterior branches of the spinal nerves

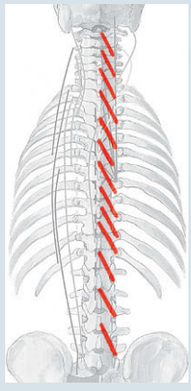


O: mamillary processes of the lumbar vertebrae,
transverse processes of the thoracic vertebrae,
inferior articular processes of the cervical vertebrae

I: base of the spinous process of the 3rd–1st lumbar, 12th–1st thoracic, and 7th–2nd cervical vertebrae

F: unilaterally active: segmental laterоflexion, rotation;
bilaterally active: segmental extension

Multifidi (They are particularly strong in the lumbar region and skip two to four vertebrae at a time.)
Posterior branches of the spinal nerves

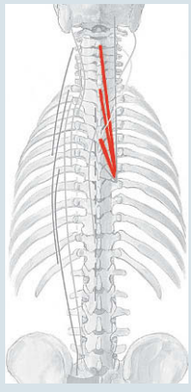


O: dorsal surface of the sacrum,
posterior sacro-iliac ligament,
dorsal part of the iliac crest,
mamillary processes of the lumbar vertebrae,
transverse processes of the thoracic vertebrae,
inferior articular process of the 7th–4th cervical vertebrae

I: spinous process of the 5th–1st lumbar, 12th–1st thoracic, and 7th–2nd cervical vertebrae

F: unilaterally active: segmental laterоflexion, rotation;
bilaterally active: segmental extension

Semispinalis thoracis (Its muscle fibers skip five to seven vertebrae at a time.)
Posterior branches of the spinal nerves



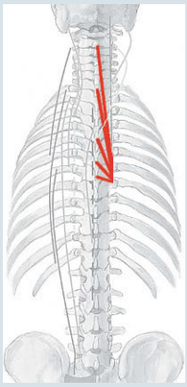
O: transverse process of the (12th) 11th–7th (6th) thoracic vertebrae

I: spinous process of the (4th) 3rd thoracic to the 6th cervical vertebrae

F: unilaterally active: rotation of the vertebral column and head to the contralateral side;
bilaterally active: extension

18 Autochthonous muscles of the back (continued)

Semispinalis cervicis
Posterior branches of the spinal nerves

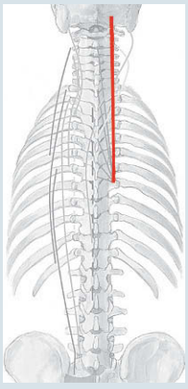


O: transverse process of the (7^{th}) 6^{th} thoracic to 7^{th} cervical vertebrae

I: spinous process of the 6^{th}–3^{rd} cervical vertebrae

F: unilaterally active: rotation of the vertebral column and head to the contralateral side, sidebending; bilaterally active: extension

Semispinalis capitis
Posterior branches of the spinal nerves



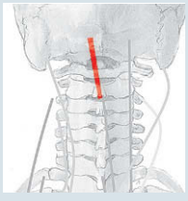
O: transverse process of the (8^{th}) 7^{th} thoracic to 3^{rd} cervical vertebrae

I: squamous part of occipital bone between highest nuchal line and superior nuchal line, medial part

F: unilaterally active: rotation of the vertebral column and head to the contralateral side, sidebending; bilaterally active: extension

III Autochthonous deep muscles of the neck (→ Figs. 2.77, 2.78, 2.81–2.83)

Rectus capitis posterior major
Suboccipital nerve (dorsal branch of the cervical nerve [C1])

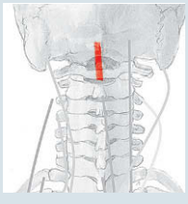


O: spinous process of the axis

I: middle third of the inferior nuchal line

F: unilaterally active: rotates and bends the head to the ipsilateral side; bilaterally active: involved in the fine-tuned positioning and kinematics of the head joints, extension

Rectus capitis posterior minor
Suboccipital nerve (dorsal branch of the cervical nerve [C1])



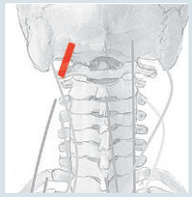
O: posterior tubercle of the posterior arch of atlas

I: inferomedial to the inferior nuchal line

F: unilaterally active: rotates and bends the head to the ipsilateral side; bilaterally active: involved in the fine-tuned positioning and kinematics of the head joints, extension

18 Autochthonous muscles of the back (continued)

Obliquus capitis superior
Suboccipital nerve (dorsal branch of the cervical nerve [C1])

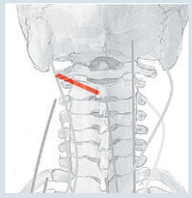


O: transverse process of the atlas

I: lateral third of the inferior nuchal line

F: unilaterally active: bends the head to the ipsilateral side;
bilaterally active: involved in the fine-tuned positioning and kinematics of the head joints, extension

Obliquus capitis inferior
Suboccipital nerve (dorsal branch of the cervical nerve [C1])



O: spinous process of the axis

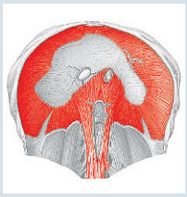
I: transverse process of the atlas

F: unilaterally active: bends the head to the ipsilateral side;
bilaterally active: involved in the fine-tuned positioning and kinematics of the head joints, extension

19 Diaphragm (→ Figs. 2.98–2.101)

The diaphragm separates the thoracic cavity from the abdominal cavity. Its cupulas form the floor of the right and left pleural cavity, respectively. The lumbar part delineates the retroperitoneal space dorsally and is part of the posterior abdominal wall.

Diaphragma
Phrenic nerve (cervical plexus)



O: sternal part: inner surface of the xiphoid process, rectus sheath
costal part: inner surface of the costal cartilage of ribs XII–VI
lumbar part:
– medial part: body of the 3rd–1st lumbar vertebrae
– lateral part: with medial arcuate ligament (psoas arcade) and lateral arcuate ligament (quadratus arcade) at the costal process of ribs I and XII

I: all parts unite in the central tendon

F: diaphragmatic (abdominal) breathing (inspiration), abdominal press

Passageways and weak spots in the diaphragm

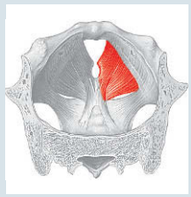
Name	Position	Structure
Aortic hiatus	lumbar part, between right crus, left crus and vertebral column	aorta; thoracic duct
Esophageal hiatus	lumbar part (medial part, left side)	esophagus; vagus nerves; left phrenic nerve: left phrenico-abdominal branch
Caval opening	central tendon	inferior vena cava; right phrenic nerve: right phrenico-abdominal branch
Sternocostal triangle [LARREY's triangle]	between costal part and lumbar part	superior epigastric artery/vein
Lumbocostal triangle	between sternal part and costal part	
Not labeled	lumbar part, (medial part)	greater and lesser splanchnic nerves; azygos vein; hemi-azygos vein
Not labeled	lumbar part, between medial part and lateral part	sympathetic trunk
Not labeled	central tendon	left phrenic nerve: left phrenico-abdominal branch

20 Muscles of the pelvic floor and perineal muscles (→ Figs. 7.63–7.65, 7.87–7.89, 7.99, 7.115)

The pelvic diaphragm is formed by the levator ani and the ischiococcygeus. Beneath it lie the perineal muscles.

a) Pelvic diaphragm

Levator ani (It consists of the pubococcygeus and the iliococcygeus. Beginning at the pubococcygeus, the puborectalis forms a loop around the rectum.)
Branches of the sacral nerve [S3 and S4]

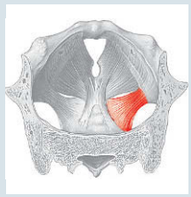


O: pubococcygeus: inner surface of the pubis adjacent to the pubic symphysis
iliococcygeus: tendinous arch of levator ani

I: central tendon of perineum, coccyx, sacrum, loop formation with fibers of the opposite side behind the anus (puborectalis)

F: stabilizes pelvic organs, hence facilitates urinary and fecal continence, encompasses the rectum from behind, hence distal rectal occlusion (puborectalis)

Ischiococcygeus
Branches of the sacral nerve [S3 and S4]

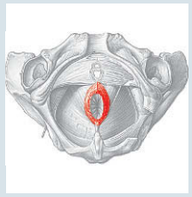


O: ischiadic spine, sacrospinal ligament

I: sacrum, coccyx

F: similar to levator ani

External anal sphincter
Pudendal nerve (sacral plexus)



O: subcutaneous part: dermis and subcutis around the anus
superficial and deep part: central tendon of perineum

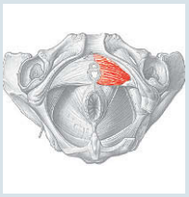
I: dermis and subcutis around the anus, anococcygeal ligament

F: occlusion of the anus

20 Muscles of the pelvic floor and perineal muscles (continued)

b) Perineal muscles

Deep transverse perineal muscle
Pudendal nerve (sacral plexus)



O: inferior pubic ramus

I: central tendon of perineum

F: secures the levator gap

External urethral sphincter (part of the deep transverse perineal muscle)
Pudendal nerve (sacral plexus)

U: circular muscle, muscle fibers from the deep transverse perineal muscle

A: connective tissue surrounding the urethra (membranous part), vaginal wall (sphincter urethrovaginalis)

F: occlusion of the urethra, occlusion of the urinary bladder during ejaculation

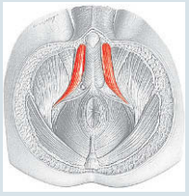
Superficial transverse perineal muscle (inconsistent muscle)
Pudendal nerve (sacral plexus)

O: ramus of ischium

I: central tendon of perineum

F: supports the deep transverse perineal muscle

Ischiocavernosus
Pudendal nerve (sacral plexus)

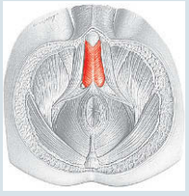


O: ramus of ischium

I: crus of penis/clitoris

F: stabilizes the cavernous bodies of penis/clitoris, ejaculation

Bulbospongiosus (surrounds the bulb of penis in men and the bulb of vestibule in women)
Pudendal nerve (sacral plexus)



O: central tendon of perineum, in men also at the raphe of penis

I: surrounds the bulb of penis/bulb of vestibule

F: stabilizes the cavernous bodies of penis/clitoris, ejaculation

21 Joints of the upper extremity (→ Fig. 3.8)

a) Joints of the shoulder girdle

Name of joint	Type of joint	Range of movement
Medial clavicular joint sternoclavicular joint	uneven articular surfaces, irregular joint functionally: spheroidal joint (characteristic: articular disc)	rotation in the sagittal axis (when lifting the shoulder), rotation in the longitudinal axis of the arm (during anteversion and retroversion of the shoulder), rotation in the longitudinal axis of the clavicle (when swinging the arm)
Lateral clavicular joint acromioclavicular joint	plane joint, functionally: spheroidal joint (characteristic: variable, mostly incomplete articular disc)	rotation in the sagittal axis (when lifting the shoulder), rotation in the transverse axis (when swinging the arm), rotation in the longitudinal axis (during anteversion and retroversion of the shoulder)

b) Joints of the upper extremity

Name of joint	Type of joint	Range of movement
Shoulder joint	spheroidal joint	anteversion (flexion) retroversion (extension) abduction adduction medial rotation lateral rotation (arm rotation, circumduction: combined movement with anteversion, abduction, retroversion, adduction)
Elbow joint a) humero-ulnar joint b) humeroradial joint c) proximal radio-ulnar joint	 hinge joint spheroidal joint (functionally restricted: no abduction) pivot joint	 flexion extension flexion extension rotation pronation supination
Distal radio-ulnar joint	pivot joint	pronation supination
Carpal joints a) proximal carpal joint, radiocarpal joint b) distal carpal joint, mediocarpal joint	 ellipsoid joint hinge joint	lateral movements of the hand: ulnar abduction radial abduction palmar flexion dorsal extension
Thumb joint carpometacarpal joint of thumb	saddle joint	abduction adduction opposition reposition
Carpometacarpal joints II–V	plane joints	variable degree of sliding movements
Metacarpophalangeal joints	spheroidal joints (functionally restricted)	flexion extension abduction* adduction* (* in relation to the middle finger)
Finger joints	hinge joints	flexion extension

21 Joints of the upper extremity (continued)

c) Planes and axes of the joints of the upper extremity

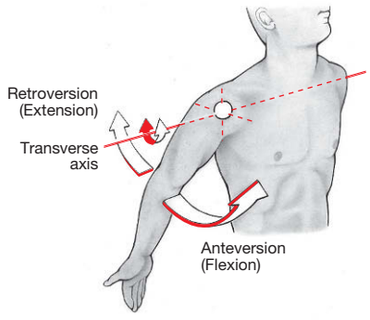


Fig. 1 Shoulder joint;
movement in the sagittal plane.

