MUSCULOSKELETAL SYSTEM

The general outline of the bony skeleton is shown below.

. A summary view of the skeleton
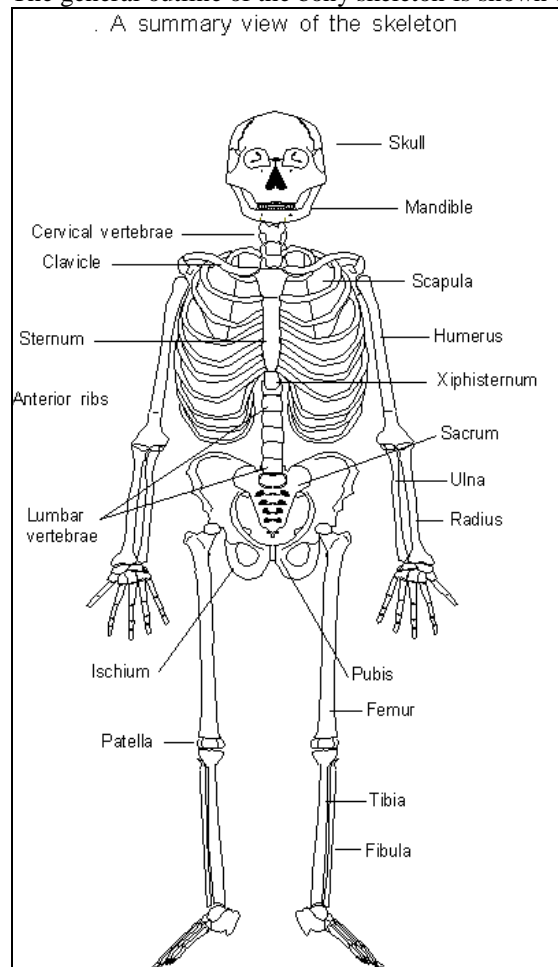
The upper limbs are slender compared to the lower limbs because they have little compressive load.

COLLAGEN

Collagen is the main supportive protein of connective tissue and is the basis for cartilage and bone. It has great tensile strength and, although it resists stretching, is flexible.

TENDONS

Tendons transmit the pull of muscles to bone. In general tendons are about four times as strong as the muscles which stress them. Tendons are flexible, resist tension, concentrate and convey muscle power to areas where muscle bulk would impede function (e.g. to fingers). If tension or mechanical stresses within tendons are severe then small bones develop (e.g. the kneecap). The collagenous fibres of tendons arise in the muscle at one end merge with bone at the other. Aponeuroses (=away from + tendon) are sheets of connective tissue "sheet-like tendons" that join muscles to muscles and distribute the tension brought about by muscle contraction.

LIGAMENTS

Ligaments are used where there is continuous tension (e.g. some thickenings in the joint capsules) or a need for stability. Ligaments are found outwith and internal to joints. Some ligaments may guide tendons. In the knee the cruciate ligaments are very important for stability whereas in the shoulder joint, which needs freedom of movement, there is only one ligament

CARTILAGE

Cartilage is used where compression, tension and shear forces must be met with firmness and flexibility. Fibrous cartilage is tough and is used for cushioning (e.g. intervertebral discs). Hyaline cartilage is found in costochondral cartilages and tracheal rings.

The molecular basis of cartilage
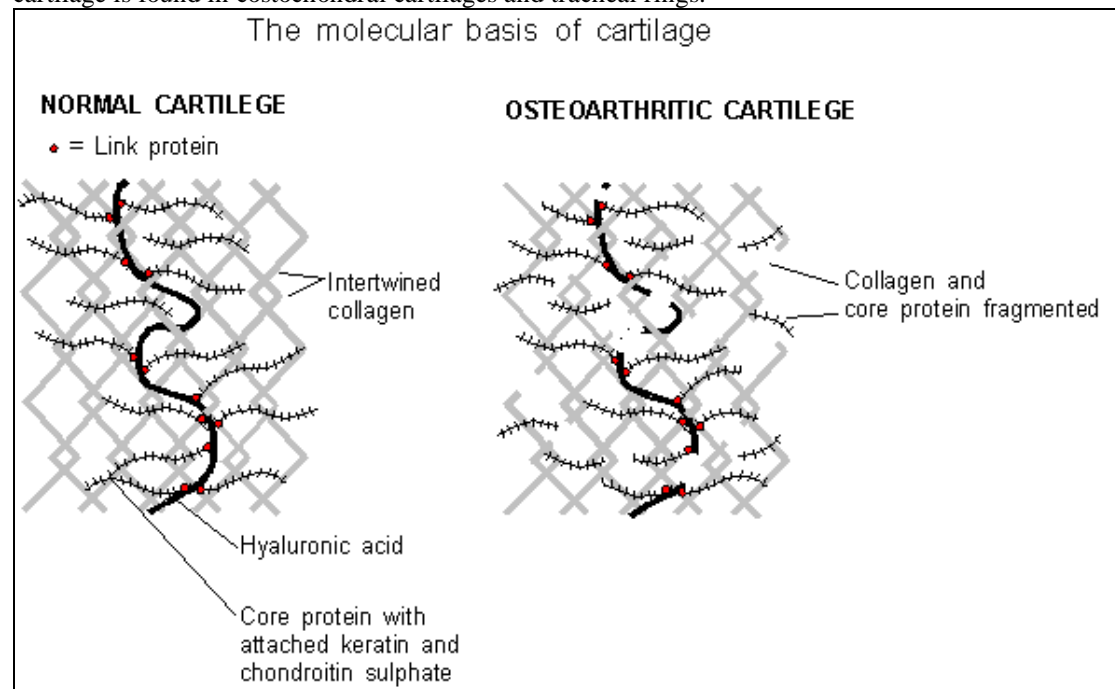
Maximum loss of articular cartilage tends to occur at sites of maximum load. The knees and hips are typically affected and non-weightbearing joints such as wrists and elbows are often spared. In normal cartilage collagen fibres are arranged like the springs of a mattress giving high tensile strength and compressibility. In osteoarthritis collagen networks break down and attempts at repair produce immature cartilage and attempts to form new cartilage may result in ossification and bony fragments can break off to form loose bodies within the joint.
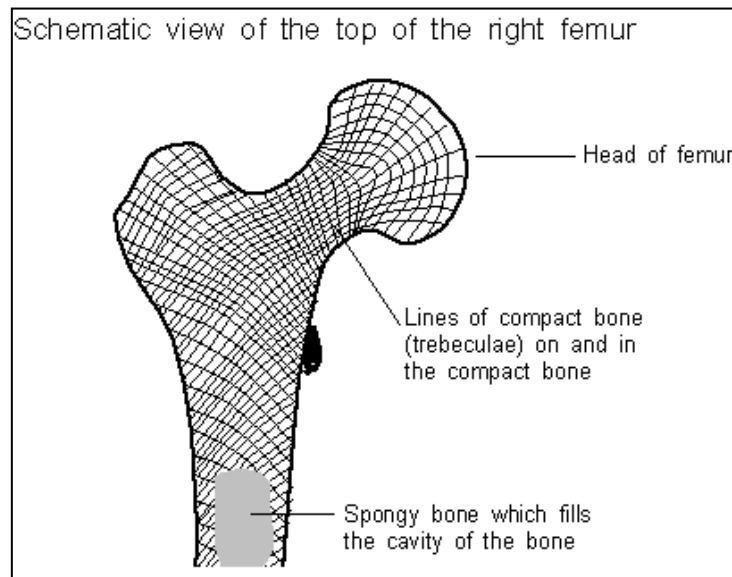
BONES

Architecture of bone
Bone is made up of an extracellular collagenous matrix (=substance between cells) mostly composed of fibrous material and ground substance made from proteins and minerals (mostly calcium hydroxyapatite crystals). Bones, weight for weight, are as strong as steel, and are four times as strong as reinforced concrete. In general dense compact "architectural" bone which forms about four fifths of the skeleton surrounds the more metabolically active spongy bone.

Two types of cell are used to form and mold growing bone, and to repair bony abnormalities. *Osteoblasts* (=bone + maker) form a single layer lining active bone surfaces and they are sensitive to parathormone (page 00) vitamin D metabolites, oestrogens, and steroids. *Osteoclasts* (=bone + breaking) reabsorb bone and can refashion fractures once the need for the extra reinforcing bone initially laid down (callus) has passed.

Long bones

Long bones in all vertebrates are generally tubular which gives the maximum strength and rigidity for a minimum structural weight. In long bones the compact dense bony diaphysis (= through + growth) encloses the medullary (= pith) marrow cavity and merges at each end with the metaphysis. About a fifth of the inner spongy bone is calcified but this calcification can provide valuable struts along lines of stress. The head of the femur in cross section and the strutting trabeculae (= beams) which form along the lines of stress are shown .

Schematic view of the top of the right femur

— Head of femur

— Lines of compact bone (trebeculae) on and in the compact bone
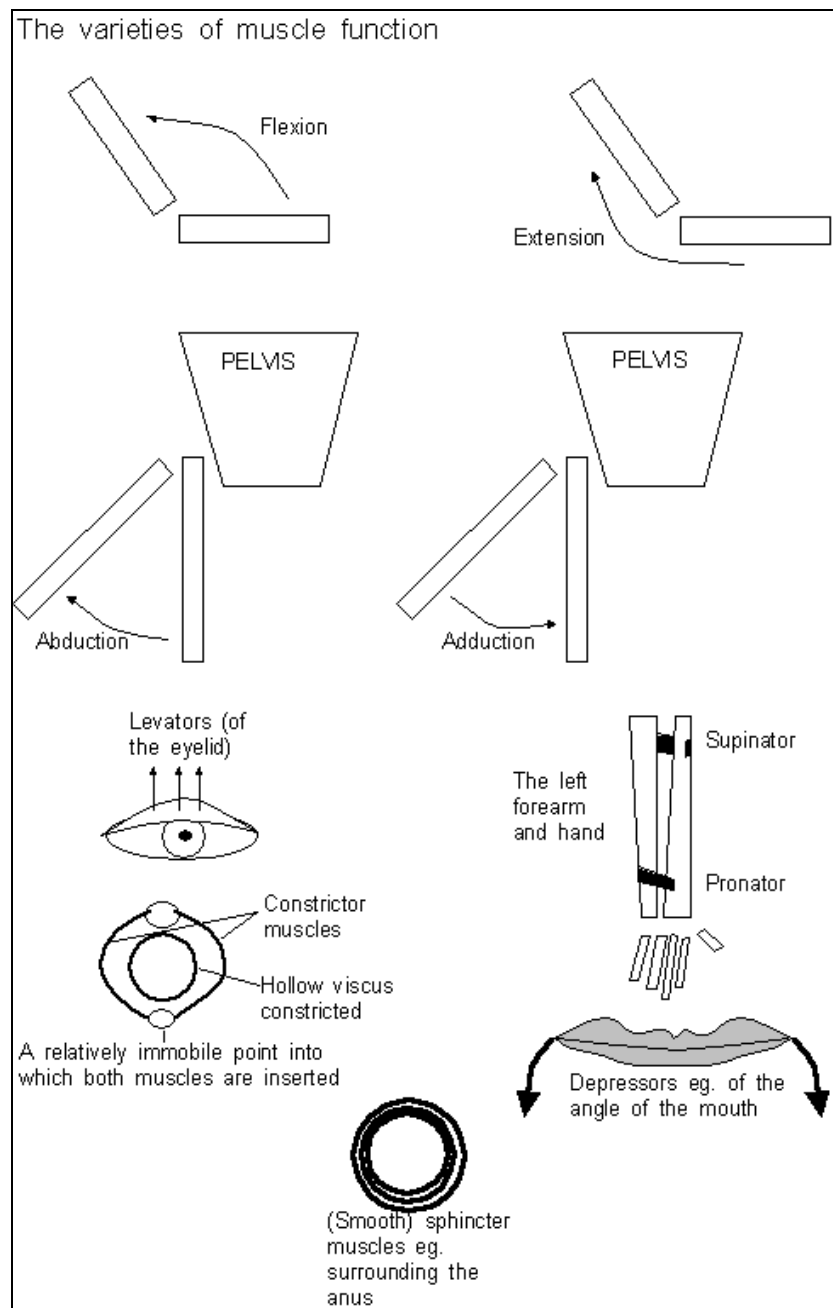
— Spongy bone which fills the cavity of the bone

The final epiphyseal (= upon + growth) surfaces are covered with articular cartilage. Both the inner and outer surfaces of the shafts of long bones are lined with osteogenic (= bone making) cells which form the periosteum (=around + bone) and endosteum (= within + bone).

Pain from bones is related to bone destruction, often related to increasing pressure within an area of bone, mechanical problems (if associated with use such pain is relieved by rest) and by inflammation (such pain is often present at rest with stiffness being worse at the start of movement)

Some bone problems
- Osteomalacia (and rickets which occurs in growing bone) is caused by an increased quantity of unmineralized bone matrix resulting from a relative or absolute lack of vitamin D. Causes of include dietary deficiencies, failures of gut absorption, liver disease and kidney diseases
- Osteoporosis is characterized by low bone mass with an increase in bone fragility and risk of fracture. It is a complex disease in which genetic factors are important and which is affected by diet, smoking, alcohol and exercise
- Osteoarthritis is associated with increased production of cartilage, matrix components, new bone, and synovial hyperplasia. Genetic predisposition, trauma, obesity, and hormonal influences may all contribute. It seems that a proportion of osteoarthritis is attributable to our recent evolution as bipedal organisms which has not allowed sufficient time for better joints to evolve
- Paget's disease is primarily caused by an increase in the size and number of osteoclasts, with associated increase in bone resorption and a compensatory increase in the rate of bone formation thus constituting an increased rate of bone turnover. Bone loses its lamellar (= plate-like) structure and expands and looks woven on X-ray. There is pain, deformity, fractures, and a risk of bone neoplasms

MUSCLES

The varieties of muscle function

Flexion

Extension

PELVIS

PELVIS

Abduction

Adduction

Levators (of the eyelid)

Constrictor muscles

Hollow viscus constricted

A relatively immobile point into which both muscles are inserted

(Smooth) sphincter muscles eg. surrounding the anus

The left forearm and hand

Supinator

Pronator

Depressors eg. of the angle of the mouth

There are three types of muscle:

- Striated (skeletal) muscle
- Cardiac striated muscle
- Smooth muscle

Skeletal muscles

In this account the anatomical position of the muscles are shown and the function only mentioned in the text where necessary. Muscles are limited in that the can only contract. Movements at joints can be flexion, extension, abduction, adduction, and rotation in some joints. Pathologically joints may be dislocated or subluxed. Apart from the introduction I deal with the contents of various regions rather than focus on each tissue in turn.

The muscle fibres seen in macroscopic and microscopic context

- A single muscle fibre
- Bundle of muscle fibres
- Endomysium - surrounds single muscle fibres
- Perimysium - surrounds bundles of muscle fibres
- Epimysium - surounds the muscle
- Tendon attachment to bone
- A band
- H zone
- I band
- Z line
- Actin
- Myosin
- Swiveling heads on actin which pull the actin towards the centre of the myosin and thus cause the muscle fibre to contract

The basic unit of skeletal muscle is the fibre. The thick myosin filaments have long tapering ends which have outward projections whereas the thinner filaments of actin and other related proteins have "beads" upon them. Contraction occurs when myosin binds to actin, with the beads of the latter swiveling so that the thick and thin filaments are pulled past each other. The overlapping areas of the filaments give rise to the striations visible on light microscopy. Striated muscle contraction is termed *isometric* when contraction causes tension but with no shortening and *isotonic* when the muscle contracts. Individual fibres contract completely (shortening by about 30 percent) or not at all. Each group of fibres supplied by a single motor nerve cell constitutes a motor unit and the more precise the muscle movement required, the greater the motor nerve: muscle fibre ratio.

Skeletal muscle fibres are of two types. One type are slow to contract, slow to relax, fatigue slowly, and are important for posture control. The other type are "fast-twitch" which are used for rapid movements. Most striated muscles have both types and all muscle fibres of a single motor unit are of the same type. Muscle fibres can be organized in various ways to suit various needs and various functions (Fig. 7).

In general striated muscles are usually named with the origin first and the insertion second

The basic job of striated muscles is to contract (muscles can only pull: they cannot push), and thereby either shorten themselves or serve to immobilize bones to which they are attached. Striated muscles can also generate heat by shivering. Skeletal muscles are joined to bones or top joint capsules by tendons which contain closely packed collagenous fibres.