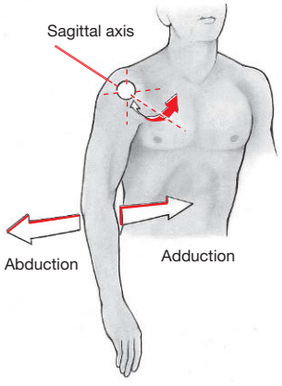


Fig. 2 Shoulder joint;
movement in the frontal plane.

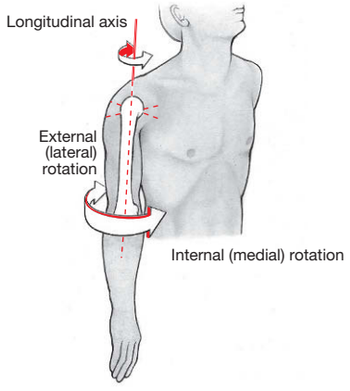


Fig. 3 Shoulder joint;
movement in the transverse plane.

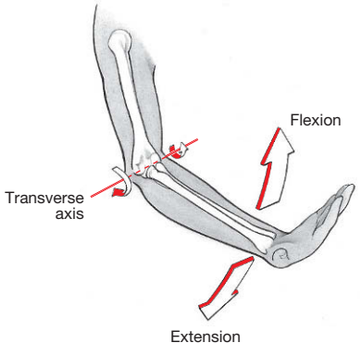


Fig. 4 Elbow joint;
movement in the sagittal plane.

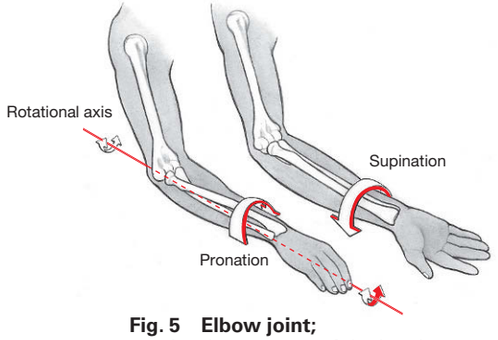


Fig. 5 Elbow joint;
rotational movement of the hand.

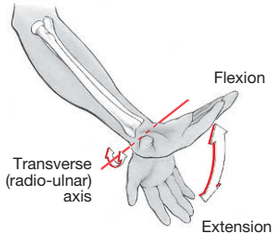


Fig. 6 Carpal joints;
movement in the sagittal plane.

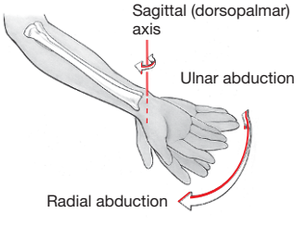


Fig. 7 Carpal joints;
movement in the frontal plane.

Palmar flexion and dorsiflexion in the carpal joint are also known as flexion and extension, respectively.

22 Branches and innervation areas of the brachial plexus

(→ Figs. 3.102–3.115, 3.117–3.120, 3.123, 3.124, 3.127, 3.128)

	motor function	sensory function
Brachial plexus (C5) C4–T1 (T2)		
Dorsal scapular nerve (C3) C4, C5	levator scapulae, rhomboid muscles	
Suprascapular nerve C4–C6	supraspinatus, infraspinatus	
Subscapular nerves C5–C7	subscapularis, (teres major)	
Subclavian nerve C5, C6	subclavius	
Long thoracic nerve C5–C7	serratus anterior	
Pectoral nerves C5–T1	pectoralis major, pectoralis minor	
Thoracodorsal nerve C6–C8	latissimus dorsi, teres major	
Muscular branches	longus colli, longus capitis	
Musculocutaneous nerve C5–C7	coracobrachialis, biceps brachii, brachialis	skin of the radial palmar side of the forearm
Median nerve C6–T1	pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum superficialis, flexor pollicis longus, flexor digitorum profundus (radial part), pronator quadratus, flexor pollicis brevis (superficial head), opponens pollicis, lumbricals I, II	skin of the radial part of the palm (3½ fingers), skin of the distal phalanges (dorsal: 3½ fingers)
Ulnar nerve C8–T1	flexor carpi ulnaris, flexor digitorum profundus (ulnar part), palmaris brevis, flexor digiti minimi, opponens digiti minimi, abductor digiti minimi, flexor pollicis brevis (deep head), adductor pollicis, lumbricals III, IV, interossei	skin of the ulnar side of the hand (palmar: 1½ fingers, dorsal: 2½ fingers), skin of the distal phalanges (dorsal: 1½ fingers)
Medial cutaneous nerve of arm C8–T1		skin of the medial palmar side of the upper arm
Medial cutaneous nerve of forearm C8–T1		skin of the ulnar palmar side of the forearm
Axillary nerve C5–C6	deltoid, teres minor	skin of the shoulder
Radial nerve C5–T1	triceps brachii, anconeus, brachioradialis, extensor carpi radialis longus, extensor carpi radialis brevis, supinator, extensor digitorum, extensor pollicis longus, abductor pollicis longus, extensor pollicis brevis, extensor indicis, extensor carpi ulnaris	skin of the dorsal side of the upper arm, forearm, and hand (2½ radial fingers, with the exception of the distal phalanges)

23 Segmental innervation of the muscles of the arm, diagnostically relevant indicator muscles

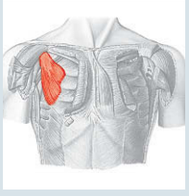
(according to **MUMENTHALER** and **SCHLIACK**)
The muscles printed in bold are used clinically as indicator muscles for a specific spinal cord segment.

Supraspinatus	C4–C5	Abductor pollicis longus	C6–C8
Teres minor	C4–C5	Extensor pollicis brevis	C7–T1
Deltoid: C5	C5–C6	Extensor pollicis longus	C6–C8
Infraspinatus	C4–C6	Extensor digitorum	C6–C8
Subscapularis	C5–C6	Extensor indicis	C6–C8
Teres major	C5–C7	Extensor carpi ulnaris	C6–C8
Biceps brachii: C6	C5–C6	Extensor digiti minimi	C6–C8
Brachialis	C5–C6	Flexor digitorum superficialis	C7–T1
Coracobrachialis	C5–C7	Flexor digitorum profundus	C7–T1
Triceps brachii: C7	C6–C8	Flexor carpi ulnaris	C7–T1
Brachioradialis	C5–C6	Abductor pollicis brevis	C7–T1
Extensor carpi radialis longus	C5–C7	Flexor pollicis brevis	C7–T1
Extensor carpi radialis brevis	C5–C7	Opponens pollicis	C6–C7
Supinator	C5–C6	Flexor digiti minimi	C7–T1
Pronator teres	C6–C7	Adductor pollicis	C8–T1
Flexor carpi radialis	C6–C7	**Abductor digiti minimi: C8**	C8–T1
Flexor pollicis longus	C6–C8	**Interossei: C8**	C8–T1

24 Ventral muscles of the shoulder girdle (→ Figs. 2.85–2.87, 3.64, 3.65, 3.66c, d, 3.70)

The shoulder muscles are composed of two groups. The muscles of the shoulder girdle insert at the scapula or the clavicle and primarily move the shoulder girdle and, thus, only indirectly the arm. The muscles of the shoulder insert at the humerus and move it directly. The serratus anterior, pectoralis minor, and subclavius represent the ventral muscles of the shoulder girdle.

Pectoralis minor
Medial and lateral pectoral nerves (brachial plexus, infraclavicular part)

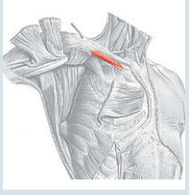


O: ribs (II) III–V close to the bone-cartilage margin

I: tip of the coracoid process

F: shoulder girdle: depress
thorax: elevating the upper ribs (inspiration: auxiliary breathing muscle)

Subclavius
Subclavian nerve (brachial plexus, infraclavicular part)

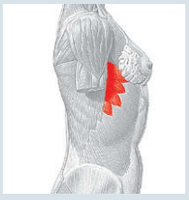


O: bone-cartilage margin of rib I

I: lateral third of the clavicle

F: shoulder girdle: stabilizes the sternoclavicular joint, protects the subclavian vessels
The fascia of the subclavius and the adventitia of the subclavian vein adhere tightly and this keeps the venous lumen open.

Serratus anterior (A scapula alata is caused by the paralysis of the serratus anterior or the rhomboid.)
Long thoracic nerve (brachial plexus, supraclavicular part)



O: superior part: ribs I, II
diverging part: ribs II–III
converging part: ribs IV–IX

I: superior part: superior angle of the scapula
diverging part: medial border of the scapula
converging part: inferior angle of the scapula

F: shoulder girdle: holds the scapula against the trunk, together with the rhomboids presses the scapula against the thorax
superior part: elevates the scapula
diverging part: depresses the scapula
converging part: depresses the scapula and, together with the trapezius, rotates its lower angle outwards for the elevation of the arm over the horizontal axis
thorax: elevates the ribs when the scapula is in a fixed position (inspiration)

25 Ventral muscles of the shoulder (→ Figs. 2.85–2.87, 3.64, 3.65, 3.67f, 3.70)

The pectoralis major is the only ventral shoulder muscle and responsible for the shape of the surface relief of the ventral upper chest wall.

Pectoralis major (The muscle fibers converge laterally to form a broad flat tendon that is shaped like a pocket which is open at its top.)
Medial and lateral pectoral nerves (brachial plexus, infraclavicular part)

O: clavicular part: sternal half of the clavicle
sternocostal part: manubrium and body of sternum, costal cartilage of ribs II–VII
abdominal part: anterior lamina of the rectus sheath

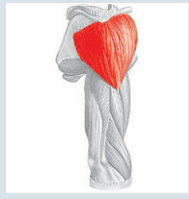
I: crest of greater tubercle of the humerus

F: shoulder joint: adduction (most important muscle), inwards rotation
clavicular part: anteversion (most important muscle); retroversion from an anteverted position
shoulder girdle: depression, anteversion
thorax: elevates the sternum and the upper ribs when the shoulder girdle is in a fixed position (inspiration: auxiliary breathing muscle)

26 Lateral muscles of the shoulder (→ Figs. 3.65, 3.67d, e, 3.69, 3.76)

The deltoid provides a distinct surface relief for the shoulder. Beneath it and separated by the subdeltoid bursa lies the tendon of the supraspinatus.

Deltoid
Axillary nerve (brachial plexus, infraclavicular part)

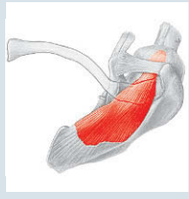


O: clavicular part: acromial third of the clavicle
acromial part: acromion
spinal part: spine of scapula

I: deltoid tuberosity

F: shoulder joint:
clavicular part: adduction (from approx. 60° onwards increasingly abduction), medial rotation, anteversion
acromial part: abduction to the horizontal plane
spinal part: adduction (from approx. 60° onwards increasingly abduction), lateral rotation, retroversion

Supraspinatus
Suprascapular nerve (brachial plexus, supraclavicular part)



O: supraspinous fossa, supraspinous fascia

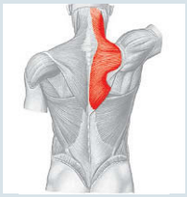
I: upper facet of the greater tubercle, joint capsule

F: shoulder joint:
abduction at the scapular level up to the horizontal plane, small lateral rotation

27 Dorsal muscles of the shoulder girdle (→ Figs. 3.65, 3.66a, b, 3.71)

The dorsal muscles of this group, trapezius, levator scapulae, rhomboid major, and rhomboid minor, are considered as superficial muscles of the back due to their location. Their origin and innervation identifies them as muscles of the back that have migrated into the shoulder region.