Muscle diseases may cause:
- Weakness
- Wasting (occasionally hypertrophy)
- Pain
- Muscular fatigue
- Cramps
- Twitching
- Myotonia (delayed muscle relaxation after voluntary contraction)

Myos*itis* is inflammation of muscle and the muscles affected may be weak and painful or tender on palpation. Myo*pathy* is non-inflammatory muscle dysfunction which is usually caused by metabolic problems.

Cardiac muscle

Cardiac striated muscle is branched and has to be wound into a bag shape to squeeze the blood within the heart.

The winding nature of heart muscle
This winding enables blood to be squeezed rather than pushed out of the ventricles

Anterior interventricular groove

Vortex at apex of the left ventricle

Posterior interventricular groove

Vortex and apex of the right ventricle
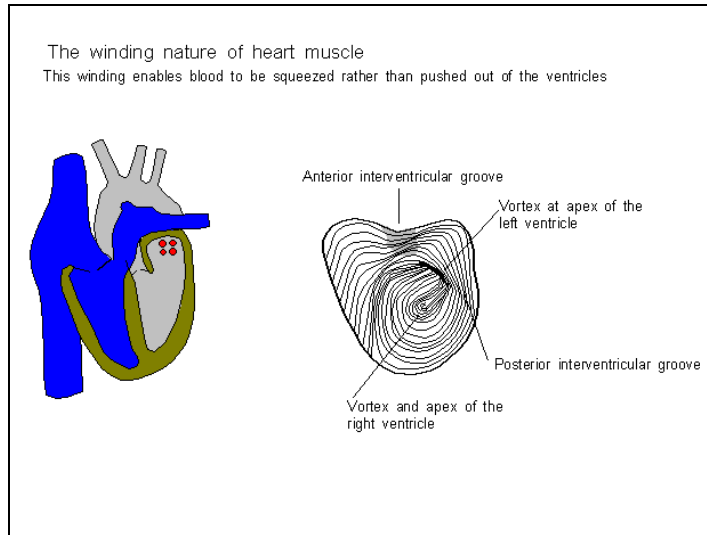
Smooth muscle

Smooth muscle is non-striated and spindle shaped. Smooth muscle is present in the skin, blood vessels, urogenital tract, respiratory tract tubes, gut and gut derivatives.

JOINTS

The movements around various joints are detailed below.

Nomenclature of various joint movements

Flexion of neck joints ← → Extension of neck joints

Flexion of elbow joint

Extension of elbow joint

Flexion of hip joint

Extension of hip joint

Extension of knee joint

Flexion of knee joint

Dorsiflexion of ankle joint

Plantar flexion of ankle joint

Adduction of left shoulder joint - abduction is moving it back

RIGHT HAND

Adduction of left hip joint - abduction is moving it back

Supination - lying on back

Pronation - lying on front

Abduction and adduction at the elbow and knee joints are both minimal

Movements of the (right) foot, medial view

Dorsiflexion

Plantar flexion

Inversion

Eversion
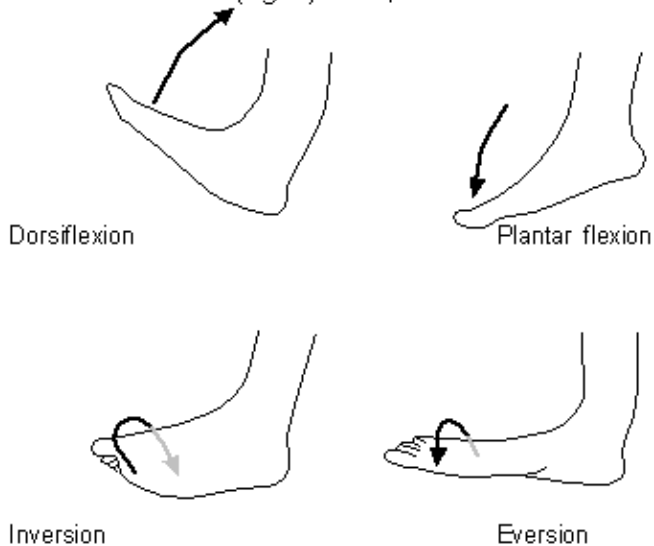
Abduction and adduction is movement of the distal foot away from and towards the midline respectively

Movements of fingers and thumb.
Opposition occurs when the thumb tip presses on the fingertips

Abduction of thumb and fingers. The thumb comes to lie at right angles to the palm and the index finger

Adduction of thumb and fingers. The thumb comes to lie alongside the palm.

Flexion of fingers and thumb

Extension of fingers and thumb
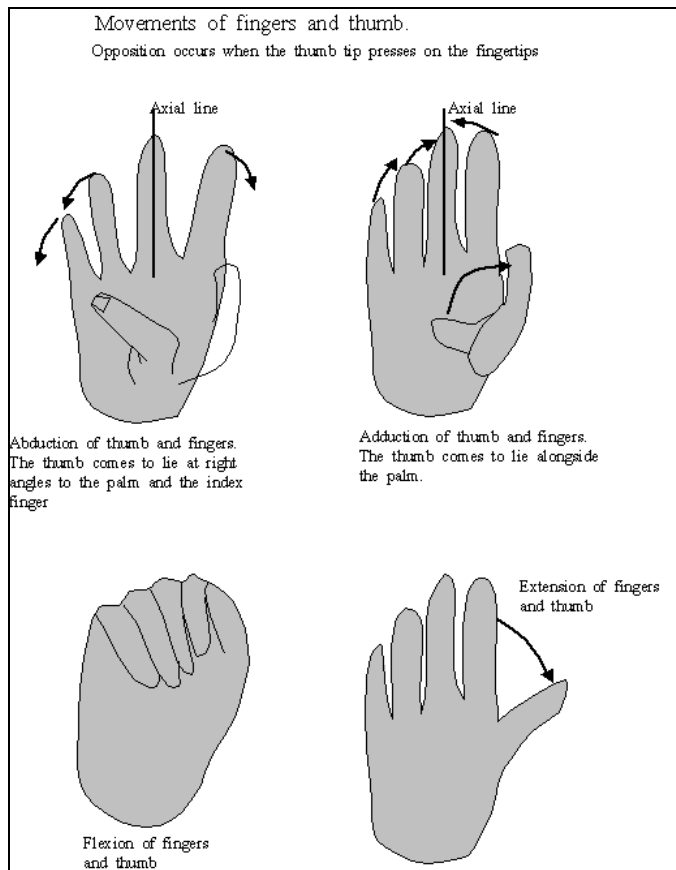
In effect joints occur whenever two or more skeletal elements meet but do not fuse. The structure of some joint encourages wide-ranging movement (e.g. the shoulder joint) but in others movement is specifically limited. Mechanically speaking, mobile joints can be ball and socket (the femur in the acetabulum), ellipsoid (radius and wrist bones) or plane

An archetypal synovial joint

Muscle
Bone
Synovial fluid
Synovial cavity
Joint capsule
Synovial lining
Bone
Tendon
Articular cartiledge
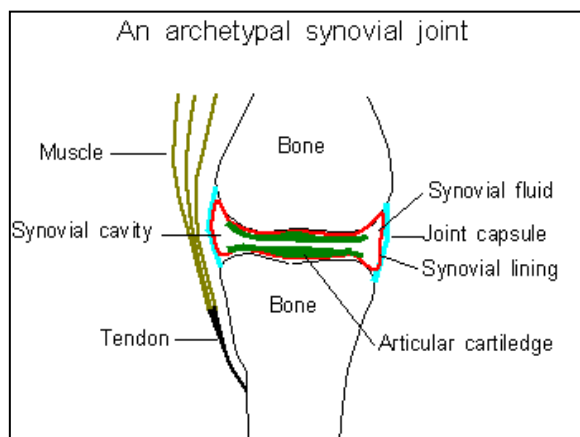
There are three basic joint structures. *Fibrous joints* have very limited movement. Synarthroses (=together + joints) are immovable joints such as are found in the skull. *Cartilaginous joints* such as occur between the vertebrae of the spinal column, usually have a thin layers of hyaline (=glassy) cartilage covering each bony surface surrounding which is a thicker circular layer of fibrocartilage. Movement is limited but a degree of compression "shock absorbing" occurs. *Synovial joints* allow movement. The capsule contains collagen and elastic fibres, is continuous with the periosteum and is lined with synovial membrane. Menisci (=small moons) are tough pads of fibrous cartilage. Fluid, which is formed by the synovium, lubricates the surface of articular cartilage from which it is extruded, and also nourishes cartilage (which is devoid of blood vessels).

Some joint problems:
- Joint *swelling* can be caused by fluid, subcutaneous tissue, synovial or bony overgrowth, excessive fluid (effusion) affecting the joint or bursae (=sac) which are in direct contact with joints or are separate
- Joint *tenderness* can be caused by inflammation, mechanical damage or metabolic processes (gout, for example).

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- Joint *stiffness* is caused by bony or connective tissue problems but gelling of synovial fluid may result in variable stiffness such as early morning (i.e. after rest) stiffness that occur in rheumatoid arthritis *Crepitus,* which tends to be coarse in osteoarthritis and fine in rheumatoid arthritis, is a crackling sound made on joint movement, represents roughness of articulating surfaces or tendon sheaths
- Joint *instability* may be caused by lax ligaments, rupture, and joint displacement including dislocation or subluxation (with dislocation the articulating surfaces are separated whereas in subluxation they remain partially in contact)
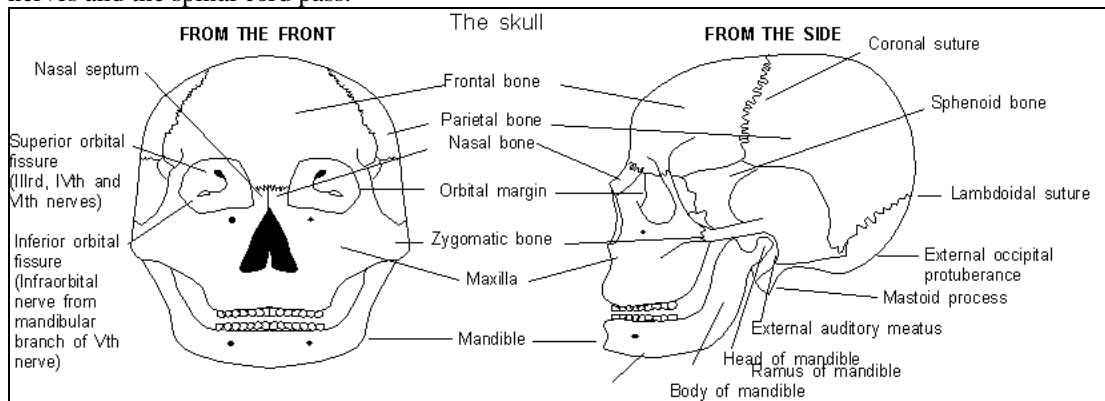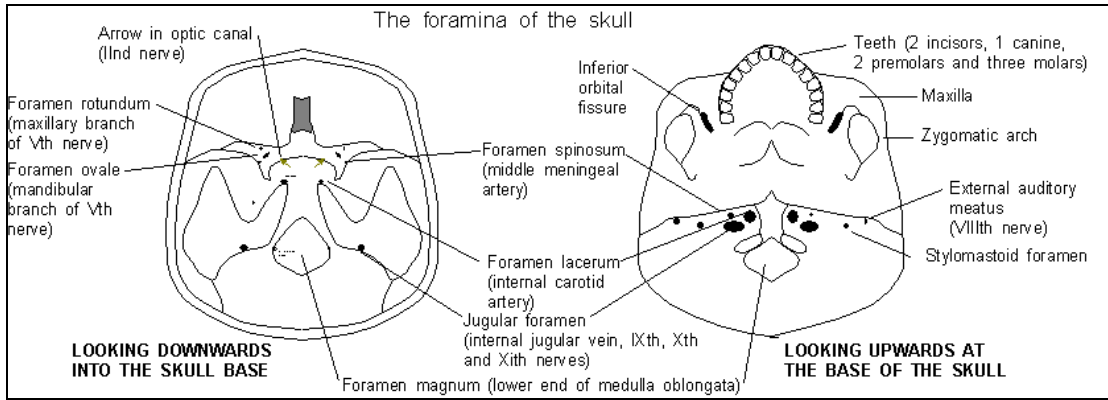
PRACTICAL ASPECTS OF THE MUSCULOSKELETAL SYSTEM

The first amphibians had a pair of forelimbs and a pair of hindlimbs with the hindlimbs being more powerful because it was more effective to push than pull. Joint movement was important and so a ball and socket joint was advantageous. However the forelimbs were more used to influence the direction conferred by the push of the hindlimbs and this required mobility and flexibility of the forelimbs which thus developed an anchor bone (the scapula) attached by muscle with its joint socket being much less deep than that of the hindlimb. Later the need for forelimb mobility increased further as our ancestors took to the trees. The fibula is reduced because there is now no need for foot rotation.

In all terrestrial four-limbed animals the second segment of the limbs is a pair of bones (radius and ulna, tibia and fibula) probably because our ancestors that first traveled on land as they left the sea (or more likely river estuaries) tended to slither and thus their limbs were not weight bearing. Their limbs needed to be able to bend but also required firm contact with the land and thus an ability to rotate the forearm and lower leg would have been advantageous. Once we were able to stand the hindlimb became the lower limb. The lower limb had to absorb shocks entailed by walking (the average human walks about 50,000 miles in a lifetime) and the arrangement of foot bones and the longitudinal and transverse arches achieves this as does knee bending.
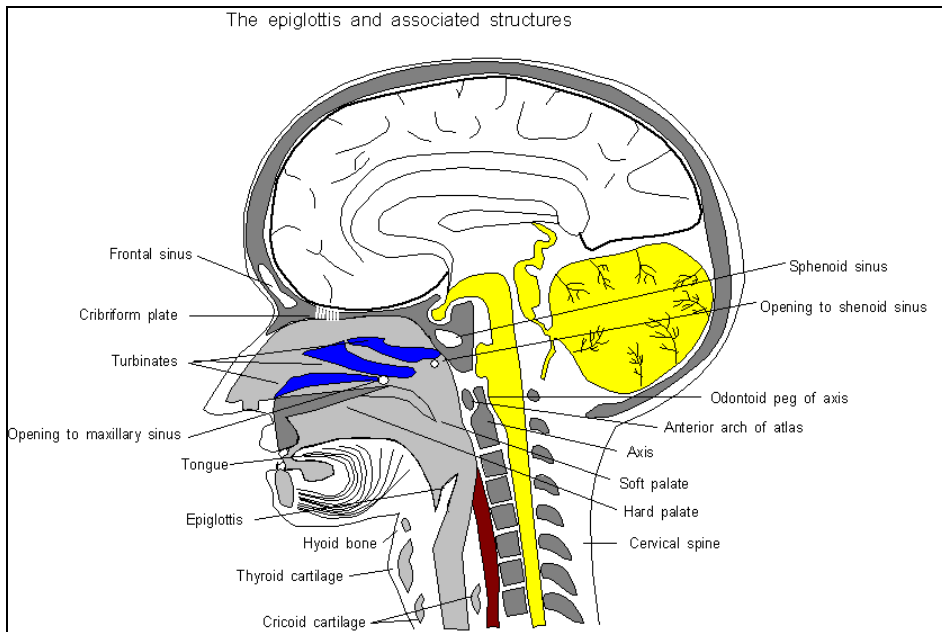
THE HEAD AND NECK

The skull is a bony box which contains the brain and appropriate foramina through which vessels, nerves and the spinal cord pass.

The foramina of the skull

Left diagram (LOOKING DOWNWARDS INTO THE SKULL BASE):

- Arrow in optic canal (IInd nerve)
- Foramen rotundum (maxillary branch of Vth nerve)
- Foramen ovale (mandibular branch of Vth nerve)
- Foramen spinosum (middle meningeal artery)
- Foramen lacerum (internal carotid artery)
- Jugular foramen (internal jugular vein, IXth, Xth and Xith nerves)
- Foramen magnum (lower end of medulla oblongata)

LOOKING DOWNWARDS INTO THE SKULL BASE

Right diagram (LOOKING UPWARDS AT THE BASE OF THE SKULL):

- Inferior orbital fissure
- Teeth (2 incisors, 1 canine, 2 premolars and three molars)
- Maxilla
- Zygomatic arch
- External auditory meatus (VIIIth nerve)
- Stylomastoid foramen

LOOKING UPWARDS AT THE BASE OF THE SKULL

A cross section of the skull including the nasal region is shown below.