Trapezius
Accessory nerve [XI] and branches of the cervical plexus

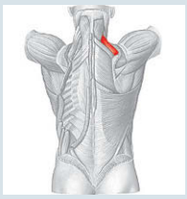


O: descending part: at the occipital bone between highest nuchal line and superior nuchal line, spinous processes of the upper cervical vertebrae
transverse part: spinous processes of the lower cervical and upper thoracic vertebrae
ascending part: spinous processes of the middle and lower thoracic vertebrae

I: descending part: acromial third of the clavicle
transverse part: acromion
ascending part: spine of scapula

F: descending part: prevents lowering of the shoulder girdle and arm (e.g. carrying a suitcase), elevates the scapula and rotates its lower tip laterally to allow the elevation of the arm above the horizontal plane together with the serratus anterior, rotates the head to the contralateral side when the shoulder is in a fixed position, erects the cervical part of the vertebral column when innervated bilaterally
transverse part: pulls the scapula downwards
ascending part: depresses the scapula and rotates it downwards

Levator scapulae
Direct branches of the cervical plexus and dorsal scapular nerve (brachial plexus, supraclavicular part)

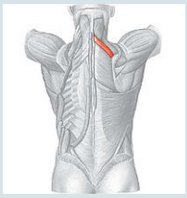


O: posterior tubercles of the transverse processes of the 1st–4th cervical vertebrae

I: superior angle of the scapula

F: shoulder girdle:
elevates the scapula

Rhomboid minor
Dorsal scapular nerve (brachial plexus, supraclavicular part)

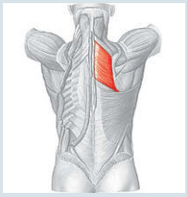


O: spinous process of the 6th and 7th cervical vertebrae

I: medial border of the scapula cranial to the spine of scapula

F: pulls the scapula medially and cranially,
fixes the scapula to the torso together with the serratus anterior

Rhomboid major
Dorsal scapular nerve (brachial plexus, supraclavicular part)



O: spinous process of the upper four thoracic vertebrae

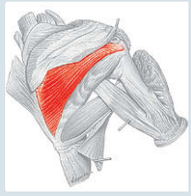
I: medial border of the scapula caudal to the spine of scapula

F: pulls the scapula medially and cranially,
fixes the scapula to the torso together with the serratus anterior

28 Dorsal muscles of the shoulder (→ Figs. 3.65, 3.67a–c, 3.71)

The infraspinatus is located farthest cranially. Following caudally are the teres minor and the teres major. The subscapularis is the only muscle of this group located on the ventral side of the scapula. The latissimus dorsi covers a large area of the lower segments of the autochthonous muscles of the back.

Infraspinatus
Suprascapular nerve (brachial plexus, supraclavicular part)

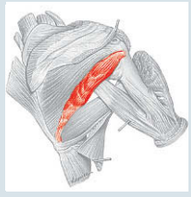


O: infraspinous fossa, infraspinous fascia

I: middle facet of the greater tubercle, joint capsule

F: shoulder joint:
cranial part: lateral rotation (most important muscle)

Teres minor
Axillary nerve (brachial plexus, infraclavicular part)

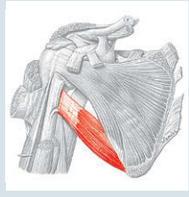


O: middle third of the lateral border

I: lower facet of the greater tubercle, joint capsule

F: shoulder joint:
lateral rotation,
adduction in the scapular plane

Teres major
Thoracodorsal nerve (brachial plexus, infraclavicular part)

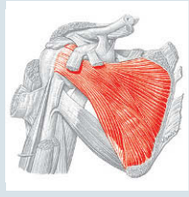


O: inferior angle

I: crest of lesser tubercle medial to the latissimus dorsi

F: shoulder joint:
medial rotation,
adduction,
retroversion

Subscapularis (Beneath the muscle and adjacent to the insertion site lies the subtendinous bursa of subscapularis.)
Subscapular nerves (brachial plexus, infraclavicular part)

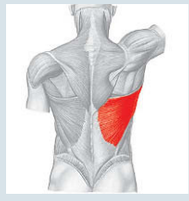


O: subscapular fossa

I: lesser tubercle, joint capsule

F: shoulder joint:
medial rotation (most important muscle)

Latissimus dorsi
Thoracodorsal nerve (brachial plexus, infraclavicular part)



O: spinous process of the six lower thoracic vertebrae and the lumbar vertebrae,
thoracolumbar fascia,
dorsal surface of the sacrum,
outer lip of the iliac crest,
ribs IX–XII,
frequently inferior angle of the scapula

I: crest of lesser tubercle

F: shoulder joint:
adduction,
medial rotation,
retroversion

29 Ventral muscles of the upper arm (→ Figs. 3.61, 3.72, 3.74, 3.75)

The biceps brachii shapes the surface relief of the upper arm. The coracobrachialis is in close proximity to its short head. Of all muscles of the upper arm, the brachialis is located the deepest.

Biceps brachii (The tendon of the long head courses freely through the shoulder joint.)
Musculocutaneous nerve (brachial plexus, infraclavicular part)

O: long head:
supraglenoid tubercle
short head:
tip of the coracoid process

I: radial tuberosity via the bicipital aponeurosis at the antebrachial fascia

F: shoulder joint:
long head: abduction, anteversion, medial rotation
short head: adduction, anteversion, medial rotation
elbow joint:
flexion (most important muscle), supination (most important muscle with flexed elbow)

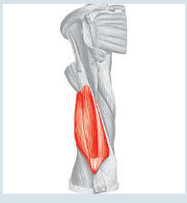
Coracobrachialis (normally pierced by the musculocutaneous nerve)
Musculocutaneous nerve (brachial plexus, infraclavicular part)

O: coracoid process

I: anterior surface of the humerus medial and distal to the crest of lesser tubercle

F: shoulder joint:
medial rotation, adduction, anteversion

Brachialis
Musculocutaneous nerve (brachial plexus, infraclavicular part)



O: anterior surface of the humerus (lower half)

I: tuberosity of ulna

F: elbow joint:
flexion, tenses the joint capsule

30 Dorsal muscles of the upper arm (→ Figs. 3.73, 3.76, 3.77)

The three heads of the triceps brachii constitute the muscles at the dorsal side of the upper arm. Further distally, the anconeus is located on the ulnar side at the transition to the forearm and serves as a continuation of the medial head of the triceps muscle.

Triceps brachii
Radial nerve (brachial plexus, infraclavicular part)

O: long head: infraglenoid tubercle
medial head: posterior surface of the humerus medial and distal of the radial groove
lateral head: posterior surface of the humerus lateral and proximal of the radial groove

I: olecranon

F: shoulder joint:
long head:
adduction, retroversion
elbow joint:
extension (most important muscle)

Anconeus (located adjacent to the lateral part of the medial head of the triceps brachii)
Radial nerve (brachial plexus, infraclavicular part)

O: lateral epicondyle of humerus

I: posterior surface of the ulna, olecranon

F: elbow joint:
extension

31 Ventral superficial muscles of the forearm (→ Figs. 3.61, 3.78–3.81, 3.93)

The pronator teres, flexor carpi radialis, palmaris longus, and flexor carpi ulnaris form the superficial layer. The flexor digitorum superficialis constitutes the middle layer.

Pronator teres
Median nerve (brachial plexus, infraclavicular part)

O: humeral head: medial epicondyle of the humerus
ulnar head: coronoid process

I: middle third of the lateral surface of the radius

F: elbow joint:
pronation (most important muscle), flexion

Flexor carpi radialis
Median nerve (brachial plexus, infraclavicular part)

O: medial epicondyle of the humerus, antebrachial fascia

I: palmar area of the base of metacarpal II

F: elbow joint:
flexion,
pronation
carpal joint:
palmar flexion,
radial abduction

Palmaris longus (inconsistent muscle)
Median nerve (brachial plexus, infraclavicular part)

O: medial epicondyle of the humerus

I: palmar aponeurosis

F: elbow joint:
flexion
carpal joint:
palmar flexion, tensing the palmar aponeurosis

Flexor digitorum superficialis (Shortly before the tendons of this muscle reach their insertion sites, they are pierced by the tendons of the flexor digitorum profundus.)
Median nerve (brachial plexus, infraclavicular part)

O: humero-ulnar head:
medial epicondyle of the humerus, coronoid process
radial head: anterior surface of the radius

I: with four long tendons at the base of the middle phalanx of the 2nd–5th fingers

F: elbow joint:
flexion
carpal joint:
palmar flexion
metacarpophalangeal joints (II–V):
flexion
proximal interphalangeal joints (II–V):
flexion (most important flexor)

Flexor carpi ulnaris
Ulnar nerve (brachial plexus, infraclavicular part)

O: humeral head: medial epicondyle of the humerus
ulnar head: olecranon, upper two-thirds of the posterior border of the ulna

I: via the pisiform and the pisometacarpal and pisohamate ligaments at the base of metacarpal V and the hamate

F: elbow joint:
flexion
carpal joint:
palmar flexion,
ulnar abduction

32 Ventral deep muscles of the forearm (→ Figs. 3.78, 3.80, 3.82, 3.89, 3.90, 3.94)

Located medially and forming the deep muscular layer are the flexor digitorum profundus and lateral thereof the flexor pollicis longus. The pronator quadratus covers the distal quarter of the forearm and represents the deepest layer.

Flexor digitorum profundus
Ulnar nerve for the ulnar part, anterior interosseous nerve from the median nerve for the radial part (brachial plexus, infraclavicular part)

O: anterior surface of the ulna, interosseous membrane

I: base of the distal phalanx of the 2nd–5th fingers

F: carpal joint:
palmar flexion
metacarpophalangeal joints (II–V):
flexion
interphalangeal joints (II–V):
flexion (most important flexor of the interphalangeal joints)

Flexor pollicis longus
Anterior interosseous nerve from the median nerve (brachial plexus, infraclavicular part)

O: anterior surface of the radius

I: base of the distal phalanx of the thumb

F: carpal joint:
palmar flexion
carpometacarpal joint (I):
flexion,
opposition
interphalangeal joint (I):
flexion

Pronator quadratus
Anterior interosseous nerve (median nerve, brachial plexus, infraclavicular part)

O: distal part of the anterior surface of the ulna

I: anterior surface of the radius

F: radio-ulnar joints:
pronation

33 Lateral (radial) muscles of the forearm (→ Figs. 3.83, 3.89, 3.90)

The group of radial muscles of the forearm consists of the brachioradialis, extensor carpi radialis longus, and extensor carpi radialis brevis (from proximal to distal).

Brachioradialis
Radial nerve (brachial plexus, infraclavicular part)

O: lateral border of the humerus

I: proximal of the styloid process of the radius

F: elbow joint:
flexion (because of the large virtual lever arm, flexion is particularly effective from a mid-flexed position),
pronation or supination (facilitated pronation from an opposite end-of-range position and vice versa)

Extensor carpi radialis longus
Radial nerve (brachial plexus, infraclavicular part)

O: lateral supracondylar ridge up to the lateral epicondyle

I: dorsal area of the base of metacarpal II

F: elbow joint:
flexion,
pronation (facilitated from an opposite end-of-range position)
carpal joint:
dorsiflexion,
radial abduction

Extensor carpi radialis brevis
Radial nerve (brachial plexus, infraclavicular part)

O: lateral epicondyle of the humerus

I: dorsal area of the base of metacarpal III

F: elbow joint:
flexion,
pronation (facilitated from an opposite end-of-range position)
carpal joint:
dorsiflexion,
radial abduction

34 Dorsal superficial muscles of the forearm (→ Figs. 3.84a, 3.86, 3.87, 3.91)

The group of dorsal superficial muscles of the forearm is composed of the extensor digitorum, extensor digiti minimi, and extensor carpi ulnaris (from radial to ulnar).