The epiglottis and associated structures

- Frontal sinus
- Cribriform plate
- Turbinates
- Opening to maxillary sinus
- Tongue
- Epiglottis
- Hyoid bone
- Thyroid cartilage
- Cricoid cartilage
- Sphenoid sinus
- Opening to shenoid sinus
- Odontoid peg of axis
- Anterior arch of atlas
- Axis
- Soft palate
- Hard palate
- Cervical spine

The sinuses are air-filled spaces which lighten the skull. The superficial muscles of the head and neck are shown below.

The superficial muscles of the head and neck

- Temporalis Mandibular branch of V nerve
- Frontalis VII nerve
- Orbicularis oculi VII nerve
- Levator labii superioris alequae nasi VII nerve
- Zygomaticus minor VII nerve
- Zygomaticus major VII nerve
- Masseter Mandibular branch of V nerve
- Buccinator VII nerve
- Platysma VII nerve
- Occipitalis VII nerve
- Trapezius XI nerve
- Sternocleiomastoid XI nerve
- Posterior belly of digastric Mandibular branch of V nerve

The superficial and lateral neck muscles are:
- Platysma
- Trapezius
- Sternomastoid

The sternomastoid has two heads inferiorly, one attaching to the manubrium and the other to the medial third of the clavicle.

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There are six pairs of muscles which move the eyeball.

Figure 38. Nerve supply to the eye muscles.

The right eye as seen from above

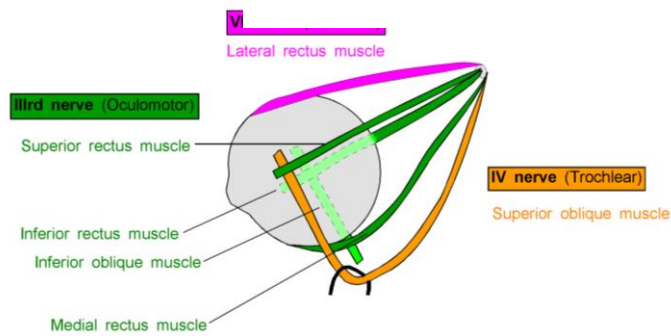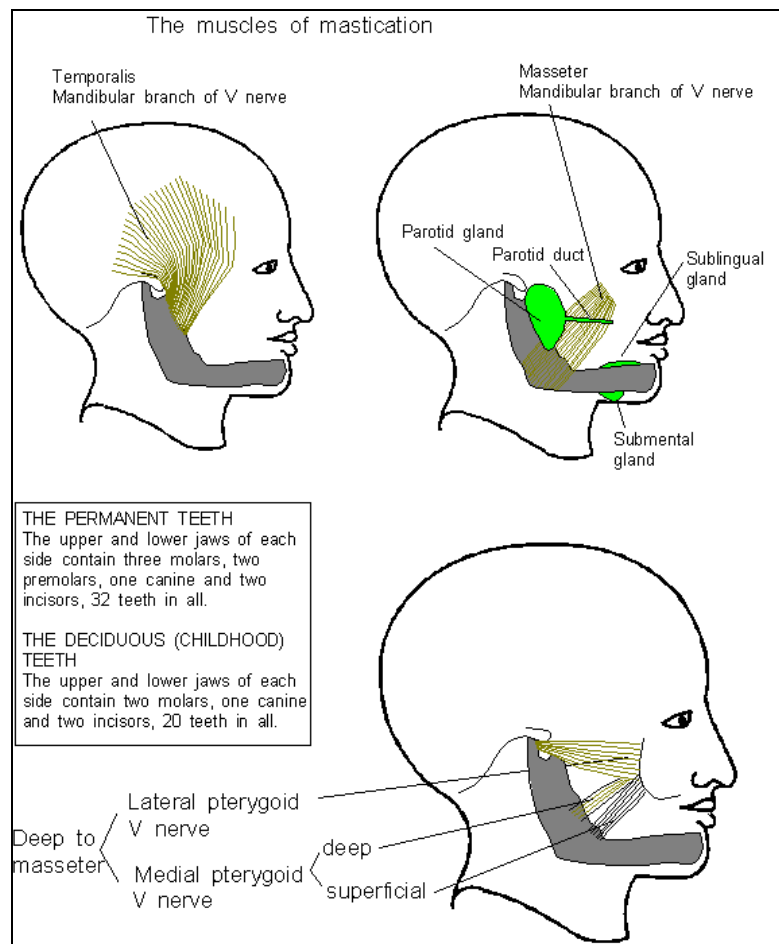- When the eye is looking straight ahead the lateral rectus muscle abducts the eye and the medial rectus adducts the eye
- When the eye is looking laterally the superior rectus rotates the eye upwards
- When the eye is looking laterally the inferior rectus rotates the eyeball downwards
- When the eye is looking medially the superior oblique rotates the eyeball downwards
- When the eye is looking medially the inferior oblique rotates the eye upwards

There are four pairs of muscles of mastication which move the mandible to allow the teeth to come together. All are driven by the mandibular branch of the Vth nerve.

The muscles of mastication

Temporalis
Mandibular branch of V nerve

Masseter
Mandibular branch of V nerve

Parotid gland
Parotid duct
Sublingual gland
Submental gland

THE PERMANENT TEETH
The upper and lower jaws of each side contain three molars, two premolars, one canine and two incisors, 32 teeth in all.

THE DECIDUOUS (CHILDHOOD) TEETH
The upper and lower jaws of each side contain two molars, one canine and two incisors, 20 teeth in all.

Lateral pterygoid
V nerve

Deep to masseter

Medial pterygoid
V nerve

deep

superficial

The hyoid (=shaped like the Greek letter v) bone is a central point for several muscles. Above the hyoid there are five pairs of muscles:
- Mylohyoid,
- Digastric (=having two bellies)
- Stylohyoid
- Hyoglossus
- Geniohyoid (which is not illustrated because it is above the medial part of mylohyoid)

Muscles relevant to the hyoid bone.

Muscles above the hyoid bone help open themouth against resistance.
Muscles below the hyoid bone depress the larynx in the later stages of swallowing.

Digastric
- Anterior belly mandibular V
- Posterior belly VII nerve

Undersurface of jaw

Splenius capitis
C3-5

Hyoglossus
XII nerve

Stylohyoid
VII nerve

Longus capitis
C1-3

Myohyoid
Mandibular V

HYOID BONE

Sternocleidomastoid
(as if pulled aside)

Levator scapuli
C3-5

Sternohyoid
C1-3

Omohyoid
C1-3

Cricothyroid
X nerve

Scalenus anterior
Scalenus medius
Scalenus posterior
C6-8

Sternothyroid
C1-3

Clavicles

Below the hyoid bone there are four pairs of muscles:
- Sternohyoid,
- Thyrohyoid - which raises the larynx

- Omohyoid
- Sternothyroid (the sternohyoid is an upward continuation of this)

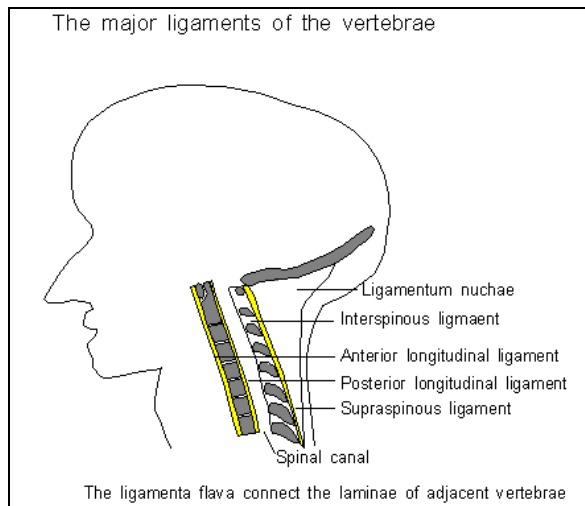All are driven by C1-3 nerves except the superior part of omohyoid which is C1 alone.

THE VERTEBRAE

The diagram below shows the configuration of various vertebrae. The vertebrae, the intervertebral joints, facet joints and ligaments constitute a rigid but moderately flexible backbone which support the head and neck and allows the rib movements necessary for ventilation of the lungs.

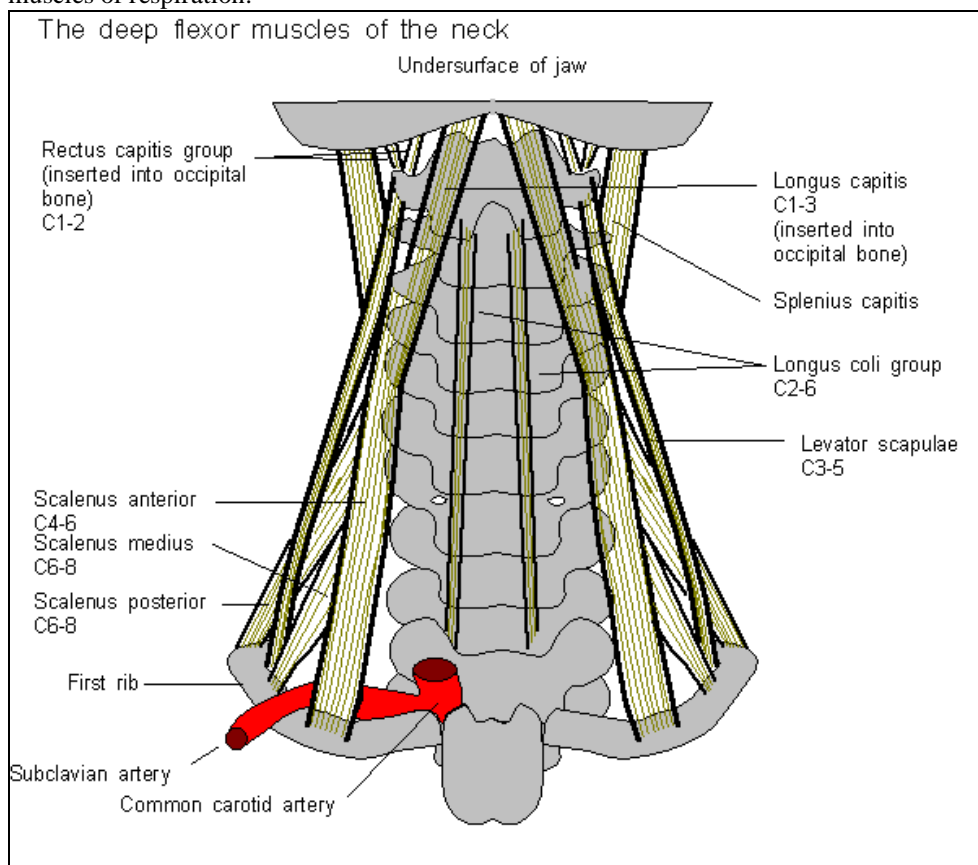A diagramatic account of the vertebrae and the sacrum
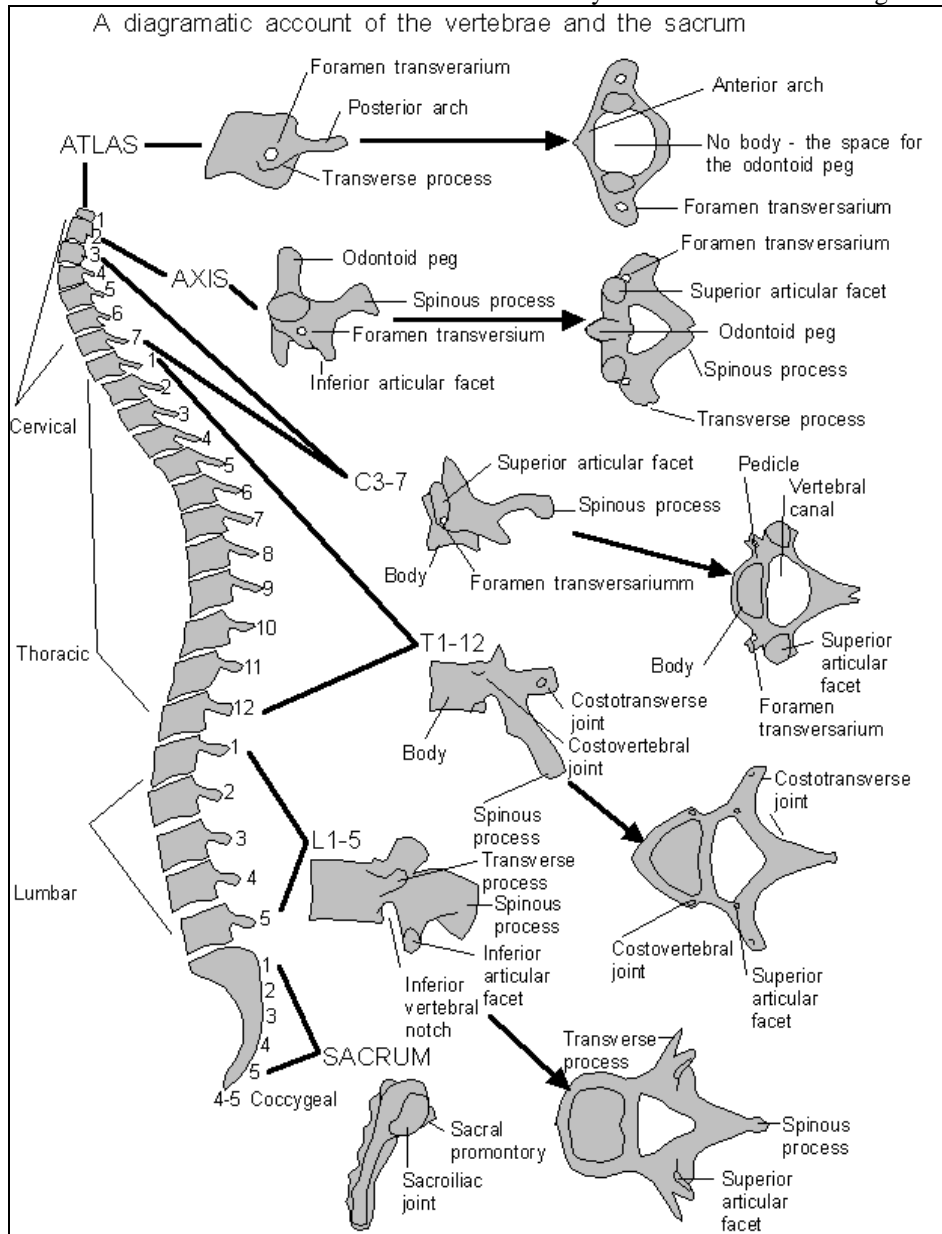
The top two vertebrae, the atlas (C1) and axis (C2), are modified so the skull can be rotated, flexed or extended. The axis has facets on its superior surface which articulate with the occipital condyles so that the head can be flexed, extended and flexed laterally. The body of the atlas is not present and its place is taken by the odontoid peg of the axis around which the atlas, and thus the head, rotates. The lower end of the ligamentum nuchae (=ligament of the neck) is attached to the prominent spinous process of C7 (which serves as a landmark which enables counting off of the spinous processes of other vertebrae) and attaches to the occipital protuberance of the skull. The vertebrae inferior to C2 have an intervertebral joint and two facet joints.

The ligaments between vertebrae ensure stability along with some flexibility. A strong anterior longitudinal ligament run from the anterior surface of the atlas to the front of the sacrum and a weaker posterior longitudinal ligament run down on the posterior surface of the vertebral bodies.