Extensor digitorum
Deep branch of the radial nerve (brachial plexus, infraclavicular part)

O: lateral epicondyle of the humerus, antebrachial fascia

I: dorsal aponeuroses of the 2nd–5th fingers

F: elbow joint:
extension
carpal joint:
dorsiflexion
metacarpophalangeal joints (II–V)/ interphalangeal joints (II–V):
extension (most important extensor in the metacarpophalangeal and proximal interphalangeal joints)

Extensor digiti minimi
Deep branch of the radial nerve (brachial plexus, infraclavicular part)

O: lateral epicondyle of the humerus, antebrachial fascia

I: dorsal aponeurosis of the 5th finger

F: elbow joint:
extension
carpal joint:
dorsiflexion
metacarpophalangeal joint (V)/ interphalangeal joint (V):
extension (most important extensor in the metacarpophalangeal and proximal interphalangeal joints)

Extensor carpi ulnaris
Deep branch of the radial nerve (brachial plexus, infraclavicular part)

O: humeral head: lateral epicondyle of the humerus
ulnar head: olecranon, posterior surface of the ulna, antebrachial fascia

I: dorsal area of metacarpal V

F: elbow joint:
extension
carpal joint:
dorsiflexion,
ulnar abduction

35 Dorsal deep muscles of the forearm (→ Figs. 3.78, 3.84b, c, 3.87–3.91)

The supinator wraps around the lateral side of the proximal radius. Distally the extensor pollicis longus, extensor indicis, abductor pollicis longus, and extensor pollicis brevis follow (from lateral to medial).

Supinator (The deep branch of the radial nerve pierces this muscle in the longitudinal direction of the forearm. The entrance point of the nerve into the supinator channel is marked by a small tendinous arch [FROHSE-FRÄNKEL's arcade].)
Deep branch of the radial nerve (brachial plexus, infraclavicular part)

O: lateral epicondyle of the humerus, supinator crest of the ulna, radial collateral and anular ligaments of radius

I: anterior surface of the radius (proximal third)

F: radio-ulnar joints:
supination (most important muscle with extended elbow)

Extensor pollicis longus
Deep branch of the radial nerve (brachial plexus, infraclavicular part)

O: distal half of the posterior surface of the ulna, interosseous membrane

I: distal phalanx of the thumb

F: carpal joint:
dorsiflexion
carpometacarpal joint (I):
extension,
reposition
metacarpophalangeal joint/ interphalangeal joint (I):
extension

Extensor indicis
Deep branch of the radial nerve (brachial plexus, infraclavicular part)

O: distal quarter of the posterior surface of the ulna, interosseous membrane

I: dorsal aponeurosis of the index finger

F: carpal joint:
dorsiflexion
metacarpophalangeal joint (II):
extension,
adduction
interphalangeal joint (II):
extension

Abductor pollicis longus
Deep branch of the radial nerve (brachial plexus, infraclavicular part)

O: posterior surface of the ulna, interosseous membrane, posterior surface of the radius

I: base of metacarpal I

F: carpal joint:
dorsiflexion
carpometacarpal joint (I):
abduction

Extensor pollicis brevis
Deep branch of the radial nerve (brachial plexus, infraclavicular part)

O: posterior surface of the radius, interosseous membrane

I: base of the proximal phalanx of the thumb

F: carpal joint:
dorsiflexion
carpometacarpal joint (I):
abduction,
reposition
metacarpophalangeal joint (I):
extension

36 Thenar muscles (→ Figs. 3.93, 3.94, 3.97)

The thenar eminence is composed of the abductor pollicis brevis, flexor pollicis brevis, and adductor pollicis (from radial to ulnar). The opponens pollicis lies beneath the abductor pollicis brevis.

Abductor pollicis brevis
Median nerve (brachial plexus, infraclavicular part)

O: flexor retinaculum, eminence of wrist joint

I: radial sesamoid bone of the metacarpophalangeal joint (I), proximal phalanx of the thumb

F: carpometacarpal joint (I): abduction, opposition
metacarpophalangeal joint (I): flexion

Flexor pollicis brevis
Superficial head *median nerve;* deep head: *deep branch of the ulnar nerve (brachial plexus, infraclavicular part)*

O: superficial head: flexor retinaculum
deep head: capitate, trapezium

I: radial sesamoid bone of the metacarpophalangeal joint (I), proximal phalanx of the thumb

F: carpometacarpal joint (I): opposition, adduction
metacarpophalangeal joint (I): flexion

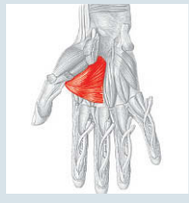
Opponens pollicis
Median nerve and ulnar nerve (brachial plexus, infraclavicular part)

O: flexor retinaculum, eminence of wrist joint

I: metacarpal I

F: carpometacarpal joint (I): opposition

Adductor pollicis
Deep branch of the ulnar nerve (brachial plexus, infraclavicular part)



O: oblique head: hamate, metacarpals II–IV
transverse head: metacarpal III

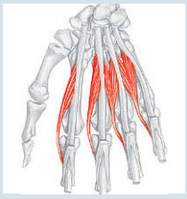
I: ulnar sesamoid bone of the metacarpophalangeal joint (I), proximal phalanx of the thumb

F: carpometacarpal joint (I): adduction, opposition
metacarpophalangeal joint (I): flexion

37 Palmar muscles (→ Figs. 3.91, 3.93, 3.94, 3.97–3.99, 3.101)

The lumbricals originate from the tendons of the flexor digitorum profundus. The palmar interossei and the dorsal interossei fill the space between the metacarpals.

Lumbricals I–IV
Median nerve (I, II); *ulnar nerve* (III, IV) *(brachial plexus, infraclavicular part)*

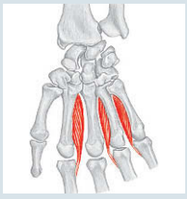


O: tendons II–IV of the flexor digitorum profundus (I + II from radial side; III + IV sides facing each other, two-headed)

I: projecting radially into the dorsal aponeurosis (lateral tract) of the fingers II–V

F: metacarpophalangeal joints (II–V): flexion
interphalangeal joints (II–V): extension (most important extensors of the distal interphalangeal joints)

Palmar interossei I–III
Deep branch, ulnar nerve (brachial plexus, infraclavicular part)



O: ulnar side of metacarpal II, radial side of metacarpals IV and V

I: proximal phalanx and dorsal aponeurosis (lateral tract) of the fingers II, IV and V

F: metacarpophalangeal joints (II, IV, V): flexion (most important flexors!), adduction (with reference to the axis of the middle finger)
interphalangeal joints (II, IV, V): extension

Dorsal interossei I–IV (two-headed)
Deep branch, ulnar nerve (brachial plexus, infraclavicular part)

O: sides facing each other of metacarpals I–V

I: proximal phalanx and dorsal aponeurosis of the fingers II–IV

F: metacarpophalangeal joints (II–IV): flexion (most important flexors!), abduction (with reference to the axis of the middle finger)
interphalangeal joints (II–IV): extension

38 Hypothenar muscles (→ Figs. 3.93, 3.94, 3.97)

The hypothenar eminence is composed of the abductor digiti minimi, flexor digiti minimi brevis, and opponens digiti minimi (from ulnar to radial). The cutaneous palmaris brevis is part of this hypothenar group.

Palmaris brevis *Superficial branch of the ulnar nerve (brachial plexus, infraclavicular part)*			
	O: palmar aponeurosis	**I:** skin of the hypothenar	**F:** tenses the skin in the area of the hypothenar eminence
Abductor digiti minimi *Deep branch of the ulnar nerve (brachial plexus, infraclavicular part)*			
	O: pisiform, flexor retinaculum	**I:** metacarpophalangeal joint V	**F:** carpometacarpal joint (V): opposition metacarpophalangeal joint (V): abduction
Flexor digiti minimi brevis *Deep branch of the ulnar nerve (brachial plexus, infraclavicular part)*			
	O: flexor retinaculum, hook of hamate	**I:** proximal phalanx of the 5th finger	**F:** carpometacarpal joint (V): opposition metacarpophalangeal joint (V): flexion
Opponens digiti minimi *Deep branch of the ulnar nerve (brachial plexus, infraclavicular part)*			
	O: flexor retinaculum, hook of hamate	**I:** metacarpal V	**F:** carpometacarpal joint (V): opposition

39 Joints of the lower extremity (→ Fig. 4.3)

a) Bony connections of the pelvic girdle

Name	Type of connection	Range of movement
Sacro-iliac joint	rigid joint, amphiarthrosis	flexibility and rotation by a few millimeters as a consequence of pelvic deformations caused by various forces
anterior sacro-iliac ligaments posterior sacro-iliac ligaments interosseous sacro-iliac ligaments sacrotuberal ligament sacrospinal ligament	syndesmoses, fibrous joints	
pubic symphysis	cartilaginous joint, synchondrosis with interpubic disc	
superior pubic ligament inferior pubic ligament		

b) Joints of the free lower extremity

Name of joint	Type of joint	Range of movement
Hip joint	spheroidal/ball and socket joint	flexion (anteversion) extension (retroversion) adduction abduction medial rotation lateral rotation
Knee joint	pivot (rotary) and ginglymus (hinge) joint, "trochoginglymus"	flexion extension medial rotation (only possible in a flexed position) lateral rotation (only possible in a flexed position)
Upper tibiofibular joint	rigid joint, amphiarthrosis	limited sliding movements in transversal and vertical directions as well as limited rotations
Lower tibiofibular connection	syndesmosis, fibrous joint	embracing of the malleolar mortise; with dorsiflexion in the ankle joint the malleolar mortise widens slightly
Ankle joint	hinge joint, ginglymus	plantar flexion (depression of the dorsum of the foot), dorsiflexion (elevation of the dorsum of the foot)
Talotarsal joint a) talocalcaneonavicular joint (= anterior division) b) subtalar joint (= posterior division)	combined pivot-spheroidal joint spheroidal joint pivot joint	elevation of the medial margin of the foot (= supination), elevation of the lateral margin of the foot (= pronation)
Transverse tarsal (midtarsal) joint, (CHOPART's joint) a) talocalcaneonavicular joint b) calcaneocuboid joint	rigid joints, amphiarthroses	limited plantar, dorsal, and rotational movements, securing the longitudinal plantar arch of the foot (key joint of the flat foot)
Intertarsal joints a) cuneonavicular joint b) intercuneiform joints c) cuneocuboid joint	rigid joints, amphiarthroses	very restricted movements during adaptive changes of the shape of the foot while touching the ground, e.g. during walking
Tarsometatarsal joints (LISFRANC's joint)	rigid joints, amphiarthroses	very limited plantar and dorsal movements and torsion of the forefoot
Intermetatarsal joints	rigid joints, amphiarthroses	very limited co-movements during torsion of the forefoot
Metatarsophalangeal joints	functionally restricted spheroidal joints	flexion, extension, abduction (straddling toes), adduction (squeezing toes together)
Interphalangeal joints	hinge joints, ginglymi	flexion, extension of toes

39 Joints of the lower extremity (continued)

c) Planes and axes of movements of the joints of the lower extremity

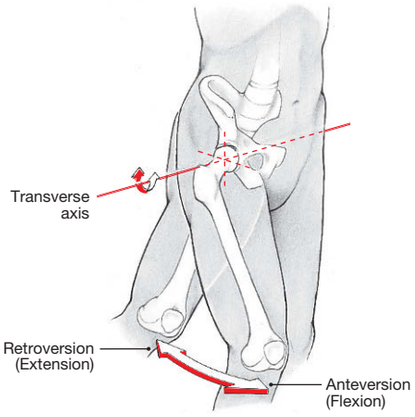


Fig. 8 Hip joint;
movement in the sagittal plane.

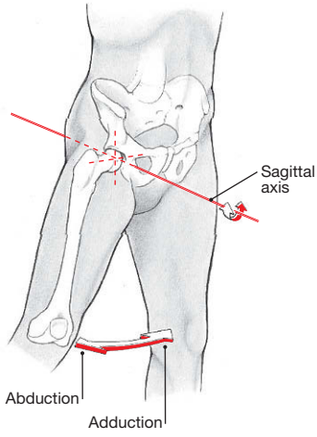


Fig. 9 Hip joint;
movement in the frontal plane.

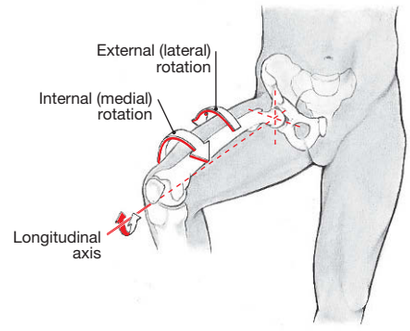


Fig. 10 Hip joint;
movement in the transverse plane.

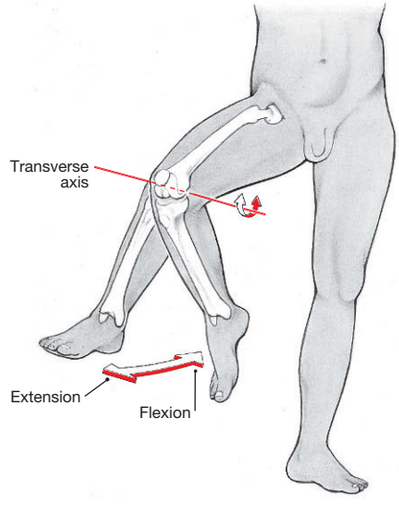


Fig. 11 Knee joint;
movement in the sagittal plane.
* Due to the uneven curvature of the femoral condyles, this particular axis changes its position significantly during movement.

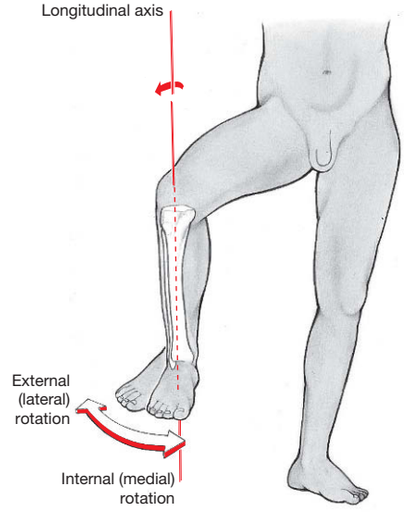


Fig. 12 Knee joint;
movement in the transverse plane.

39 Joints of the lower extremity (continued)

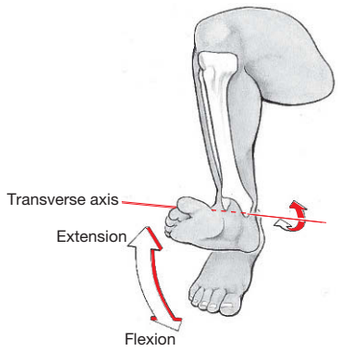


Fig. 13 Ankle joint;
movement in the sagittal plane.
Flexion and extension movements mainly occur in the talocrural joint.

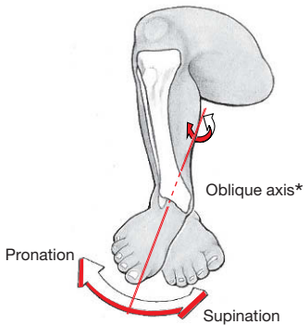


Fig. 14 Talocalcaneonavicular joint;
pronation and supination movements of the foot.
At maximal plantar flexion, pronation in the talocalcaneonavicular joint is also referred to as lateral abduction, and supination as medial abduction.
* The axis projects from the medial side of the neck of the talus in a postero-inferior direction to the lateral process of the calcaneal tuberosity; for didactic reasons this axis is shown less steep than normal.

The plantar flexion in the ankle joint is also referred to as flexion and the dorsiflexion as extension.

40 Branches and innervation areas of the lumbosacral plexus

(→ Figs. 2.154, 4.151, 4.152, 4.154–4.161, 4.165, 4.166, 7.108)

	motor function	sensory function
Lumbar plexus (T12) L1–L3 (L4)		
Muscular branches T12–L4	iliopsoas, quadratus lumborum	
Iliohypogastric nerve [iliopubic nerve] T12, L1 lateral cutaneous branch anterior cutaneous branch	rectus abdominis, obliquus internus abdominis, transversus abdominis, pyramidalis, cremaster	 skin above the hip skin above the iliac crest, the inguinal ligament, and the mons pubis
Ilio-inguinal nerve T12, L1 anterior scrotal nerves/ anterior labial nerves	rectus abdominis, obliquus internus abdominis, transversus abdominis, pyramidalis, cremaster	 skin in the inguinal region, the root of the penis, the scrotum, or the labia majora
Genitofemoral nerve L1, L2 genital branch femoral branch		 scrotal layers (including the dartos fascia), skin above the saphenous opening
Lateral cutaneous nerve of thigh L2, L3		skin on the lateral and anterior side of the thigh down to the knee
Obturator nerve L2–L4 anterior branch cutaneous branch posterior branch muscular branches	pectineus, adductor brevis, adductor longus, gracilis obturatorius externus, adductor magnus, (adductor brevis), adductor minimus	capsule of the hip joint skin at the inside of the thigh above the knee, capsule of the hip joint, periosteum at the posterior side of the thigh
Femoral nerve L2–L4 muscular branches anterior cutaneous branches saphenous nerve infrapatellar branch medial cutaneous nerve of leg	iliopsoas, pectineus, sartorius, quadriceps femoris	 capsule of the hip joint skin of the anterior and medial sides of the thigh down to the knee, periosteum of the anterior side of the thigh skin of the medial and anterior sides of the knee and on the medial side of the leg and the foot
Sacral plexus L4–S5, Co1		
Nerve to obturator internus L5–S2	obturator internus, gemellus superior	
Nerve to piriformis S1, S2	piriformis	
Nerve to quadratus femoris L4–S1	quadratus femoris, gemellus inferior	
Superior gluteal nerve L4–S1	gluteus medius and gluteus minimus, tensor fasciae latae	
Inferior gluteal nerve L5–S2	gluteus maximus	
Posterior cutaneous nerve of thigh S1–S3 inferior clunial nerves perineal nerves		skin on the posterior side of the thigh and the proximal leg skin of the gluteal region perineum, scrotal skin or skin of the labia majora
Sciatic nerve L4–S3	ischiocrural (hamstring) muscles, all muscles of the leg and foot	
Common fibular nerve L4–S2 lateral sural cutaneous nerve sural communicating branch	biceps femoris, short head	capsule of the knee joint skin of the calf up to the lateral malleus connecting branch to the sural nerve

40 Branches and innervation areas of the lumbosacral plexus (continued)

	motor function	sensory function
Superficial fibular nerve L4–L2	fibularis [peronei] longus and brevis	
muscular branches		
medial dorsal cutaneous nerve		skin of the leg and dorsum of the foot up to the 1st–3rd toes
intermediate dorsal cutaneous nerve		skin of the leg and dorsum of the foot between 3rd and 5th toe (medial side)
dorsal digital nerves of foot		skin of the dorsum of the toes with the exception of the 1st interdigital space and the lateral side of the 5th toe
Deep fibular nerve L4–L2	tibialis anterior, extensor digitorum longus, extensor hallucis longus, extensor digitorum brevis, and extensor hallucis brevis	periosteum of the leg bones and capsule of the talocrural joint
muscular branches		
dorsal digital nerves of foot		skin of the 1st interdigital space
Tibial nerve L4–S3	triceps surae, plantaris, popliteus, tibialis posterior, flexor digitorum longus, flexor hallucis longus	capsule of the knee joint
muscular branches		
interosseus nerve of leg		periosteum of the leg bones and capsule of the talocrural joint
medial sural cutaneous nerve		skin of the calf up to the medial malleus joins the lateral sural cutaneous nerve to form the sural nerve
sural nerve		
lateral dorsal cutaneous nerve		skin of the lateral margin of the foot up to the lateral part of the 5th toe
lateral calcaneal branches		skin of the heel, lateral aspect
medial calcaneal branches		skin of the heel, medial aspect
medial plantar nerve	abductor hallucis and flexor digitorum brevis, flexor hallucis brevis (medial head), lumbricals of foot I (II)	skin of the medial margin of the foot
common plantar digital nerves		skin of the plantar side of the medial 3½ toes and their nail areas
proper plantar digital nerves		
lateral plantar nerve		
superficial branch	abductor digiti minimi, quadratus plantae	
common plantar digital nerves		
proper plantar digital nerves	flexor digiti minimi brevis, opponens digiti minimi, interossei, lumbricals of foot II–IV, adductor hallucis (transverse head)	skin on the plantar side of the lateral 1½ toes and their nail areas
deep branch		
Pudendal nerve S2–S4		
inferior rectal [anal] nerves		skin of the anal region and the perineum
S3, S4		
perineal nerves		
posterior scrotal nerves/ posterior labial nerves		mucosa of the urethra, dorsal scrotal skin or posterior areas of the labia majora and minora, vestibule of vagina
muscular branches	superficial and deep transverse perineal muscle, bulbospongiosus and ischiocavernosus, external anal sphincter	
dorsal nerve of penis/ dorsal nerve of clitoridis		skin of the penis, glans/clitoris, prepuce
Muscular branches S3, S4	levator ani, ischiococcygeus	
Anococcygeal nerve S5–Co1		skin above the coccyx and the region between coccyx and anus

41 Segmental innervation of muscles of the lower extremity, diagnostically relevant indicator muscles

(according to MUMENTHALER and SCHLIACK)
The muscles printed in bold are used clinically as indicator muscles for specific segments.

Iliopsoas: L1, L2	T12–L3
Tensor fasciae latae	L4–L5
Gluteus medius	L4–S1
Gluteus minimus	L4–S1
Gluteus maximus	L4–S2
Obturator internus	L5–S1
Piriformis	L5–S1
Sartorius	L2–L3
Pectineus	L2–L3
Adductor longus	L2–L3
Quadriceps femoris: L3	L2–L4
Gracilis	L2–L4
Adductor brevis	L2–L4
Obturator externus	L3–L4
Adductor magnus	L3–L4
Semitendinosus	L4–S1
Semimembranosus	L4–S1
Biceps femoris	L4–S2

Tibialis anterior: L4		L4–L5
Extensor hallucis longus		L4–S1
Popliteus		L4–S1
Extensor digitorum longus		L4–S1
Soleus	**L5**	L4–S2
Gastrocnemius		
Fibularis longus		L5–S1
Fibularis brevis		L5–S1
Tibialis posterior: S1		L5–S2
Flexor digitorum longus		L5–S3
Flexor hallucis longus		L5–S3
Extensor hallucis brevis		L4–S1
Extensor digitorum brevis		L4–S1
Flexor digitorum brevis		L5–S1
Abductor hallucis		L5–S1
Flexor hallucis brevis		L5–S3
Adductor hallucis		S1–S2

42 Ventral muscles of the hip (→ Figs. 2.96, 2.99, 4.112, 4.115, 4.116, 4.119–4.121)

The iliopsoas is composed of the iliacus and psoas major and the only muscle of this group. The iliopsoas is the only ventral muscle which crosses the hip joint to insert at the lower extremity. All other muscles located anterior to the hip joint also span across the knee joint and thus are collectively named muscles of the thigh.