The major ligaments of the vertebrae

Ligamentum nuchae
Interspinous ligmaent
Anterior longitudinal ligament
Posterior longitudinal ligament
Supraspinous ligament
Spinal canal

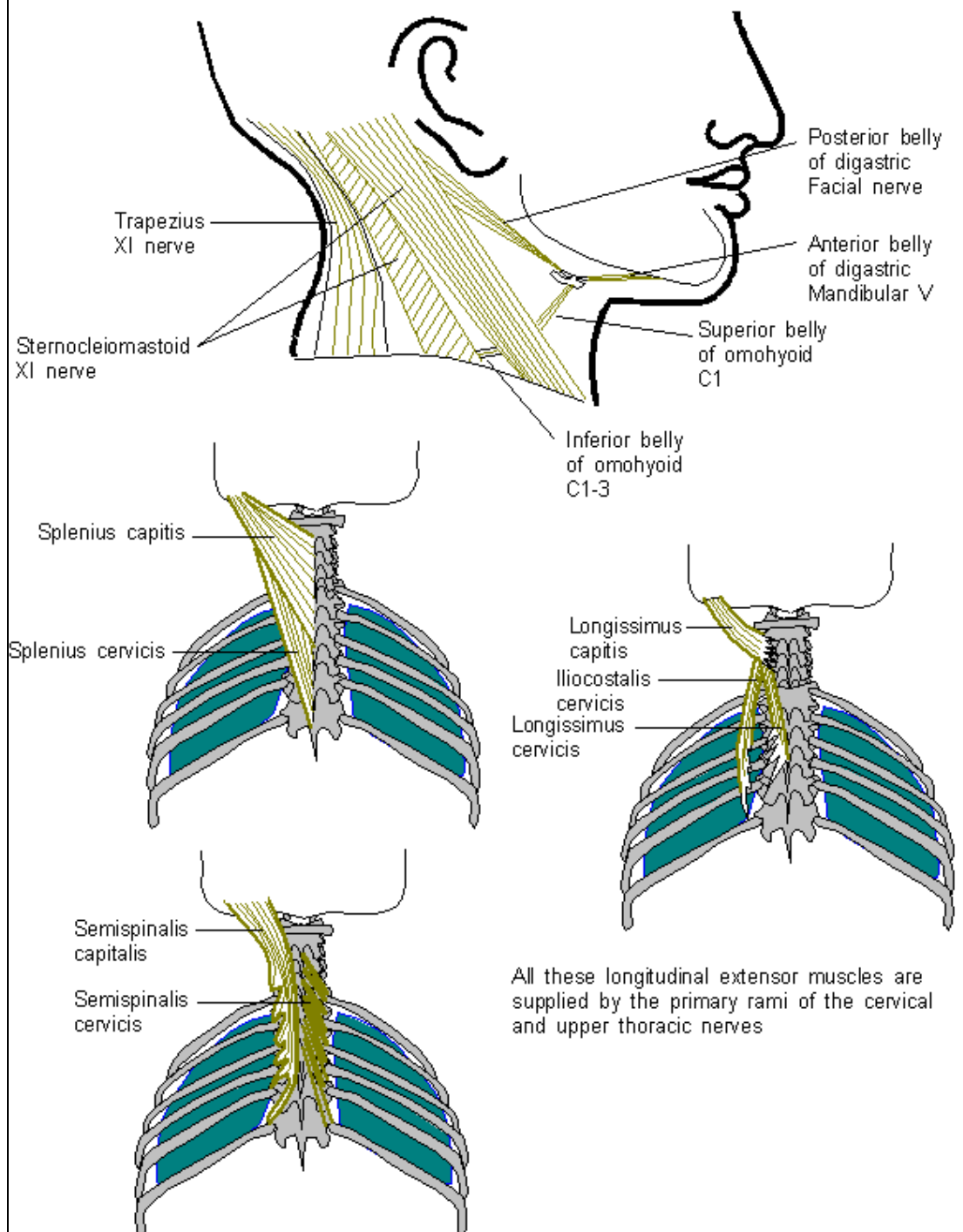The ligamenta flava connect the laminae of adjacent vertebrae

The neural arches are joined by the ligamentum flava, the interspinous ligaments and supraspinous ligaments. The axis, atlas and skull have no intervertebral discs and have extra ligament to provide stability.

The neck flexors and deep muscles which (along with ligaments) control and stabilize the skull base, atlas and axis "balancing act." The flexors include sternomastoid, scalene (=unequally three-sided) and prevertebral muscles (longus cervicis{= of neck} and capitis{= of head}). The sternomastoids acting together bring the head forward and down, but each contracting in isolation turns the head to the opposite side. The scalene muscles flex the neck laterally and the prevertebral muscles flex the neck anteriorly. All these muscles can be used to lift up the bony skeleton of the upper chest and thus provide extra intra-thoracic volume and, accordingly, when used are referred to as the accessory muscles of respiration.

The deep flexor muscles of the neck

Undersurface of jaw

Rectus capitis group
(inserted into occipital bone)
C1-2

Longus capitis
C1-3
(inserted into occipital bone)

Splenius capitis

Longus coli group
C2-6

Levator scapulae
C3-5

Scalenus anterior
C4-6
Scalenus medius
C6-8
Scalenus posterior
C6-8

First rib

Subclavian artery

Common carotid artery

Muscles which extend the neck and play a role in lateral head movements

The extensors of the thoracic spine (see below) also play a role in neck extension. Trapezius covers the three deep muscle groups:
- The splenius (= bandlike) group in which fibres align superiorly and laterally
- The erector spinae group in which fibres align upwards and parallel to the spine
- The semispinalis group in which fibres align superiorly and medially

There are numerous posteriorly situated small muscles which will not be described which control the atlas, axis and base of the skull.
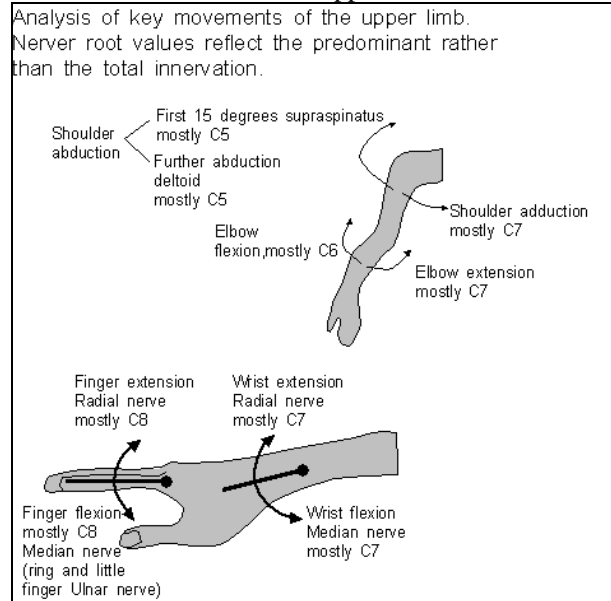
The stapedius, which is attached to the stapes(= the stirrup), and the tensor tympani (= of the drum) which is connected to the eardrum contract together to dampen the effect of high volume sounds on the auditory apparatus.
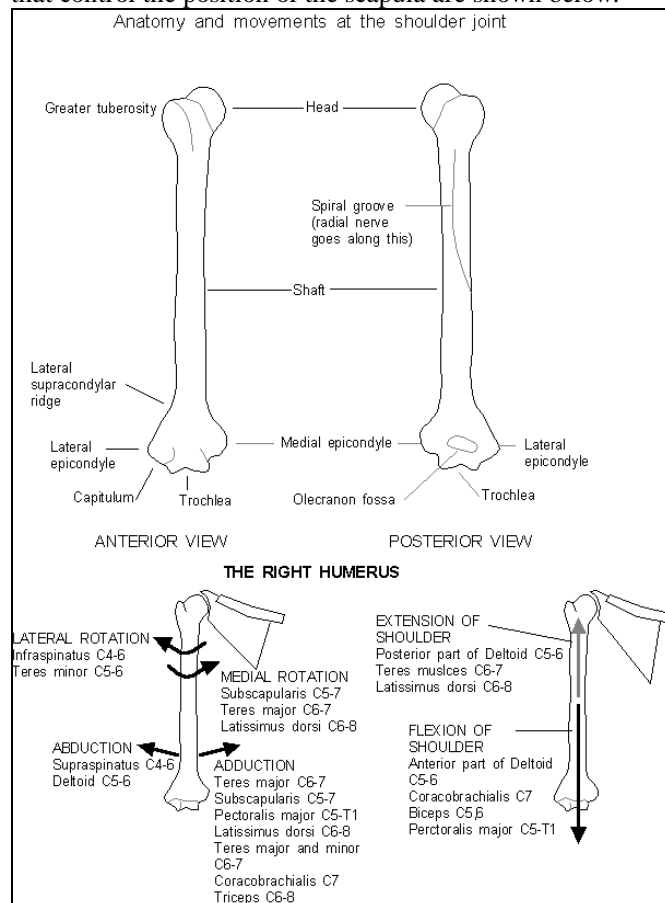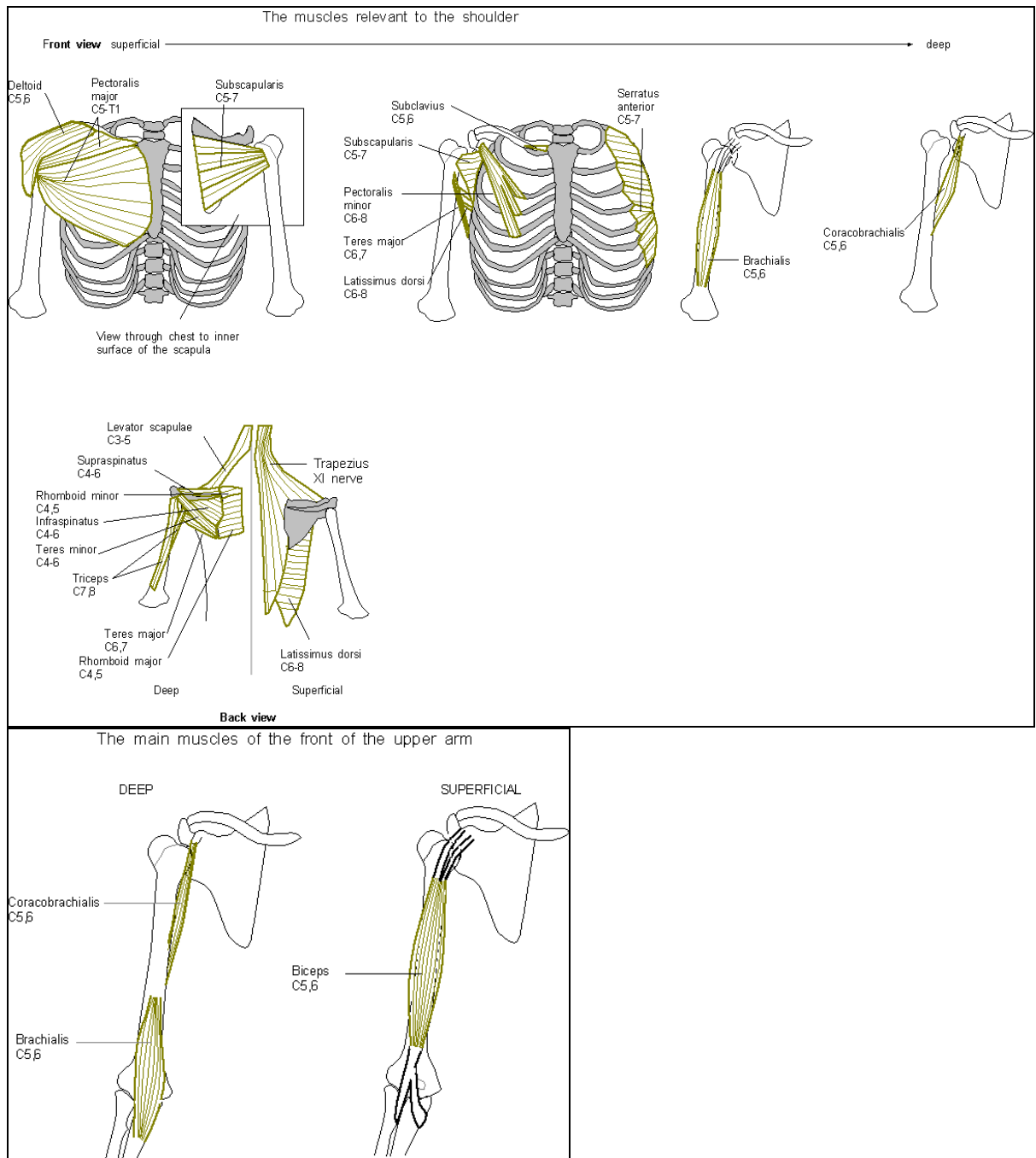
THE UPPER LIMB

The upper and lower limb have marked similarities.
The main movements of the upper limb are illustrated below.

Analysis of key movements of the upper limb.
Nerver root values reflect the predominant rather than the total innervation.

Shoulder abduction
First 15 degrees supraspinatus mostly C5
Further abduction deltoid mostly C5
Shoulder adduction mostly C7
Elbow flexion,mostly C6
Elbow extension mostly C7

Finger extension Radial nerve mostly C8
Wrist extension Radial nerve mostly C7
Finger flexion mostly C8 Median nerve (ring and little finger Ulnar nerve)
Wrist flexion Median nerve mostly C7

The muscles of the shoulder girdle that indirectly affect shoulder movement and stability and those that control the position of the scapula are shown below.

Anatomy and movements at the shoulder joint

Greater tuberosity
Head
Spiral groove (radial nerve goes along this)
Shaft
Lateral supracondylar ridge
Lateral epicondyle
Medial epicondyle
Lateral epicondyle
Capitulum
Trochlea
Olecranon fossa
Trochlea

ANTERIOR VIEW
POSTERIOR VIEW

THE RIGHT HUMERUS

LATERAL ROTATION
Infraspinatus C4-6
Teres minor C5-6

MEDIAL ROTATION
Subscapularis C5-7
Teres major C6-7
Latissimus dorsi C6-8

ABDUCTION
Supraspinatus C4-6
Deltoid C5-6

ADDUCTION
Teres major C6-7
Subscapularis C5-7
Pectoralis major C5-T1
Latissimus dorsi C6-8
Teres major and minor C6-7
Coracobrachialis C7
Triceps C6-8

EXTENSION OF SHOULDER
Posterior part of Deltoid C5-6
Teres muslces C6-7
Latissimus dorsi C6-8

FLEXION OF SHOULDER
Anterior part of Deltoid C5-6
Coracobrachialis C7
Biceps C5,6
Perctoralis major C5-T1

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The muscles relevant to the shoulder

Front view superficial ————————————————————→ deep

Deltoid C5,6
Pectoralis major C5-T1
Subscapularis C5-7
Subclavius C5,6
Serratus anterior C5-7
Subscapularis C5-7
Pectoralis minor C6-8
Teres major C6,7
Latissimus dorsi C6-8
Brachialis C5,6
Coracobrachialis C5,6

View through chest to inner surface of the scapula

Levator scapulae C3-5
Supraspinatus C4-6
Rhomboid minor C4,5
Infraspinatus C4-6
Teres minor C4-6
Triceps C7,8
Teres major C6,7
Rhomboid major C4,5
Trapezius XI nerve
Latissimus dorsi C6-8

Deep   Superficial

Back view

The main muscles of the front of the upper arm

DEEP   SUPERFICIAL

Coracobrachialis C5,6
Brachialis C5,6
Biceps C5,6

The bony shoulder unit (clavicle, scapula and humerus) allow mobility. The only direct contact with the midline skeleton is at the sternoclavicular joint. Otherwise the scapula is "floating" and positioned by various muscles. Ventrally there are three inner muscles:

- Pectoralis minor (pectus = chest)
- Serratus (= having a sawlike edge) anterior
- Subclavius (= under the clavicle)

Dorsally the deep muscles are:

- Supraspinatus (= above the spine {of the scapula})
- Infraspinatus (= below the spine {of the scapula})
- Elevator scapulae
- The teres muscles
- The rhomboids (= like a parallelogram)

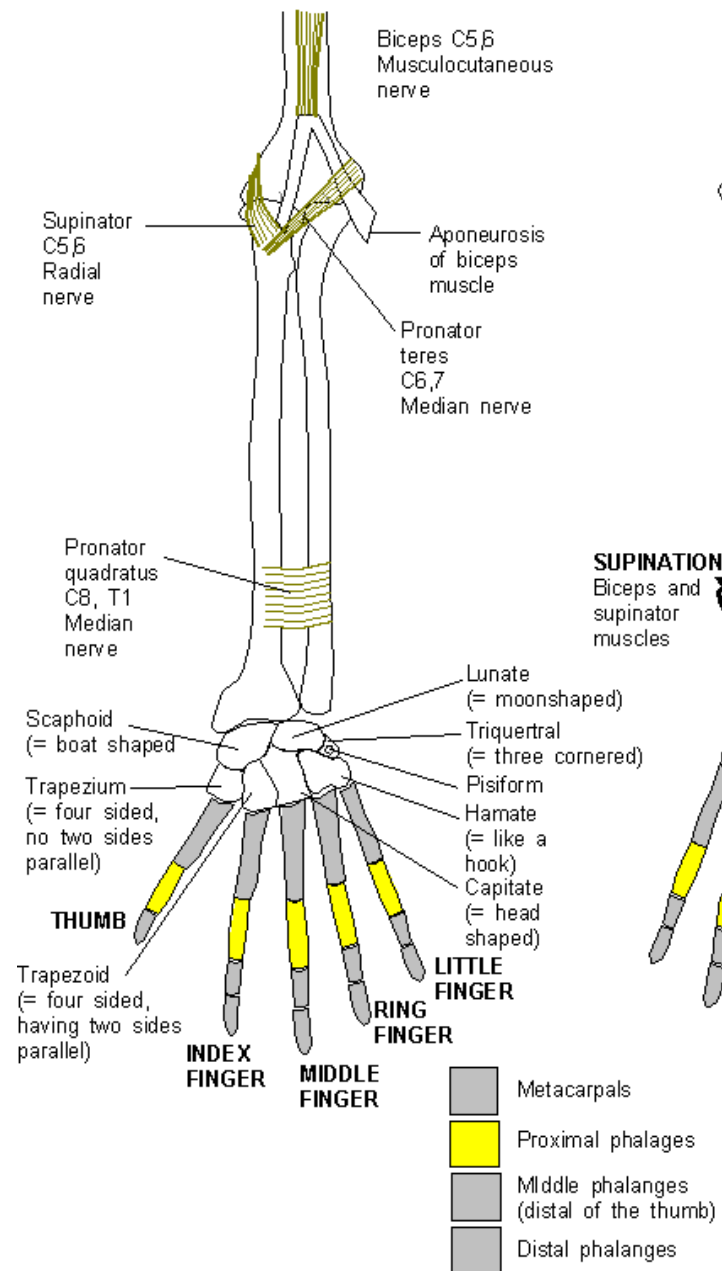The superficial muscles which directly affect the shoulder girdle are:
- Trapezius (= table shaped), which can shrug the shoulder, extend the neck, rotate the skull, or move the scapula
- Latissimus (= widest) dorsi
- Deltoid (= triangular)