Iliacus (part of the iliopsoas)
Muscular branches (lumbar plexus)

O: iliac fossa

I: lesser trochanter

F: lumbar vertebral column:
lateroflexion
hip joint:
flexion (most important muscle), lateral rotation from a medial rotational position

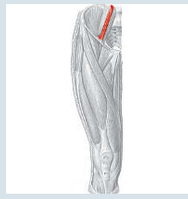
Psoas major (part of the iliopsoas)
Muscular branches (lumbar plexus)

O: superficial layer: lateral surface of the bodies of the 12th thoracic to 4th lumbar vertebrae, intervertebral discs
deep layer: costal process of the 1st–4th lumbar vertebrae

I: lesser trochanter and adjacent area of the medial lip of the linea aspera

F: lumbar vertebral column:
lateroflexion
hip joint:
flexion (most important muscle), lateral rotation from a medial rotational position

Psoas minor (part of the iliopsoas; inconsistent; often ends in a long flat tendon)
Muscular branches (lumbar plexus)



O: lateral surface of the bodies of the 12th thoracic and 1st lumbar vertebrae

I: fascia of the iliopsoas, iliopectineal arch

F: lumbar vertebral column:
lateroflexion

43 Dorsolateral muscles of the hip (→ Figs. 4.113, 4.115, 4.117a, 4.123, 4.125–4.128)

The gluteus maximus is of major importance for the shape of the gluteal region and covers all other muscles of this group almost completely. At the ventrocranial margin, the gluteus medius is visible which in turn covers the gluteus minimus. Caudally and deep to the gluteus maximus follow the piriformis, gemellus superior, obturator internus, obturator externus, gemellus inferior, and quadratus femoris.
Obturator internus, gemellus superior, and gemellus inferior are collectively named triceps coxae. Located farthest laterally, the tensor fasciae latae is located with its short muscle belly projecting into the iliotibial tract.

Gluteus maximus
Inferior gluteal nerve (sacral plexus)

O: gluteal surface of the ala of ilium dorsal to the posterior gluteal line, posterior surface of sacrum, thoracolumbar fascia, sacrotuberal ligament

I: cranial part: iliotibial tract
caudal part: gluteal tuberosity

F: hip joint:
extension (most important muscle), lateral rotation (most important muscle), cranial part: abduction, caudal part: adduction
knee joint:
cranial part via iliotibial tract, stabilization in the extended position, tension band effect on the femur

Gluteus medius
Superior gluteal nerve (sacral plexus)

O: gluteal surface of the ala of ilium between anterior and posterior gluteal line

I: tip of the greater trochanter

F: hip joint:
abduction (most important muscle) ventral part: flexion, medial rotation (most important muscle);
dorsal part: extension, lateral rotation

Gluteus minimus
Superior gluteal nerve (sacral plexus)

O: gluteal surface of the ala of ilium between anterior and inferior gluteal line

I: tip of the greater trochanter

F: hip joint:
abduction (most important muscle) ventral part: flexion, medial rotation (most important muscle);
dorsal part: extension, lateral rotation

Tensor fasciae latae
Superior gluteal nerve (lumbosacral plexus)

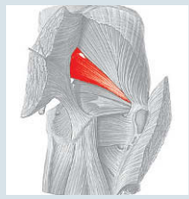
O: anterior superior iliac spine

I: via iliotibial tract, tibia below the lateral condyle

F: hip joint:
flexion, abduction, medial rotation
knee joint:
stabilization in the extended position, tension band effect on the femur

44 Pelvitrochanteric muscles of the hip (→ Figs. 4.115, 4.123, 4.126–4.128)

Piriformis
Nerve to piriformis (sacral plexus)

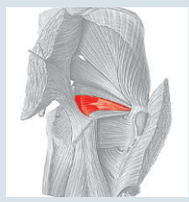


O: pelvic surface of the sacrum

I: tip of the greater trochanter

F: hip joint:
lateral rotation, abduction

Obturator internus
Nerve to obturator internus (sacral plexus)

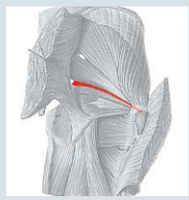


O: bony rim of the obturator foramen,
medial area of the obturator membrane

I: tip of the greater trochanter

F: hip joint:
lateral rotation

Gemellus superior
Nerve to obturator internus (sacral plexus)

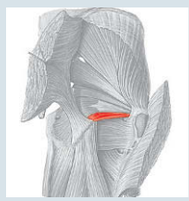


O: ischial spine

I: tendon of the obturator internus

F: hip joint:
lateral rotation

Gemellus inferior
Nerve to quadratus femoris (sacral plexus)

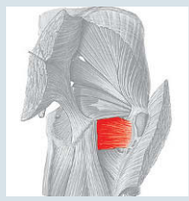


O: ischial tuberosity

I: tendon of the obturator internus

F: hip joint:
lateral rotation

Quadratus femoris
Nerve to quadratus femoris (sacral plexus)



O: ischial tuberosity

I: intertrochanteric crest

F: hip joint:
lateral rotation, adduction

44 Pelvitrochanteric muscles of the hip (continued)

Obturator externus
Obturator nerve (lumbar plexus)

O: bony rim of the obturator foramen, lateral area of the obturator membrane

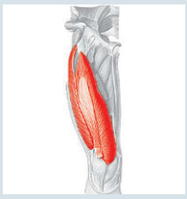
I: trochanteric fossa

F: hip joint:
lateral rotation, adduction

45 Ventral muscles of the thigh (→ Figs. 4.112, 4.115, 4.117, 4.119–4.122, 4.129, 4.130)

The sartorius crosses the thigh in an oblique angle from proximal and lateral to distal and medial. The quadriceps femoris constitutes the largest part of the muscles located ventrally on the thigh.

Quadriceps femoris
Femoral nerve (lumbar plexus)



O: rectus femoris, straight head:
anterior inferior iliac spine
rectus femoris, reflected head:
cranial rim of the acetabulum
vastus medialis: medial lip of the linea aspera
vastus lateralis: greater trochanter, lateral lip of the linea aspera
vastus intermedius: anterior surface of the thigh
articularis genus: distal at the anterior surface of the thigh

I: patella,
tibial tuberosity via patellar ligament, areas to both sides of the tibial tuberosity via patellar retinaculum

F: hip joint: (only rectus femoris):
flexion
knee joint:
extension (sole extensor!)

Sartorius
Femoral nerve (lumbar plexus)

O: anterior superior iliac spine

I: superficial at the medial condyle of the tibia

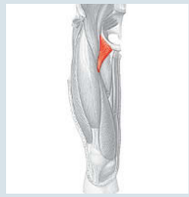
F: hip joint:
flexion, lateral rotation, abduction
knee joint:
flexion, medial rotation

46 Medial muscles of the thigh (adductors)

(→ Figs. 4.112, 4.115, 4.118–4.122, 4.126–4.130)

The gracilis is positioned farthest medially. The pectineus, adductor brevis, adductor longus, and adductor magnus are arranged from proximal to distal.

Pectineus
Femoral nerve and obturator nerve (lumbar plexus)

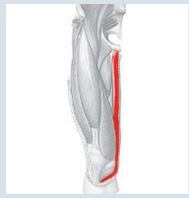


O: pecten pubis

I: lesser trochanter and pectineal line of the thigh

F: hip joint: adduction, flexion, lateral rotation

Gracilis
Obturator nerve (lumbar plexus)

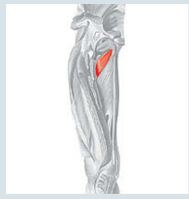


O: body of pubis, inferior pubic ramus

I: superficial at the medial condyle of the tibia

F: hip joint: adduction, flexion, lateral rotation
knee joint: flexion, medial rotation

Adductor brevis
Obturator nerve (lumbar plexus)

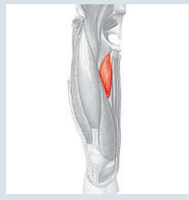


O: inferior pubic ramus

I: proximal third of the medial lip of the linea aspera

F: hip joint: adduction, flexion, lateral rotation

Adductor longus
Obturator nerve (lumbar plexus)

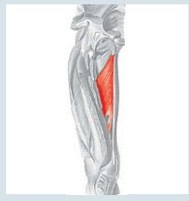


O: pubis up to the pubic symphysis

I: middle third of the medial lip of the linea aspera

F: hip joint: adduction, flexion, lateral rotation

Adductor magnus (An incomplete proximal separation of the adductor magnus is named the adductor minimus.)
Main part: *obturator nerve (lumbar plexus);* dorsal part: *tibial division of the sciatic nerve (sacral plexus)*



O: main part: inferior pubic ramus, ramus of ischium
dorsal part: tuberosity of ischium

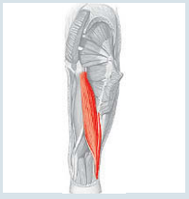
I: proximal two-thirds of the medial lip of the linea aspera, medial epicondyle of the thigh, anteromedial intermuscular septum

F: hip joint: adduction, lateral rotation
main part: flexion
dorsal part: extension

47 Dorsal muscles of the thigh (ischiocrural muscles)
(→ Figs. 4.113, 4.115, 4.124, 4.126–4.130)

The biceps femoris, semitendinosus, and semimembranosus (from lateral to medial) constitute the dorsal muscles of the thigh.

Biceps femoris (long head: crossing two joints, short head: crossing one joint)
Caput longum: *sciatic nerve, tibial division (sacral plexus)*
Caput breve: *sciatic nerve, fibular division (sacral plexus)*



O: long head: ischial tuberosity
short head: middle third of the lateral lip of the linea aspera

I: head of fibula

F: hip joint:
extension,
lateral rotation,
adduction
knee joint:
flexion,
lateral rotation (most important muscle)

Semitendinosus
Sciatic nerve, tibial division (sacral plexus)

O: ischial tuberosity

I: superficial at the medial condyle of the tibia

F: hip joint:
extension,
medial rotation
knee joint:
flexion,
medial rotation

Semimembranosus
Sciatic nerve, tibial division (sacral plexus)

O: ischial tuberosity

I: deep at the medial condyle of the tibia

F: hip joint:
extension,
medial rotation
knee joint:
flexion,
medial rotation

48 Ventral muscles of the leg (→ Figs. 4.112, 4.131, 4.134, 4.135)

Located most superficially and medially of all muscles of this group is the tibialis anterior. Located lateral to this muscle is the extensor digitorum longus, which frequently generates the fibularis tertius at its lateral margin. Located farthest distally lies the extensor hallucis longus.

Tibialis anterior
Deep fibular nerve (sciatic nerve)

O: lateral surface of the tibia, deep fascia of leg, interosseous membrane

I: metatarsal I, medial cuneiform

F: talocrural joint: dorsiflexion (most important muscle)
talocalcaneonavicular joint: supination (weak)

Extensor hallucis longus
Deep fibular nerve (sciatic nerve)

O: lateral surface of the tibia, interosseous membrane, deep fascia of leg

I: distal phalanx of the great toe

F: talocrural joint: dorsiflexion
talocalcaneonavicular joint: pronation (weak)
joint of the great toe: extension

Extensor digitorum longus
Deep fibular nerve (sciatic nerve)

O: lateral condyle of the tibia, anterior border of the fibula, interosseous membrane of leg, deep fascia of leg

I: dorsal aponeuroses of the 2nd–5th toes

F: talocrural joint: dorsiflexion
talocalcaneonavicular joint: pronation
interphalangeal joints: extension

Fibularis [peroneus] tertius (inconsistent muscle)
Deep fibular nerve (sciatic nerve)

O: distal separation of the extensor digitorum longus

I: metatarsal V

F: talocrural joint: dorsiflexion
talocalcaneonavicular joint: pronation

49 Lateral (fibular) muscles of the leg (→ Figs. 4.112, 4.132, 4.134, 4.135)

The fibularis longus is located superficially and distally thereof lies the fibularis brevis.

Fibularis [peroneus] longus
Superficial fibular nerve (sciatic nerve)

O: head of fibula, proximal two-thirds of the fibula, deep fascia of leg

I: tuberosity of metatarsal bone I, medial cuneiform

F: talocrural joint:
plantar flexion
talocalcaneonavicular joint:
pronation (most important muscle)

Fibularis [peroneus] brevis
Superficial fibular nerve (sciatic nerve)

O: distal half of the fibula

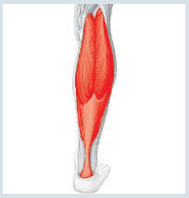
I: tuberosity of metatarsal V

F: talocrural joint:
plantar flexion
talocalcaneonavicular joint:
pronation

50 Dorsal superficial muscles of the leg (→ Figs. 4.113, 4.133a, 4.136, 4.137)

The relief of the calf is shaped by the heads of the gastrocnemius. This muscle is located superficially to the soleus and together they constitute the triceps surae. The very small plantaris can be considered the fourth head of this muscle.

Triceps surae (The broad tendon of the triceps surae is known as ACHILLES tendon.)
Tibial nerve (sciatic nerve)



O: gastrocnemius, medial head: medial condyle of the femur
gastrocnemius, lateral head: lateral condyle of the femur
soleus: proximal third of the fibula, posterior surface of the tibia (soleal line), tendinous arch of soleus
plantaris: lateral condyle of the femur

I: calcaneal tuberosity (via calcaneal tendon)

F: knee joint (only gastrocnemius and plantaris):
flexion
talocrural joint:
plantar flexion (most important muscle)
talocalcaneonavicular joint:
supination (most important muscle together with the tibialis posterior)

51 Dorsal deep muscles of the leg (→ Figs. 4.133, 4.138, 4.139)

The popliteus is the most proximal dorsal deep leg muscle and reaches the knee joint in a lateral oblique angle. Of the muscles coursing to the foot, the tibialis posterior lies between the flexor digitorum longus on the medial side and the flexor hallucis longus on the lateral side.

Popliteus
Tibial nerve (sciatic nerve)

O: lateral condyle of the femur, posterior horn of the lateral meniscus

I: posterior surface of the tibia superior to the soleal line

F: knee joint:
medial rotation,
prevents entrapment of the meniscus

Tibialis posterior
Tibial nerve (sciatic nerve)

O: interosseous membrane, tibia and fibula

I: tuberosity of navicular, plantar surface of cuneiforms I–III, metatarsals II–IV

F: talocrural joint:
plantar flexion
talocalcaneonavicular joint:
supination (most important muscle together with the triceps surae)

Flexor digitorum longus
Tibial nerve (sciatic nerve)

O: posterior surface of the tibia and fibula

I: distal phalanx of the 2nd–5th toes

F: talocrural joint:
plantar flexion
talocalcaneonavicular joint:
supination
metatarsophalangeal and interphalangeal joints of the toes:
flexion

Flexor hallucis longus
Tibial nerve (sciatic nerve)

O: distal two-thirds of the posterior surface of the fibula, interosseous membrane

I: distal phalanx of the great toe (1st toe)

F: talocrural joint:
plantar flexion
talocalcaneonavicular joint:
supination
metatarsophalangeal and interphalangeal joints of the great toe:
flexion

52 Muscles of the dorsum of the foot (→ Figs. 4.135, 4.143, 4.144)

The two muscles hardly bulge the skin at the dorsum of the foot. The extensor hallucis brevis courses to the great toe (1st toe), the extensor digitorum brevis courses to the other toes.

Extensor digitorum brevis
Deep fibular nerve (common fibular nerve)

O: dorsal aspect of the calcaneus

I: dorsal aponeurosis of the 2nd–4th toes

F: interphalangeal joints of the toes: extension

Extensor hallucis brevis
Deep fibular nerve (common fibular nerve)

O: dorsal aspect of the calcaneus

I: proximal phalanx of the grat toe (1st toe)

F: metatarsophalangeal joint of the great toe: extension

53 Medial muscles of the sole of the foot (→ Figs. 4.146–4.148)

The abductor hallucis is mainly responsible for the relief of the medial margin of the foot. Adjacent lies the flexor hallucis brevis and lateral thereof the adductor hallucis is located.

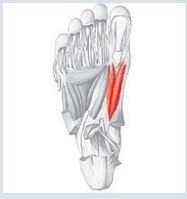
Abductor hallucis
Medial plantar nerve (tibial nerve)

O: medial process of the calcaneal tuberosity, plantar aponeurosis, flexor retinaculum

I: medial sesamoid bone of the metatarsophalangeal joint, proximal phalanx of the great toe

F: metatarsophalangeal joint of the great toe: abduction, flexion, bracing of the medial longitudinal plantar arch

Flexor hallucis brevis
Medial head: *medial plantar nerve (tibial nerve)*
Lateral head: *lateral plantar nerve (tibial nerve)*



O: plantar aspect of the cuneiforms, plantar calcaneocuboid ligament, long plantar ligament

I: medial head: medial sesamoid bone of the metatarsophalangeal joint I, proximal phalanx of the great toe
lateral head: lateral sesamoid bone of the metatarsophalangeal joint I, proximal phalanx of the great toe

F: metatarsophalangeal joint of the great toe: flexion, bracing of the longitudinal plantar arch

53 Medial muscles of the sole of the foot (continued)

Adductor hallucis
Lateral plantar nerve (tibial nerve)

O: oblique head: cuboid, lateral cuneiform, long plantar ligament, plantar calcaneocuboid ligament
transverse head: capsules of the metatarsophalangeal joints of the 3rd–5th toes, deep transverse metatarsal ligament

I: lateral sesamoid bone and capsule of the metatarsophalangeal joint, proximal phalanx of the great toe

F: metatarsophalangeal joint of the great toe:
adduction towards the 2nd toe,
flexion,
bracing of the longitudinal and transverse plantar arches

54 Muscles in the midregion of the sole of the foot (→ Figs. 4.143, 4.144, 4.146–4.150)

In its proximal part, the flexor digitorum brevis is firmly attached to the plantar aponeurosis. Beneath this muscle, the quadratus plantae connects with the main tendon of the flexor digitorum longus. The lumbricals I–IV of the foot originate from its four tendinous branches. The plantar interossei I–III and the dorsal interossei I–IV of the foot fill the space between the metatarsals.

Flexor digitorum brevis (Shortly before their insertion point, the tendons of this muscle are pierced by the tendons of the flexor digitorum longus.)
Medial plantar nerve (tibial nerve)

O: plantar aspect of the calcaneal tuberosity, plantar aponeurosis

I: middle phalanx of the 2nd–5th toes

F: metatarsophalangeal and proximal interphalangeal joints of the toes:
flexion,
bracing of the longitudinal plantar arch

Quadratus plantae
Lateral plantar nerve (tibial nerve)

O: plantar aspect of the calcaneus, long plantar ligament

I: lateral margin of the tendon of the flexor digitorum longus

F: supports the flexor digitorum longus

Lumbricals I–IV
Medial (I) und lateral (II–IV) plantar nerve (tibial nerve)

O: lumbricals: tendons of the flexor digitorum longus
I: single headed
II–IV: double headed

I: medial side of the proximal phalanx of the 2nd–5th toes

F: metatarsophalangeal joints of the toes:
flexion,
adduction

Plantar interossei I–III
Lateral plantar nerve (tibial nerve)

O: plantar aspect of the metatarsals III–V, long plantar ligament

I: medial side of the proximal phalanx of the 3rd–5th toes

F: metatarsophalangeal joints of the toes:
flexion,
adduction towards the 2nd toe

54 Muscles in the midregion of the sole of the foot (continued)

Dorsal interossei I–IV (double headed muscles)
Lateral plantar nerve (tibial nerve)

O: adjacent sides of the metatarsals I–V facing each other, long plantar ligament

I: proximal phalanx of the 2nd–4th toes (2nd toe bilateral, 3rd and 4th toes from lateral)

F: metatarsophalangeal joints of the toes:
flexion,
medial abduction of the 2nd toe,
lateral abduction of the 2nd, 3rd and 4th toes

55 Lateral muscles of the sole of the foot (→ Figs. 4.146–4.148)

The abductor digiti minimi is located along the lateral margin of the foot. Beneath its plantar area lie the flexor digiti minimi brevis and the opponens digiti minimi.

Abductor digiti minimi
Lateral plantar nerve (tibial nerve)

O: lateral process of the calcaneal tuberosity, plantar aponeurosis

I: tuberosity of metatarsal bone V, proximal phalanx of the 5th toe

F: metatarsophalangeal joint of the 5th toe:
abduction,
flexion,
bracing of the longitudinal plantar arch

Flexor digiti minimi brevis
Lateral plantar nerve (tibial nerve)

O: base of metatarsal V, long plantar ligament

I: proximal phalanx of the 5th toe

F: metatarsophalangeal joint of the 5th toe:
flexion,
bracing of the longitudinal plantar arch

Opponens digiti minimi (inconsistent muscle)
Lateral plantar nerve (tibial nerve)

O: base of metatarsal V, long plantar ligament

I: metatarsal V

F: metatarsophalangeal joint of the 5th toe:
opposition,
bracing of the longitudinal plantar arch

56 Cranial nerves, overview
(→ Figs. 9.41, 9.46, 9.47, 12.131–12.163)

a	**Olfactory nerve [I]**
b	**Optic nerve [II]**
c	**Oculomotor nerve [III]**
d	**Trochlear nerve [IV]**
e	**Trigeminal nerve [V]** – ophthalmic nerve [V/1] – maxillary nerve [V/2] – mandibular nerve [V/3]
f	**Abducent nerve [VI]**
g	**Facial nerve [VII]**
h	**Vestibulocochlear nerve [VIII]**
i	**Glossopharyngeal nerve [IX]**
j	**Vagus nerve [X]**
k	**Accessory nerve [XI]**
l	**Hypoglossal nerve [XII]**

57 Cranial nerves, functions (fiber qualities)
(→ Figs. 9.38, 12.136–12.163)

(GSE)	General somato-efferent: innervation of the skeletal muscles **(III, IV, VI, XII)**
(GVE)	General viscero-efferent: innervation of visceral and vascular smooth muscles, and glands **(III, VII, IX, X)**
(SVE)	Special viscero-efferent: innervation of the mimic muscles, masticatory muscles, larynx, pharynx, esophagus, sternocleidomastoid, trapezius **(V, VII, IX, X, XI)**
(GVA)	General viscero-afferent: information from viscera and blood vessels **(IX, X)**
(SVA)	Special viscero-afferent: taste **(VII, IX, X)**
(GSA)	General somato-afferent: pain, temperature, information via mechanoreceptors of the skin and musculoskeletal system **(V, VII, IX, X)**
(SSA)	Special somato-afferent: smell, vision, hearing, equilibrium/balance **(I, II, VIII)**

58 Cranial nerves (→ Figs. 12.131–12.163)

a Olfactory nerve [I] (→ Figs. 8.92, 12.138, 12.139)

All olfactory nerves are collectively named olfactory nerve. They constitute the peripheral neuron of the olfactory pathway.

Origin	olfactory cells of the olfactory region
Passage through the cranial base	cribriform plate
Passage through the dura mater	cribriform plate
Entrance into the brain	olfactory bulb
Innervation area	mucosa (olfactory epithelium) at the roof of the nasal cavity, the upper nasal concha and the upper part of the nasal septum

b Optic nerve [II] (→ Figs. 9.72, 9.73, 12.140, 12.141)

The optic nerve is not a peripheral nerve but a part of the diencephalon.