Pectoralis major can adduct or medially rotate the humerus. Pectoralis minor, along with serratus anterior, draws the scapula forwards around the rib cage. Subcapularis arises from the deeper surface of the scapula and is inserted into the upper humerus and shoulder joint capsule.
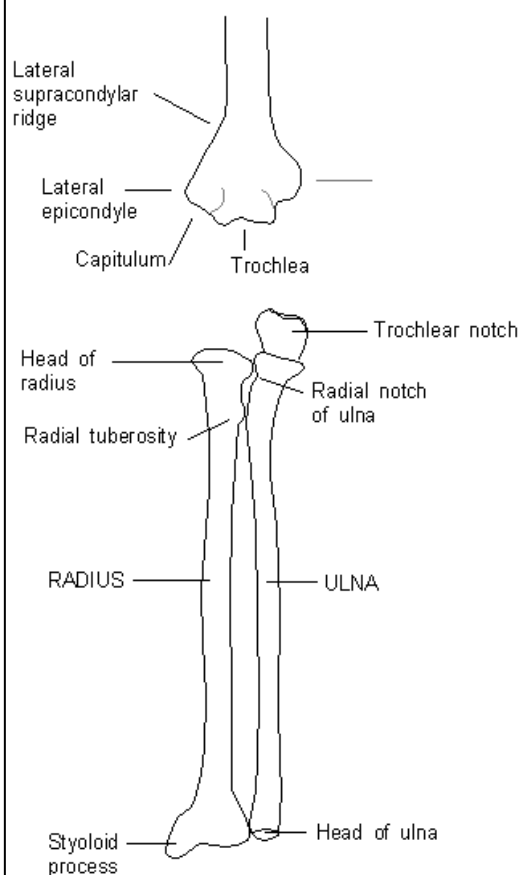
The inner muscles are:
- Deltoid, which is responsible for the first third of humerus abduction
- The teres muscles
- Supraspinatus
- Infraspinatus

Biceps C5,6
Musculocutaneous
nerve

Supinator
C5,6
Radial
nerve

Aponeurosis
of biceps
muscle

Pronator
teres
C6,7
Median nerve

Pronator
quadratus
C8, T1
Median
nerve

SUPINATION
Biceps and
supinator
muscles

Lunate
(= moonshaped)

Triquertral
(= three cornered)

Scaphoid
(= boat shaped

Pisiform

Trapezium
(= four sided,
no two sides
parallel)

Hamate
(= like a
hook)

Capitate
(= head
shaped)

THUMB

**LITTLE
FINGER**

Trapezoid
(= four sided,
having two sides
parallel)

**RING
FINGER**

**INDEX
FINGER**

**MIDDLE
FINGER**

Metacarpals

Proximal phalages

Middle phalanges
(distal of the thumb)

Distal phalanges

The bony structure of the right elbow joint

Lateral
supracondylar
ridge

Lateral
epicondyle

Capitulum

Trochlea

Trochlear notch

Head of
radius

Radial notch
of ulna

Radial tuberosity

RADIUS

ULNA

Styloid
process

Head of ulna

THE ELBOW JOINT

The ulna (= the arm) tapers distally whereas the radius tapers proximally. The ulna has a trochlear (trochlea = pulley) notch which only allows the ulna to be flexed or extended and prevents it playing an active role in supination or pronation of the forearm. Supination (= to turn onto the back) and pronation (= to turn onto the front) are effected by movement of the radius (= the spoke of a wheel) which can rotate anteriorly so that its expanded distal

end (which articulates with the proximal and bones) can be rotated around the ulna. The radio-ulnar joints are synovial. The muscles of the ventral upper arm are brachialis and biceps, both of which flex the humerus on shoulder. Brachialis (= pertaining to the arm) also adducts the shoulder. The muscles of the dorsal upper arm are the deltoid and triceps. Aconeus is a triangular muscle at the back of the elbow "as if a continuation of the triceps" which extends the elbow. Brachioradialis is a rogue muscle in that it is a flexor of the elbow joint which is supplied by the (extensor) radial nerve.

The elbow joint is synovial with complex facets. It has a capsule, and radial and ulnar collateral ligaments.
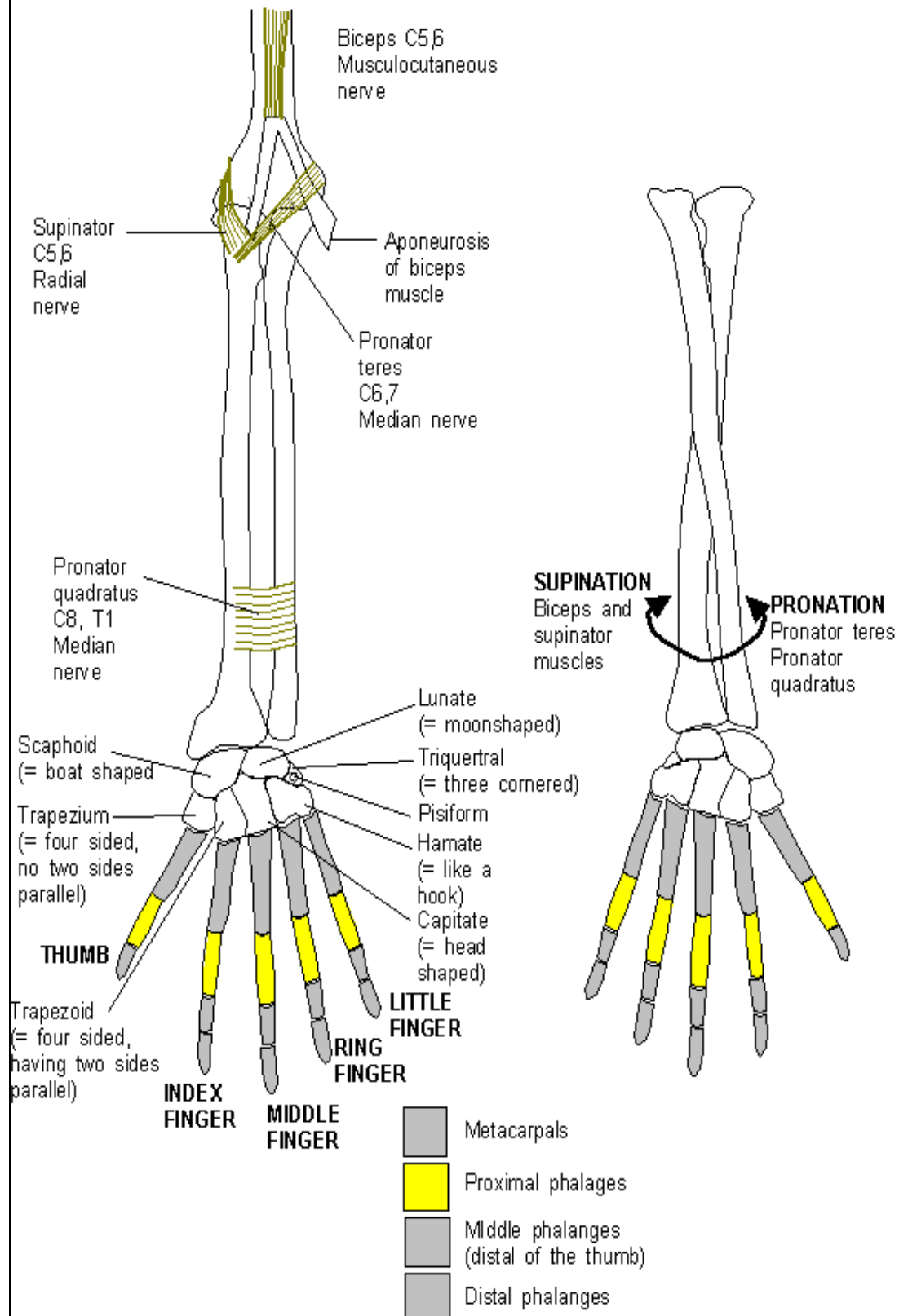
MUSCLES OF THE FOREARM

The tendons of most "post forearm finger mover muscles" actually move the fingers. The muscles themselves are in the forearm and are large and powerful movers of the digits and exert their action using long tendons because there is no room for muscle bulk on the digits themselves. Their actions will be dealt with below.
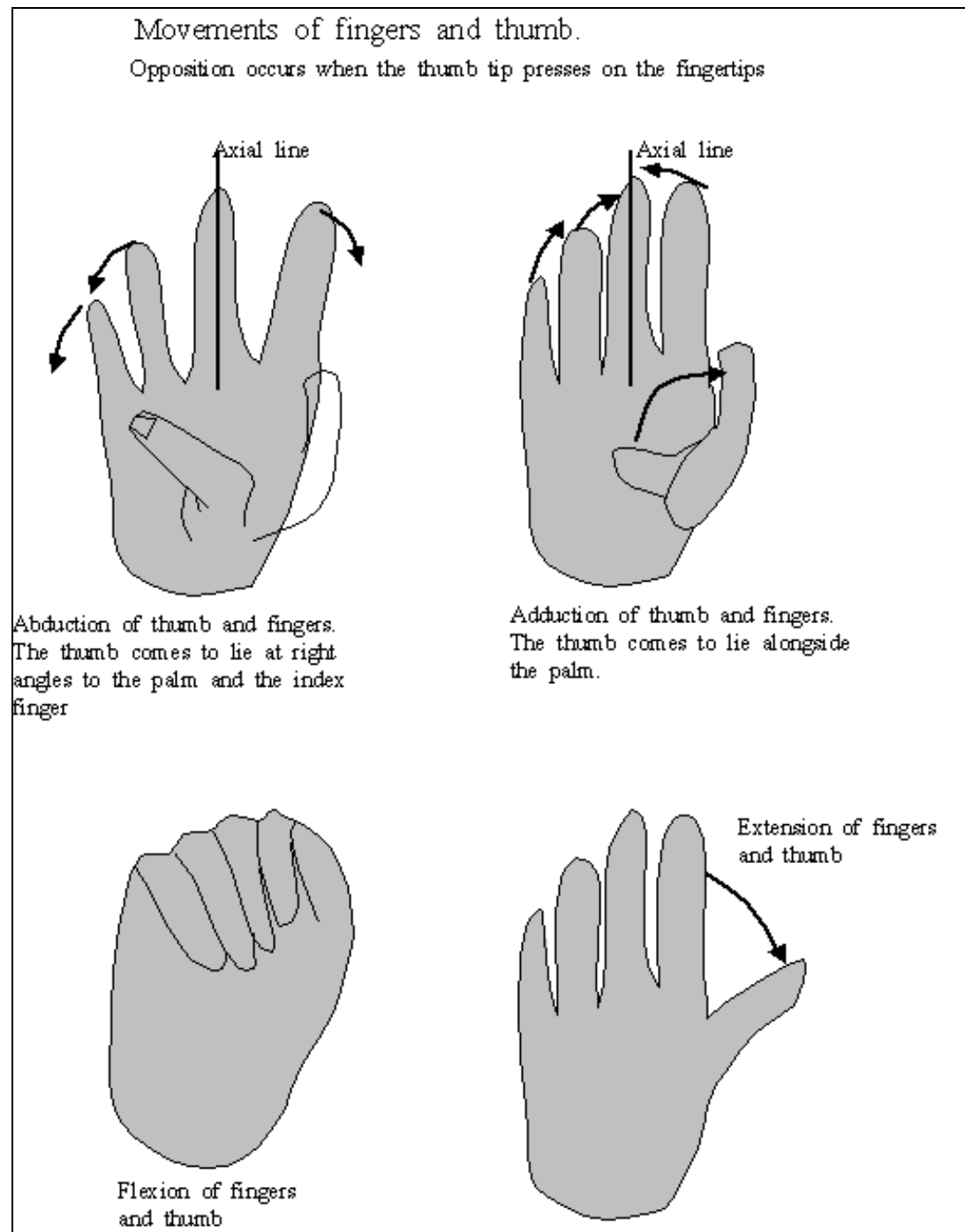
> For the purpose of this account there are five digits comprising the thumb and four fingers. The thumb is digit 1, the index finger digit 2, the middle finger digit 3, the ring finger digit 4 and the little finger digit 5

The only forearm muscles that move the forearm itself are the forearm rotators, the pronators (=to turn onto the back) pronator teres and pronator quadratus (= four sided), and supinator. Biceps from the upper arm is a supinator of the forearm.
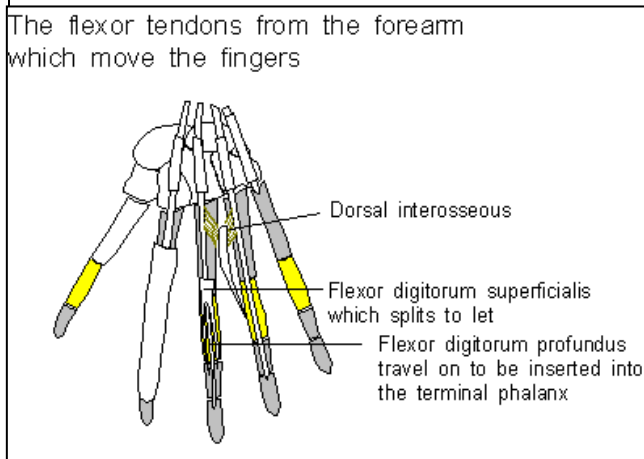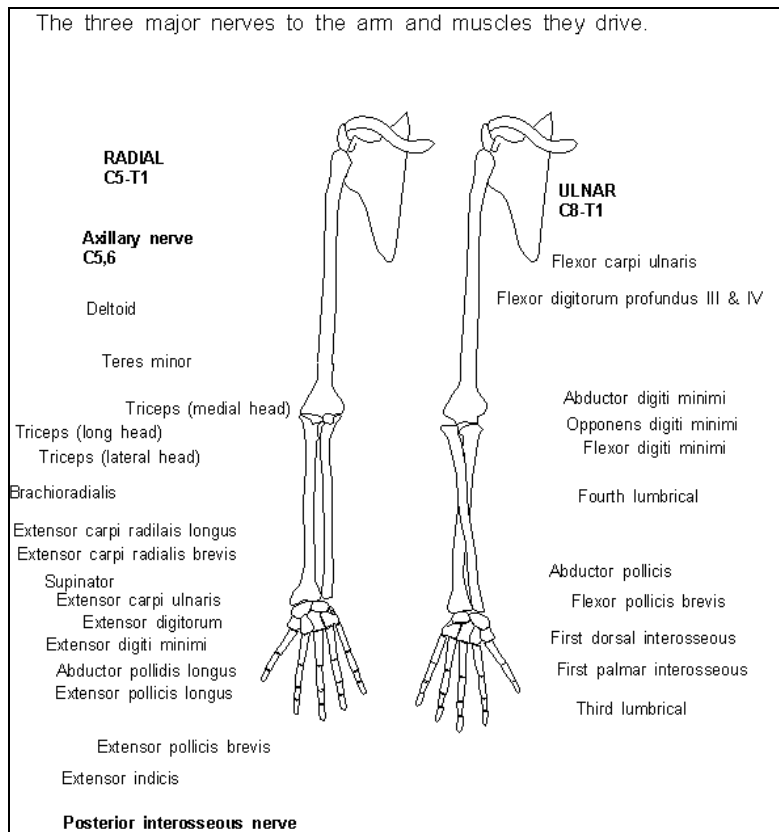
Supination and pronation of the right forearm

Biceps C5,6
Musculocutaneous nerve

Supinator C5,6 Radial nerve

Aponeurosis of biceps muscle

Pronator teres C6,7 Median nerve

Pronator quadratus C8, T1 Median nerve

Lunate (= moonshaped)

Triquertral (= three cornered)

Scaphoid (= boat shaped

Pisiform

Trapezium (= four sided, no two sides parallel)

Hamate (= like a hook)

Capitate (= head shaped)

THUMB

LITTLE FINGER

Trapezoid (= four sided, having two sides parallel)

RING FINGER

INDEX FINGER

MIDDLE FINGER

SUPINATION
Biceps and supinator muscles

PRONATION
Pronator teres Pronator quadratus

Metacarpals

Proximal phalages

Middle phalanges (distal of the thumb)

Distal phalanges

22

The movements of the fingers are shown below.

Movements of fingers and thumb.
Opposition occurs when the thumb tip presses on the fingertips

Axial line

Axial line

Abduction of thumb and fingers. The thumb comes to lie at right angles to the palm and the index finger

Adduction of thumb and fingers. The thumb comes to lie alongside the palm.

Extension of fingers and thumb

Flexion of fingers and thumb

There are three layers of "post forearm finger mover" dorsal (flexor) muscles of the forearm:
- The deepest (paradoxically) is flexor digitorum superficialis
- The deep layer comprises flexor digitorum profundus and flexor pollicis longus
- The superficial layer comprises brachioradialis, flexor carpi radialis, palmaris (= pertaining to the palm) longus, and flexor carpi ulnaris

The three major nerves to the arm and muscles they drive.

RADIAL
C5-T1

Axillary nerve
C5,6

Deltoid

Teres minor

Triceps (medial head)
Triceps (long head)
Triceps (lateral head)

Brachioradialis

Extensor carpi radilais longus
Extensor carpi radialis brevis
Supinator
Extensor carpi ulnaris
Extensor digitorum
Extensor digiti minimi
Abductor pollidis longus
Extensor pollicis longus

Extensor pollicis brevis

Extensor indicis

Posterior interosseous nerve

ULNAR
C8-T1

Flexor carpi ulnaris
Flexor digitorum profundus III & IV

Abductor digiti minimi
Opponens digiti minimi
Flexor digiti minimi

Fourth lumbrical

Abductor pollicis
Flexor pollicis brevis
First dorsal interosseous
First palmar interosseous
Third lumbrical

The flexor tendons from the forearm which move the fingers

Dorsal interosseous

Flexor digitorum superficialis which splits to let

Flexor digitorum profundus travel on to be inserted into the terminal phalanx

There are two layers of "post forearm finger mover" ventral (extensor) muscles of the forearm:

- The deep layer comprises abductor pollicis (= of the thumb) longus, extensor pollicis longus, extensor indicis, and extensor pollicis brevis
- The superficial layer comprises (brachioradialis), extensor carpi radialis longus and extensor carpi radialis brevis and extensor digitorum

Thus "post forearm finger movers" only produce simple but powerful flexion and extension of the fingers and thumb abduction .

Finger movements caused by tendons of "post forearm finger mover muscles."
On the fingers (digits 2-5) the tendons of flexor digitorum superficialis divides at the level of the proximal phalanx (=a line or array, originally of soldiers) allowing the deeper tendon of flexor digitorum profundus to go onward to be inserted into the base of the proximal phalanges. The two tendons resulting from the split of the tendon of flexor digitorum superficialis cross deep to the emerging tendon of flexor digitorum profundus to be inserted into the sides of the middle phalanx.
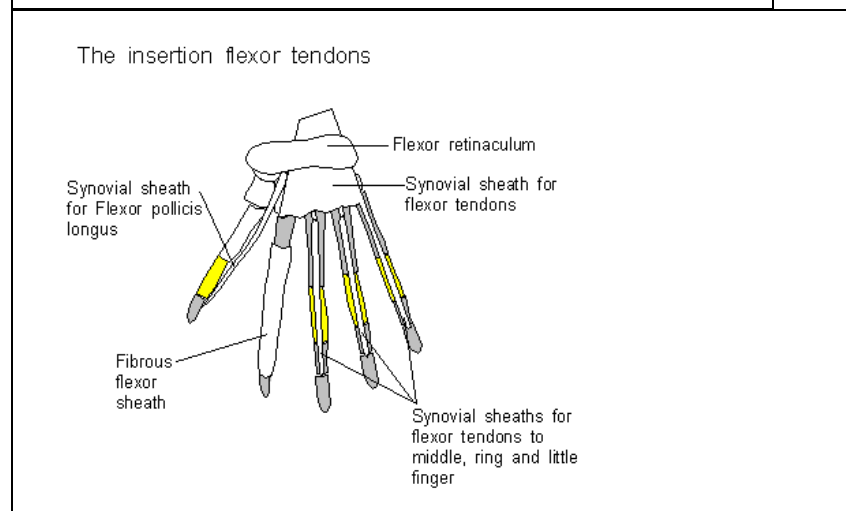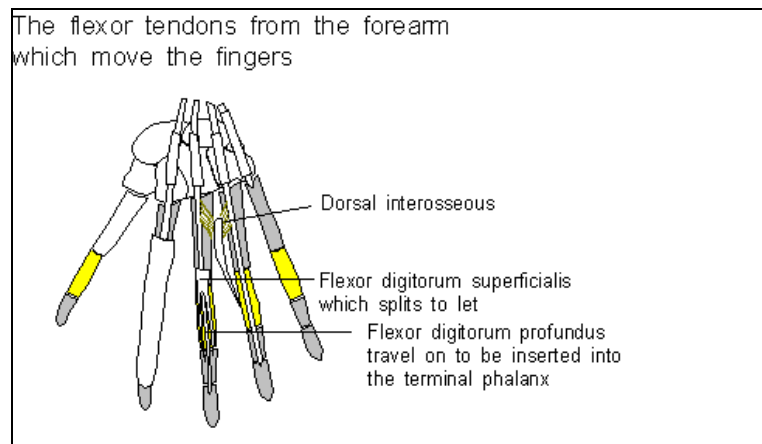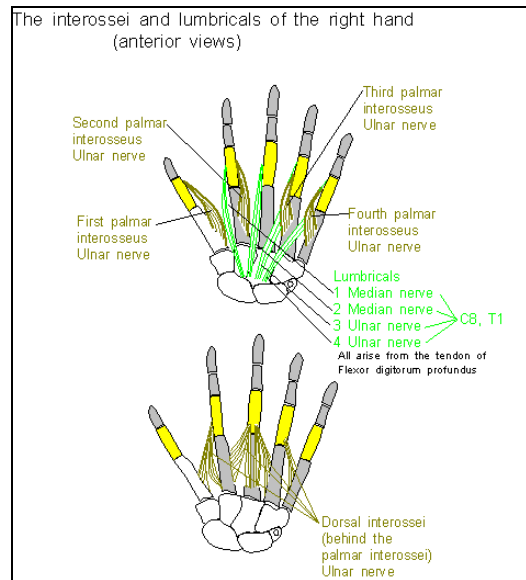
Flexor digitorum superficialis therefore flexes the proximal interphalangeal joint and, to a lesser extent, the metacarpophalangeal and wrist joints. Flexor digitorum profundus flexes the distal interphalangeal joints and, to a lesser extent, the proximal interphalangeal, metacarpophalangeal and wrist joints. The action of both muscles causes the fingers to be flexed into the palm.

Flexor pollicis longus is inserted into the distal thumb phalanx to flex the thumb and, to a lesser extent, to flex its metacarpophalangeal and carpometacarpal joints.

The tendons of the layers of "post forearm finger movers" need to be restrained by fascial bands, the retinacula, at the wrist joint to prevent them standing out like a bowstring when put under tension. In effect there is a tunnel beneath the retinacula and the ventral tunnel is known as the carpal tunnel. Structures in this tunnel may be compressed, notably the median nerve may be rendered dysfunctional to produce the carpal tunnel syndrome. Fibrous sheaths (which contain lubricating fluid between two layers) cover the tendons. There is also an extensor retinaculum.

THE SMALL MUSCLES OF THE HAND

The interossei and lumbricals of the right hand
(anterior views)

Second palmar interosseus
Ulnar nerve

Third palmar interosseus
Ulnar nerve

First palmar interosseus
Ulnar nerve

Fourth palmar interosseus
Ulnar nerve

Lumbricals
1 Median nerve
2 Median nerve
3 Ulnar nerve
4 Ulnar nerve
C8, T1
All arise from the tendon of
Flexor digitorum profundus

Dorsal interossei
(behind the
palmar interossei)
Ulnar nerve

The flexor tendons from the forearm which move the fingers

Dorsal interosseous

Flexor digitorum superficialis which splits to let

Flexor digitorum profundus travel on to be inserted into the terminal phalanx

The insertion flexor tendons

Flexor retinaculum

Synovial sheath for flexor tendons

Synovial sheath for Flexor pollicis longus

Fibrous flexor sheath

Synovial sheaths for flexor tendons to middle, ring and little finger

These lack the bulk and power of the "post forearm finger movers" and are more suited to perform the finer movements. There are three groups of hand muscles).

1. Thenar eminence muscles that move the thumb:
- Abductor pollicis brevis
- Flexor pollicis brevis
- Opponens pollicis
- Adductor pollicis

All perform their named function but smooth movements demand coordination of two or more muscles

2. Hypothenar eminence muscles which move the little finger
- Abductor digiti minimi
- Flexor digiti minimi
- Opponens digiti minimi

3. Longitudinal muscles of the palm which move the fingers

Four lumbricals (= earthworm shaped) which arise in the palm from flexor digitorum profundus tendons. Each passes to the lateral side of its metacarpophalangeal joint to be inserted into dorsal tendinous structures (in effect the shaft of the proximal phalanges).

Four palmar interossei that arise from the ventral surface of the first, second, fourth and fifth metacarpal bones. Those from the first and second pass to the medial side of their metacarpophalangeal joint and those from the fourth and fifth metacarpal bones pass to the lateral side of their metacarpophalangeal joints. All four insert into tendinous structures (in effect the shaft of the proximal phalanges) and adduct the digits.

Four palmar interossei which arise from metacarpal bones. The first and second insert into the lateral side of the tendinous structures (in effect the shafts of the proximal phalanges) of the first and second digit and the third and fourth insert into the tendinous structures (in effect the shafts) of the medial side of the third and fourth proximal phalanges. They abduct the index, middle and ring fingers (the thumb and the little finger have their own abductors). Because the axial line goes along the middle finger it can only abduct (either medially or laterally) and thus it has two interossei.
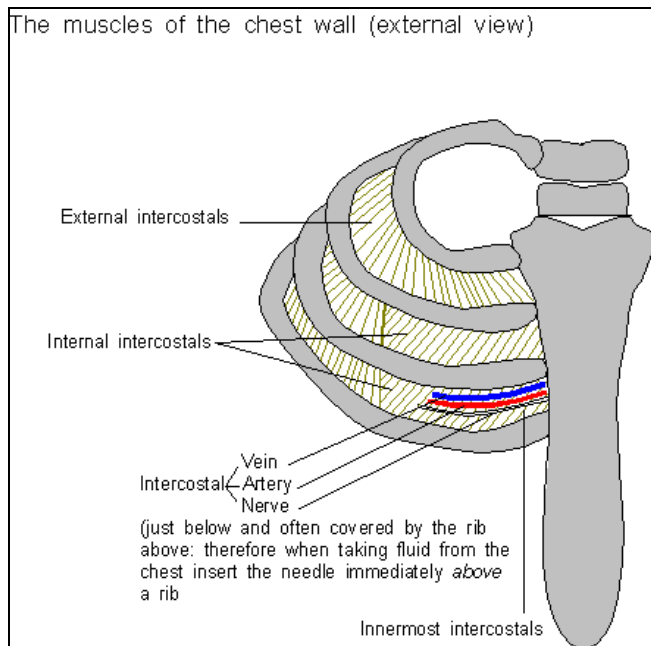

THE CHEST WALL

Ribs 3-10 have a similar configuration with an articular areas posteriorly at the head and one at the tubercle, both of which articulate with their vertebra. The anterior ends articulate with the costal cartilages. The first rib is short and flattened with grooves for the subclavian vein and artery, between which the scalenius anterior muscle is inserted. The second rib forms two joints at the manubrio-sternal junction at the sternal

The sternum

- Manubrium sterni
- Sternal angle
- Body of sternum
- Xiphisternum

angle

The ribs

Front view

Head — Tubercle

Groove for subclavian artery

Scalene tubercle

Groove for subclavian vein

Articulation area with costal cartilege

Articular facet of head

Neck

Tubercle

Angle

Articulation with costal cartilege

Articular facet of head

Head

Back view   (ribs 11 and 12 are called the "floating ribs" because their distal ends do not articulate with any skeletal structure)

This angle is prominent and enables other anterior rib ends to be counted off. Ribs 11 and 12, the "floating ribs" have but one articulation at their head and their anterior ends terminate in a small cap of cartilage.

Four sets of muscles are directly related to the ribs:
- The intercostals filling the space between the ribs
- The subcostals connecting the inner surface of several ribs
- The transversus thoracis which connect the inner surface of the ribs to the inner surface of the sternum
- A group of miscellaneous small muscles

The muscles of the chest wall (external view)

External intercostals

Internal intercostals

Intercostal { Vein / Artery / Nerve
(just below and often covered by the rib above: therefore when taking fluid from the chest insert the needle immediately *above* a rib)
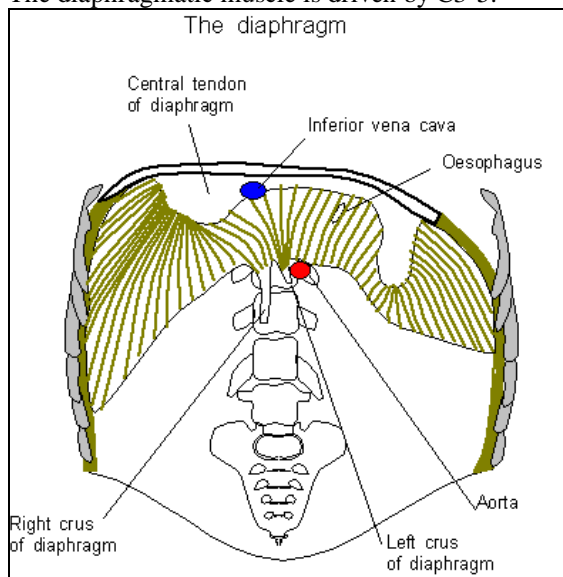
Innermost intercostals

The external intercostals are aligned downwards and around the chest. The internal intercostals align at right angles to the external intercostals. The innermost intercostals have the same alignment as the inner intercostals, the difference being that the intercostal nerves, artery and vein run between. The main function of the intercostals is respiration. Intercostal contraction raises the ribs to a more horizontal position and the capacity of the thorax is thereby increased. Each intercostal muscle is supplied by its intercostal nerve.

The clavicle is attached to the scapula at the acromio-clavicular joint which provides the only skeletal stabilizing influence and helps keep the scapula in a lateral position: the position of the scapula is otherwise controlled by muscles. The sternoclavicular joint is a synovial joint which allows the lateral end of the clavicle to be elevated or moved anteriorly. The glenoid (= socket) cavity is pear shaped and articulates with the head of the humerus to form the shoulder joint. This joint has a fibrous capsule into which the tendons of subscapularis, supraspinatus, infraspinatus and teres (= long and round) muscles are inserted. There is only one ligament. The shallowness of the glenoid cavity and the movements of the scapula allow the shoulder great mobility (flexion or abduction to 180 degrees, lateral and medial rotation, and circumduction "overarm bowling" of 360 degrees).