Origin	ganglionic layer of the retina
Course in the dura mater	sheath of optic nerve
Passage through the cranial base	optic canal
Other visible course	optic chiasm, continuation of fibers in the optic tract, lateral geniculate body
Innervation area	retina

c Oculomotor nerve [III] (→ Figs. 12.142, 12.143)

Nuclei (quality)	• nucleus of oculomotor nerve (paired main and unpaired accessory nucleus) (GSE) • accessory nucleus of oculomotor nerve (GVE) → ciliary ganglion
Exit from the brain	interpeduncular fossa of the mesencephalon
Location in the subarachnoid space	basal cistern, interpeduncular cistern
Entrance into the dura mater	roof of the cavernous sinus
Exit through the dura mater	superior orbital fissure
Passage through the cranial base	superior orbital fissure (medial part, within the tendinous ring)
Innervation areas	**motor:** levator palpebrae superioris, rectus superior, rectus medialis, rectus inferior, inferior oblique **parasympathetic:** ciliary muscle, sphincter pupillae (via ciliary ganglion)
Adjunct nerves	**sensory fibers** of the nasociliary nerve (V/1) **sympathetic fibers** of the ophthalmic plexus

d Trochlear nerve [IV] (→ Figs. 12.142, 12.143)

Nuclei (quality)	• nucleus of trochlear nerve (GSE)
Exit from the brain	dorsal, caudal of the inferior colliculus (tectum of midbrain)
Location in the subarachnoid space	cisterna ambiens, basal cistern
Entrance into the dura mater	knuckle between the anterior and posterior petroclinoid plica
Course within the dura mater	lateral wall of the cavernous sinus
Exit through the dura mater	superior orbital fissure
Passage through the cranial base	superior orbital fissure (lateral part)
Innervation area	**motor:** superior oblique

e Trigeminal nerve [V] (→ Figs. 12.144–12.147)	
Nuclei (quality)	• mesencephalic nucleus of trigeminal nerve (GSA) • pontine nucleus of trigeminal nerve (principal sensory nucleus of trigeminal nerve) (GSA) • spinal nucleus of trigeminal nerve (GSA) • motor nucleus of trigeminal nerve (SVE)
Exit from the brain	lateral margin of the pons
Location in the subarachnoid space	basal cistern, trigeminal cave
Entrance into the dura mater	as trigeminal ganglion in the lateral wall of the cavernous sinus
Division into three branches	– ophthalmic nerve [V/1] – maxillary nerve [V/2] – mandibular nerve [V/3]
– Ophthalmic nerve [V/1] Course in the dura mater	lateral wall of the cavernous sinus
Exit from the dura mater	superior orbital fissure
Exit from the cranial base	superior orbital fissure – nasociliary nerve: medial part – frontal nerve: lateral part – lacrimal nerve: lateral part
Innervation area	**sensory:** dura mater of the anterior cranial fossa, falx cerebri, tentorium cerebelli, forehead, upper eyelid, dorsum of the nose, sclera, cornea, anterior ethmoidal cells, sphenoidal sinus, nasal cavity (anterior part)
– Maxillary nerve [V/2] Course in the dura mater	lateral wall of the cavernous sinus
Exit from the dura mater	foramen rotundum
Exit from the cranial base	foramen rotundum
Innervation area	**sensory:** dura mater of the middle cranial fossa, cheek, lower eyelid, lateral surface of the nose, upper lip, teeth and gingiva of the maxilla, posterior ethmoidal cells, sphenoidal sinus, maxillary sinus, superior and middle nasal concha, palate, palatine tonsil, pharynx (roof)
Adjunct nerves	**parasympathetic (secretory) fibers** to divergent nasal branches for the nasal glands, the palatine nerves for the palatine glands as well as to the zygomatic nerve for the lacrimal gland (derived from the superior salivatory nucleus via facial nerve, greater petrosal nerve, and ganglionic branches to pterygopalatine ganglion, zygomatic nerve, communicating branch with zygomatic nerve, lacrimal nerve)
– Mandibular nerve [V/3] Course in the dura mater	lateral wall of the cavernous sinus
Exit from the dura mater	foramen ovale
Exit from the cranial base	foramen ovale
Innervation areas	**motor:** masticatory muscles, tensor veli palatini, mylohyoid, digastric (anterior belly), tensor tympani **sensory:** dura mater of the middle cranial fossa, mastoid cells, skin of the mandible, temple, cheek, auricle (upper part), external acoustic meatus, tympanic membrane (outer surface), teeth and gingiva of the mandible, anterior two-thirds of the tongue, isthmus of fauces, temporomandibular joint
Adjunct nerves	**sensory:** anterior two-thirds of the tongue (from facial nerve [VII] via chorda tympani to lingual nerve) **parasympathetic (secretory) fibers** a) to the lingual nerve for the submandibular and sublingual glands (from superior salivatory nucleus via facial nerve and chorda tympani to the submandibular ganglion) b) to the auriculotemporal nerve for the parotid gland (from inferior salivatory nucleus via glossopharyngeal nerve, tympanic nerve, tympanic plexus, and lesser petrosal nerve to the otic ganglion)

f Abducent nerve [VI] (→ Figs. 12.142, 12.143)	
Nuclei (quality)	• Nucleus of abducent nerve (GSE)
Exit from the brain	between pons and pyramis
Location in the subarachnoid space	basal cistern
Entrance into the dura mater	upper third of the clivus
Course in the dura mater	freely passing through the cavernous sinus, lateral to the internal carotid artery
Exit from the dura mater	superior orbital fissure
Passage through the cranial base	superior orbital fissure, medial part (within the tendinous ring)
Innervation area	**motor:** rectus lateralis

g Facial nerve [VII] (→ Figs. 12.148–12.152)	
Nuclei (quality)	• nucleus of facial nerve (SVE) • superior salivatory nucleus (GVE) → pterygopalatine ganglion → submandibular ganglion • solitary nucleus (SVA) • spinal nucleus of trigeminal nerve (GSA)
Exit from the brain	cerebellopontine angle
Location in the subarachnoid space	basal cistern, pontocerebellar cistern
Entrance into the cranial base	porus → internal acoustic meatus
Passage through the dura mater	fundus of internal acoustic meatus
Course inside the cranial base	facial canal
Exit from the cranial base	stylomastoid foramen
Innervation areas	**motor:** mimic muscles, auricularis muscles, digastric (posterior belly), stylohyoid, stapedius **sensory:** anterior two-thirds of the tongue (via chorda tympani to the lingual nerve) **parasympathetic:** lacrimal gland, nasal glands, palatine glands (via pterygopalatine ganglion), submandibular gland, sublingual gland (via submandibular ganglion)
Adjunct nerves	**sensory fibers** of the trigeminal nerve to the facial branches of the facial nerve

h Vestibulocochlear nerve [VIII] (→ Figs. 12.153, 12.154)	
Nuclei (quality)	• anterior and posterior cochlear nuclei (SSA) • medial, lateral, superior and inferior vestibular nuclei (SSA)
Exit from the brain	cerebellopontine angle
Location in the subarachnoid space	basal cistern, pontocerebellar cistern
Entrance into the cranial base	porus → internal acoustic meatus
Exit from the dura mater	fundus of internal acoustic meatus
Course inside the cranial base	directly to the labyrinth within the petrous part of the temporal bone
Innervation areas	**special sensory:** cochlear nerve: acoustic organ (= CORTI's organ) **special sensory:** vestibular nerve: equilibrium/balance organ

i Glossopharyngeal nerve [IX] (→ Figs. 12.155, 12.156)	
Nuclei (quality)	• nucleus ambiguus (SVE) • solitary nucleus (SVA und GVA) • inferior salivatory nucleus (GVE) → otic ganglion • spinal nucleus of trigeminal nerve (GSA)
Exit from the brain	medulla oblongata: retro-olivary groove
Location in the subarachnoid space	basal cistern
Passage through the dura mater	jugular foramen
Passage through the cranial base	jugular foramen
Innervation areas	**motor:** pharyngeal muscles (cranial part), levator veli palatini, palatoglossus, palatopharyngeus, stylopharyngeus **sensory:** mucosa of the pharynx (cranial part), palatine tonsil, posterior third of the tongue, tympanic plexus, tympanic membrane (inner surface), carotid sinus **special sensory:** tongue (posterior third) **parasympathetic:** parotid gland (via otic ganglion), lingual glands (posterior)

j Vagus nerve [X] (→ Figs. 12.157–12.159)	
Nuclei (quality)	• nucleus ambiguus (SVE) • solitary nucleus (SVA, GVA) • dorsal nucleus of vagus nerve (GVE, GVA) • spinal nucleus of trigeminal nerve (GSA)
Exit from the brain	medulla oblongata: retro-olivary groove
Location in the subarachnoid space	basal cistern
Passage through the dura mater	jugular foramen
Passage through the cranial base	jugular foramen
Innervation areas	**motor:** pharyngeal muscles (caudal part), levator veli palatini, musculus uvulae, laryngeal muscles **sensory:** dura mater of the posterior cranial fossa, deep part of the external acoustic meatus, tympanic membrane (outer surface) **special sensory:** base of the tongue **parasympathetic:** organs of the neck, thorax, and abdomen up to the CANNON-BÖHM's point

k Accessory nerve [XI] (→ Figs. 12.160, 12.161)	
Nuclei (quality)	• nucleus ambiguus (SVE) • nucleus of accessory nerve (SVE)
Exit from the brain	cranial roots: medulla oblongata: retro-olivary groove spinal roots: medulla cervicalis (lateral)
Location in the subarachnoid space	basal cistern
Entrance into the cranial cavity	foramen magnum (spinal roots)
Passage through the dura mater	jugular foramen
Passage through the cranial base	jugular foramen
Innervation areas	**motor:** sternocleidomastoid, trapezius (together with the cervical plexus)

l Hypoglossal nerve [XII] (→ Figs. 12.162, 12.163)	
Nuclei (quality)	• nucleus of hypoglossal nerve (GSE)
Exit from the brain	medulla oblongata: anterolateral sulcus
Location in the subarachnoid space	basal cistern
Passage through the dura mater	hypoglossal canal
Passage through the cranial base	hypoglossal canal
Innervation areas	**motor:** intrinsic muscles of the tongue, styloglossus, hyoglossus, genioglossus

59 Functional organization of the isocortex: primary and secondary cortical areas (→ Figs. 12.42, 12.43)

Primary cortical area*	Location	BRODMANN's area(s) (employing histological parameters, the cerebral cortex is divided into 52 cortical areas)
Primary (somato-)motor cortex (motor cortex)	precentral gyrus, frontal lobe	4
Primary somatosensory cortex	postcentral gyrus, parietal lobe	1, 2 and 3
Primary gustatory cortex	inferior part of the postcentral gyrus (corresponds to the sensory cortical area of the tongue) parts of the opercular part and of the insular cortex	43
Primary visual cortex	parts of the calcarine sulcus in the occipital lobe	17
Primary auditory cortex	transverse temporal gyri (HESCHL's transverse gyri) of the superior temporal gyrus in the temporal lobe	41

* Not listed are the primary olfactory area (prepiriform cortex) and the numerous vestibular cortical areas of the isocortex.

Secondary cortical area*	Location	BRODMANN's area(s) (employing histological parameters, the cerebral cortex is divided into 52 cortical areas)
Secondary motor cortical areas (pre- und supplemental motor cortex)	anterior to the primary motor cortex in the frontal lobe	6, 8
Secondary somatosensory cortex	posterior part of the primary somatosensory cortex in the parietal lobe	5
Secondary visual cortex	adjacent to the primary visual cortex in the occipital lobe	18, 19
Secondary auditory cortex	adjacent to the primary auditory cortex in the temporal lobe	42

* Only the most important secondary cortical areas are listed.

60 Nuclei of the Thalamus (selection) (→ Fig. 12.52)

Group	Nucleus	Function
Specific sensory relay nuclei	ventral posterolateral nucleus	sensory input from spinal nerves
	ventral posteromedial nucleus	sensory input of the head and gustatory afferences
	medial geniculate nucleus	part of the auditory pathway
	lateral geniculate nucleus	part of the visual pathway
Specific motor relay nuclei	ventral anterior and intermediate nucleus	coordination of the cerebellum and basal ganglia of the motor system
Association nuclei	pulvinar nuclei	integration of diverse specific sensory inputs
	medial nuclei	close relationship to the prefrontal cortex ("personality")
	anterior nuclei	part of the limbic system
Nonspecific relay nuclei	intralaminar nuclei (centromedian, parafascicular)	parts of the reticular system, important functions for arousal and consciousness
	median nuclei	sensory integration

The numbers refer to the numbers of the tables.

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

Z