The clavicle and its relationship to the sternum and scapula

1st Rib
Clavicle
Acromion
Glenoid cavity
Manubrium sterni
Scapula
Sternal angle
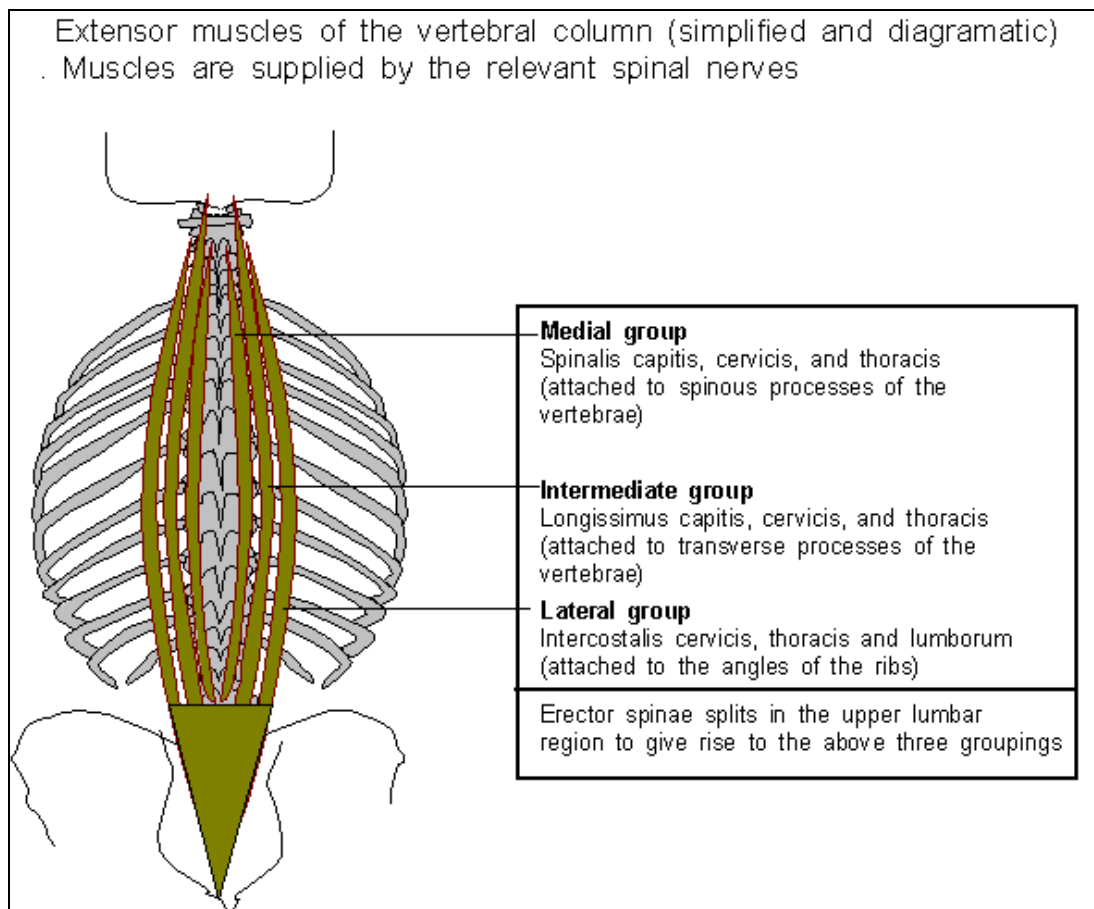Body of sternum
Xiphisternum
Humerus
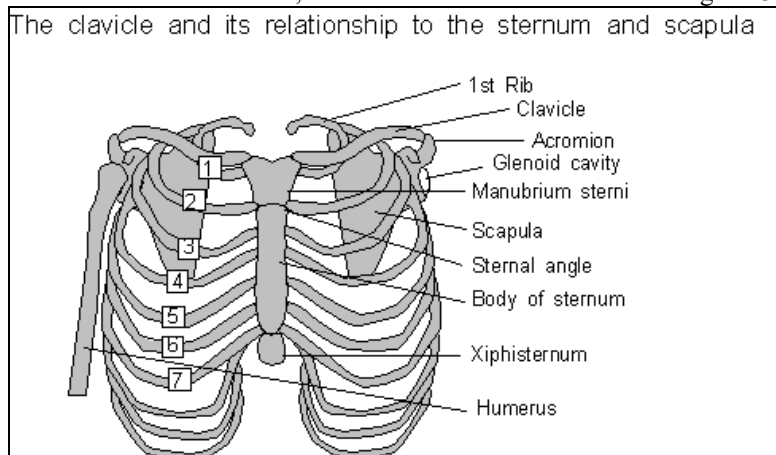
The diaphragm is a dome shaped structure, the edges of which attach to the inner surfaces of the xiphisternum, the costal margin, two ligaments posteriorly which cross the muscles of the posterior abdominal wall, and the anterior surfaces of the upper lumbar vertebrae. Various structures including the aorta and oesophagus have to pass through the diaphragm. At the top of the dome there is a central tendon. Contraction of diaphragmatic muscles and the raising of the ribs by the intercostals flattens the diaphragm and increases the thoracic cavity thus sucking air into the lungs. Contraction

of diaphragmatic muscles causes intra-thoracic pressure to fall but intra-abdominal pressure to rise. The diaphragmatic muscle is driven by C3-5.
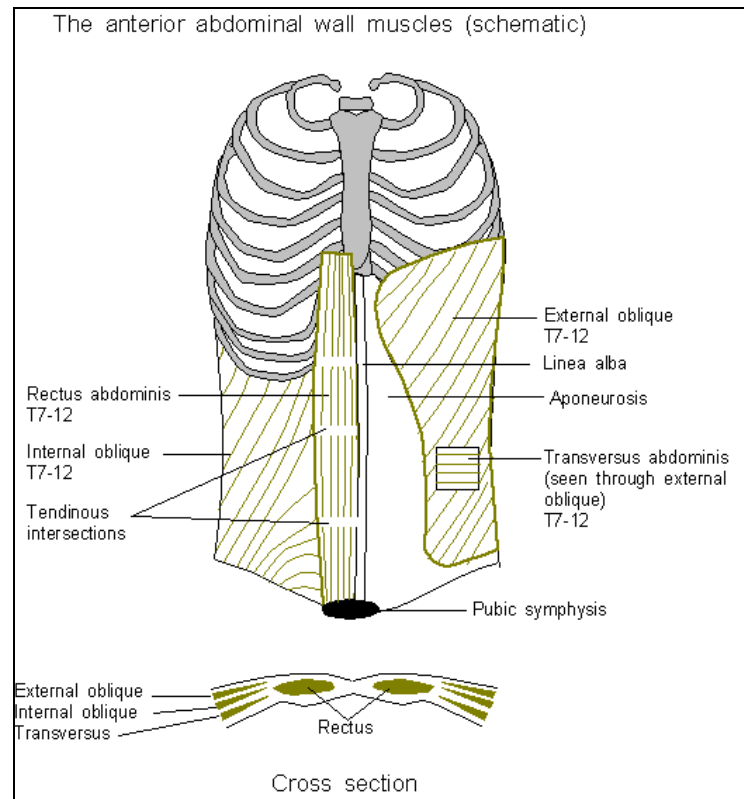

VERTEBRAL COLUMN EXTENSOR MUSCLES

Extensor muscles of the vertebral column (simplified and diagramatic) . Muscles are supplied by the relevant spinal nerves

Medial group
Spinalis capitis, cervicis, and thoracis (attached to spinous processes of the vertebrae)

Intermediate group
Longissimus capitis, cervicis, and thoracis (attached to transverse processes of the vertebrae)

Lateral group
Intercostalis cervicis, thoracis and lumborum (attached to the angles of the ribs)

Erector spinae splits in the upper lumbar region to give rise to the above three groupings

The deepest are the transversospinalis group which generally run upwards and medially from the transverse process of one vertebra to the spinous process of the vertebra above. Superficial to these are the erector spinae group - spinalis, longissimus and the intercostalis. These muscles extend the

spine and allow smooth flexion when bending over (a movement largely powered by gravity) rather than the abdominal wall muscles. Unilateral contraction causes lateral flexion of the spine.
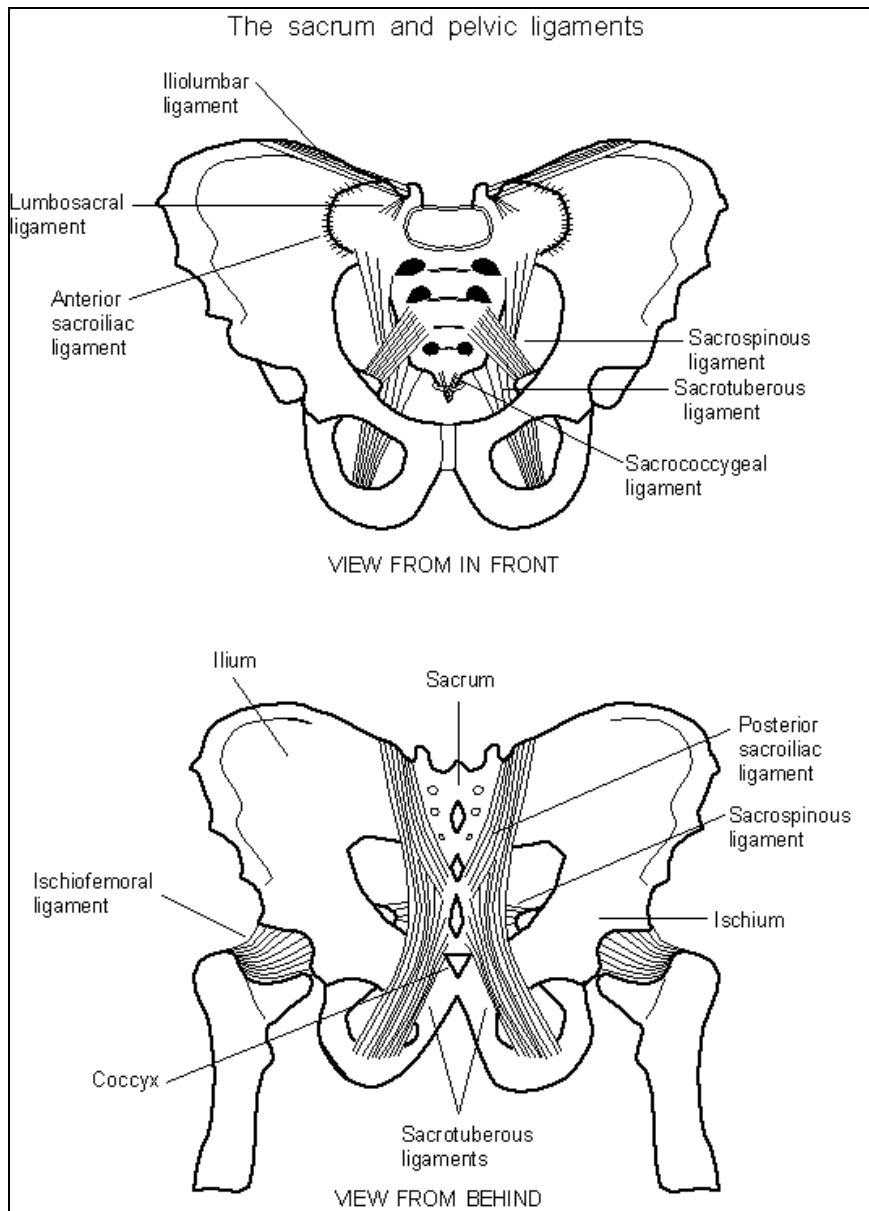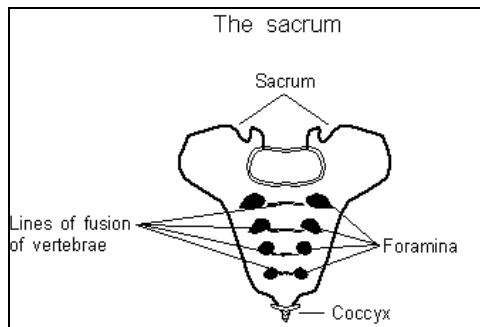

ABDOMINAL WALL MUSCLES

The anterior abdominal wall muscles (schematic)

External oblique
T7-12

Linea alba

Aponeurosis

Transversus abdominis
(seen through external
oblique)
T7-12

Rectus abdominis
T7-12

Internal oblique
T7-12

Tendinous
intersections

Pubic symphysis

External oblique
Internal oblique
Transversus

Rectus

Cross section

Anterior. Rectus abdominis is a strap-like muscle which has about three fibrous intersections. The muscles of each side connect across the midline by a fibrous strip, the linea alba. Rectus (= straight) abdominis lies in a fibrous sheath which fuses with the (aponeurotic) tendons of the anterolateral abdominal muscles. Rectus abdominis flexes the thoracic and lumbar spine.
Anterolateral. External oblique arises from the lower eight ribs and pass anteriorly and downwards to be inserted into the iliac and pubic crest and linea alba. Internal oblique arises from the inguinal ligament, iliac crest and fascia (= a band) from quadratus (four sided) lumborum and is inserts into the lower four ribs. Transversus arises from the costal cartilages of the lower six ribs, fascia from quadratus lumborum, iliac crest, and inguinal ligament and ends with an aponeurosis which connects across the midline. The anterolateral muscles assist in flexion and rotation of the trunk and can raise the intra-abdominal pressure.
Posterior. Quadratus lumborum is mostly attached to the iliac crest and is inserted into the 12th rib and transverse processes of the upper four lumbar vertebrae (several other muscles including psoas *vide infra* contribute the posterior wall of the abdominal cavity). Quadratus lumborum depresses the 12th rib and thus the rib cage. Unilateral contraction causes lateral flexion of the spine.

THE SACRUM

The sacrum transfers the weight of the upper body to the pelvis. In effect five sacral vertebrae have fused and are tapered downwards. The sacroiliac joint is immobile and is supported by a group of very strong ligaments.

The sacrum

Sacrum

Lines of fusion of vertebrae

Foramina

Coccyx

The sacrum and pelvic ligaments

Iliolumbar ligament

Lumbosacral ligament

Anterior sacroiliac ligament

Sacrospinous ligament

Sacrotuberous ligament

Sacrococcygeal ligament

VIEW FROM IN FRONT

Ilium

Sacrum

Posterior sacroiliac ligament

Sacrospinous ligament

Ischiofemoral ligament

Ischium

Coccyx

Sacrotuberous ligaments

VIEW FROM BEHIND

THE PELVIS AND HIP JOINT

The hip joint is a socket into which the ball of the femoral head is inserted. A rim of fibrocartilage deepens the cup. The joints has several ligaments. Flexion is limited to about 60 degrees by the hamstrings (if the knee is flexed the hamstrings are under less tension and flexion can be to 90 degrees), extension to about 15 degrees, abduction is about 60 degrees, adduction is limited by the limb on the other side, medial rotation about 30 degrees and lateral rotation about 60 degrees.

INTRINSIC PELVIC MUSCLES

Levator ani is attached to the inner surface of the pelvis and joins its counterpart across the midline to from most of the pelvic floor. The prostate and bladder are just above and anterior to the levator ani in the male and in the female the bladder, uterus and upper part of the vagina are similarly situated. The perineal body, a knot of fibrous tissue which forms a junction several muscle insertions is just anterior to the anus. The coccygeus (the coccyx resembles the beak of a cuckoo) muscle, pyriformis (=pear shaped), and obturator (= a disc or plate which covers an opening) internus form part of the muscles that form the pelvic cavity (the latter two muscles are dealt with as muscles relevant to the lower limb).
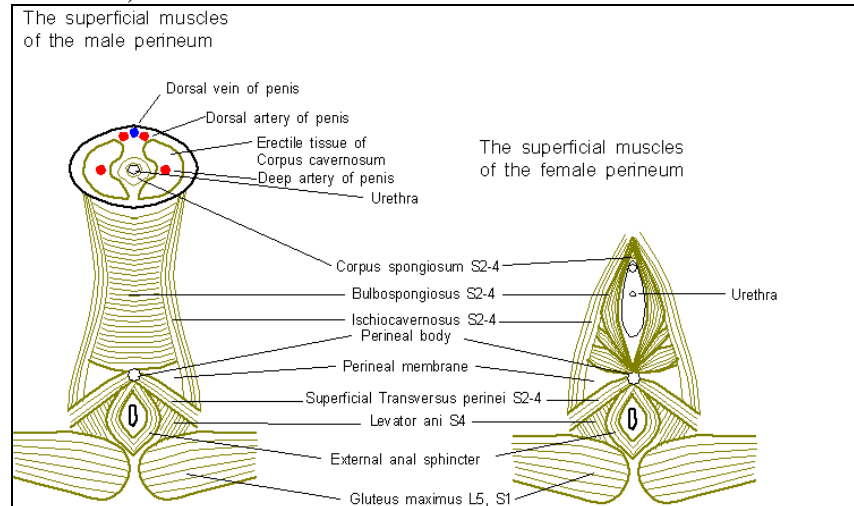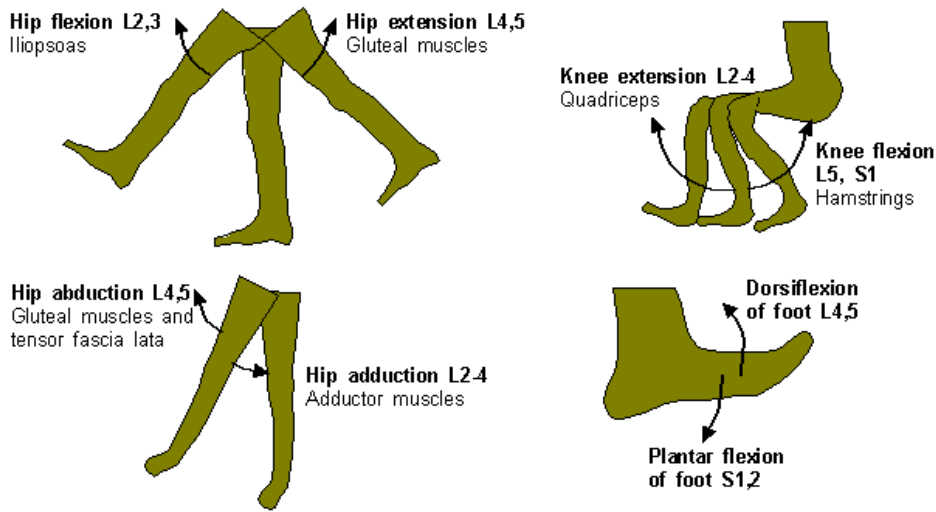

The perineal muscles are external to the pelvic floor muscles). The external anal (voluntary) sphincter surrounds the lowermost region of the anal canal. The erectile tissue of the penis is not muscular but rather relies upon hydrostatic pressure to achieve erection.

MUSCLES THAT MOVE THE HIP JOINT

The hip joint (or more accurately the humerus relative to the pelvis) can be flexed, extended, abducted, adducted, medially rotated and laterally rotated. The muscles that move the hip joint are the gluteals (which are superior and lateral to the hip joint), the flexors (which are anterior to the hip joint), and adductors (which are mostly medial to the hip joint).
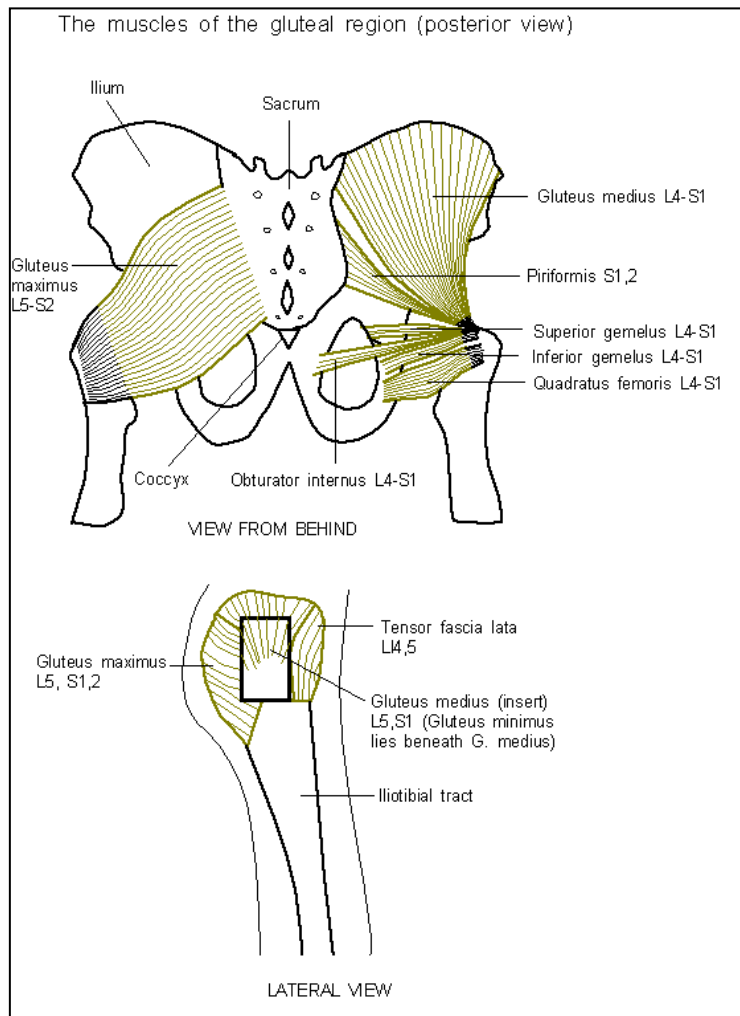
Analysis of major movements of the leg. Nerve root values reflect the predominant rather than the total innervation.

Hip flexion L2,3 — Iliopsoas

Hip extension L4,5 — Gluteal muscles

Knee extension L2-4 — Quadriceps

Knee flexion L5, S1 — Hamstrings

Hip abduction L4,5 — Gluteal muscles and tensor fascia lata

Hip adduction L2-4 — Adductor muscles

Dorsiflexion of foot L4,5

Plantar flexion of foot S1,2
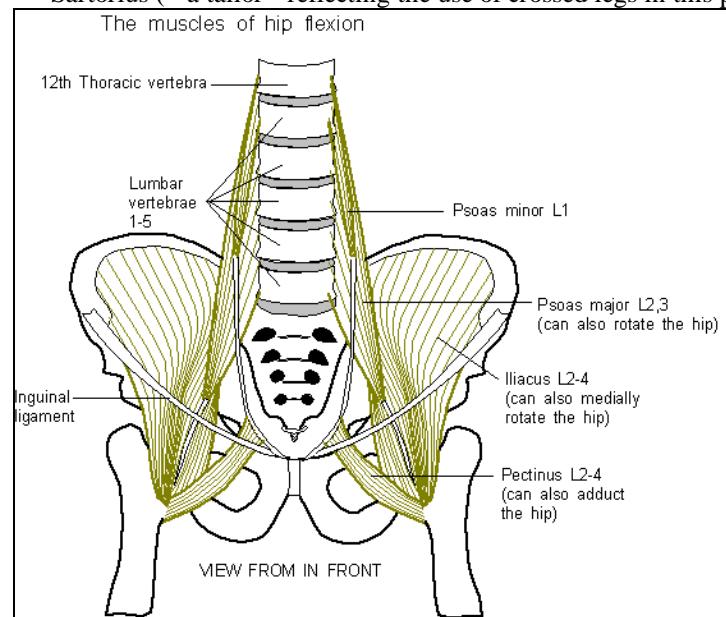
The gluteal region muscles comprise:
- Gluteus (= buttock) maximus, medius and minimus
- Tensor fascia lata
- Piriformis
- Obturator internus
- Superior and inferior gemelli (= twins)
- Quadratus femoris

The muscles of the gluteal region (posterior view)

Ilium

Sacrum

Gluteus medius L4-S1

Piriformis S1,2

Superior gemelus L4-S1

Inferior gemelus L4-S1

Quadratus femoris L4-S1

Gluteus maximus L5-S2

Coccyx

Obturator internus L4-S1

VIEW FROM BEHIND

Tensor fascia lata LI4,5

Gluteus maximus L5, S1,2

Gluteus medius (insert) L5,S1 (Gluteus minimus lies beneath G. medius)

Iliotibial tract

LATERAL VIEW

The main action of gluteus maximus is to extend the hip (the hamstrings, see later, also contribute) and laterally rotate the hip. Gluteus medius and minimus abduct and medially rotate the hip. Piriformis can abduct the hip.
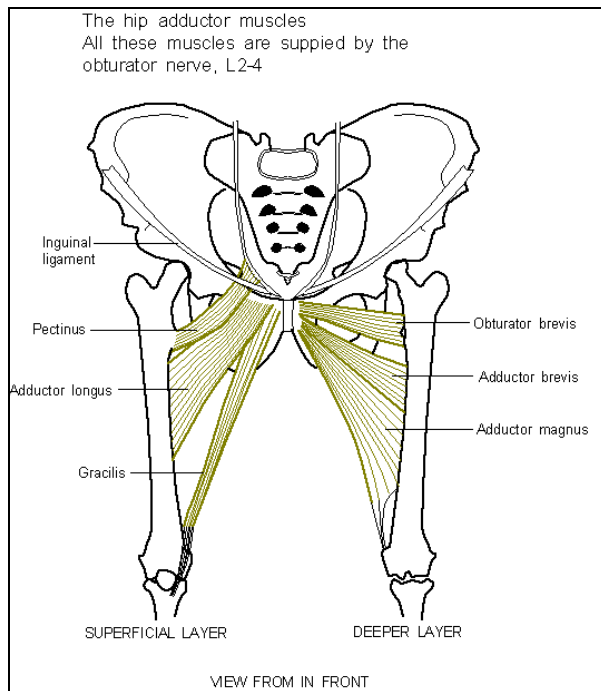
The hip flexors comprise:
- Psoas major and psoas minor (Psoas = muscles of the loins)
- Iliacus
- Pectineus (= ridged)
- Sartorius (= a tailor - reflecting the use of crossed legs in this profession).

The muscles of hip flexion

12th Thoracic vertebra

Lumbar vertebrae 1-5

Psoas minor L1

Psoas major L2,3 (can also rotate the hip)

Iliacus L2-4 (can also medially rotate the hip)

Inguinal ligament

Pectinus L2-4 (can also adduct the hip)

VIEW FROM IN FRONT

The hip adductors comprise a superficial layer (all are inserted posteriorly on the femur and can thus also laterally rotate the hip joint):
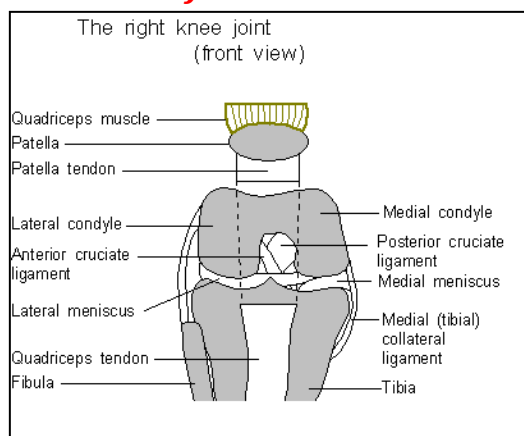- Adductor longus
- Gracilis (= graceful)
- Obturator externus
- Adductor brevis
- Adductor magnus

The hip adductor muscles
All these muscles are suppied by the
obturator nerve, L2-4

Inguinal ligament
Pectinus
Adductor longus
Gracilis
Obturator brevis
Adductor brevis
Adductor magnus
SUPERFICIAL LAYER   DEEPER LAYER
VIEW FROM IN FRONT

and a deep layer:
- Obturator externus
- adductor brevis
- adductor magnus

THE KNEE JOINT

The right knee joint
(front view)

Quadriceps muscle
Patella
Patella tendon
Lateral condyle
Anterior cruciate ligament
Lateral meniscus
Quadriceps tendon
Fibula
Medial condyle
Posterior cruciate ligament
Medial meniscus
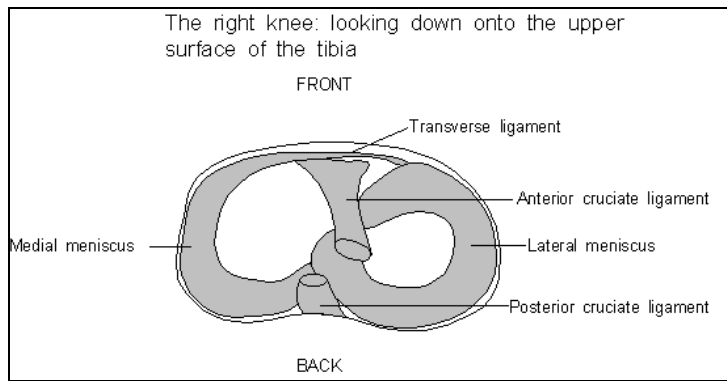Medial (tibial) collateral ligament
Tibia

The femur (= thigh) articulates with the tibia. The fibula has only a minor weight carrying role but it forms a lateral part of the bony surround of the talar joint. The patella (= kneecap) is a sesamoid (= resembling a sesame seed) bone in the tendon of quadriceps.

The knee joint is a complex synovial joint which is made stable mostly by ligaments - the muscles which in one moment stabilizes the joint and in the next tends to destabilize it. There are tibial (medial) and fibular (lateral) ligaments (tibia = shinbone and fibula = that which fastens). The anterior crucia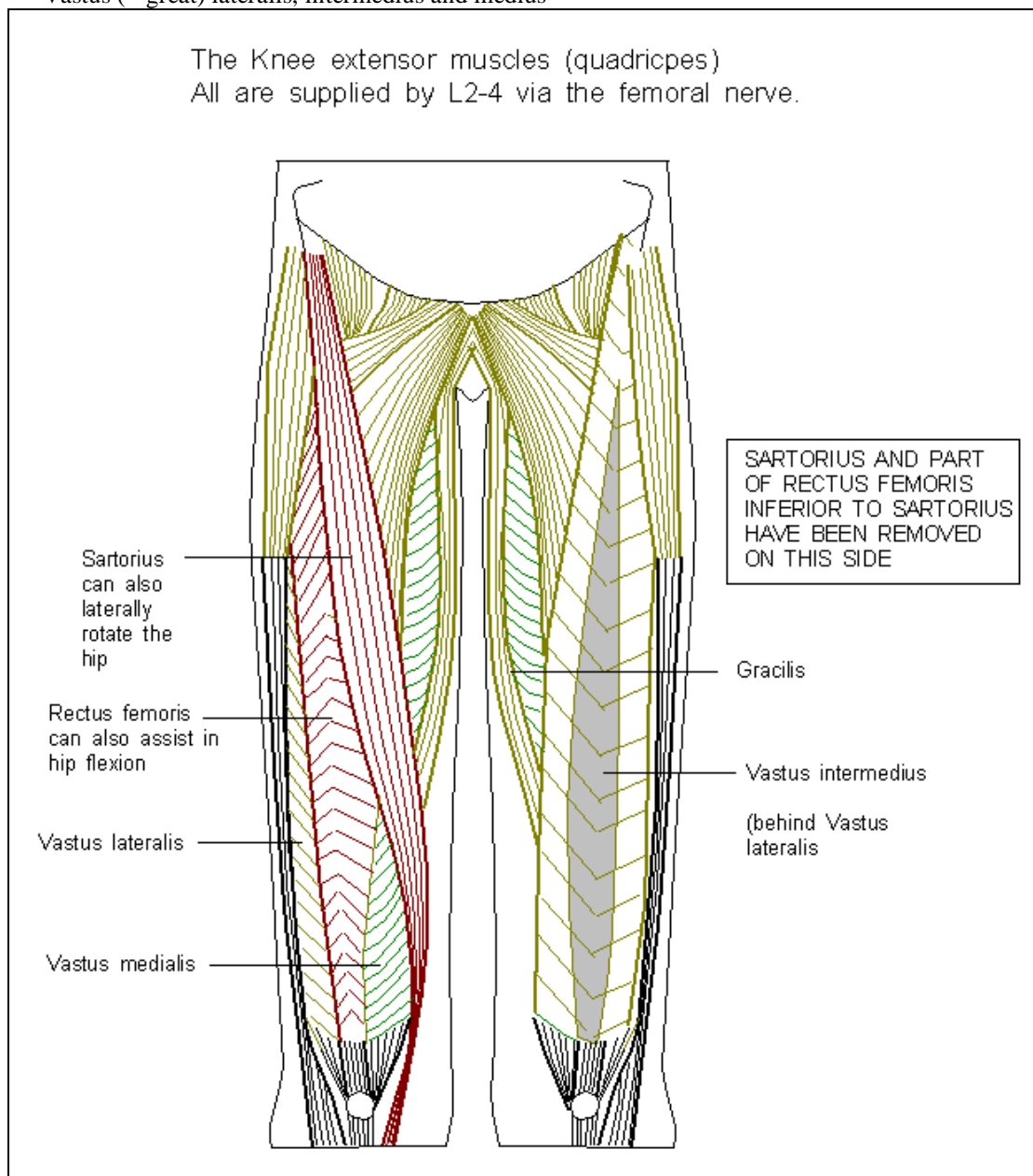te (=crossing) ligament is attached anteriorly to the intercondylar area of the tibia and run superiorly, posteriorly, and laterally to the lateral side of the intercondylar notch of the femur and thus prevents the tibia from sliding anteriorly on the femoral condyles. The posterior cruciate ligament attaches posteriorly in the intercondylar area of the tibia and runs anteriorly, superiorly, and medially (medial to the anterior cruciate ligament) to reach the medial area of the femoral intercondylar notch and thus protects the tibia from sliding posteriorly on the femoral condyles (= knuckles).

There are two menisci (= crescent shaped). Both are C shaped fibrocartilages with both ends attached to the intercondylar area of the tibia.

The right knee: looking down onto the upper surface of the tibia

FRONT

Transverse ligament

Anterior cruciate ligament

Medial meniscus

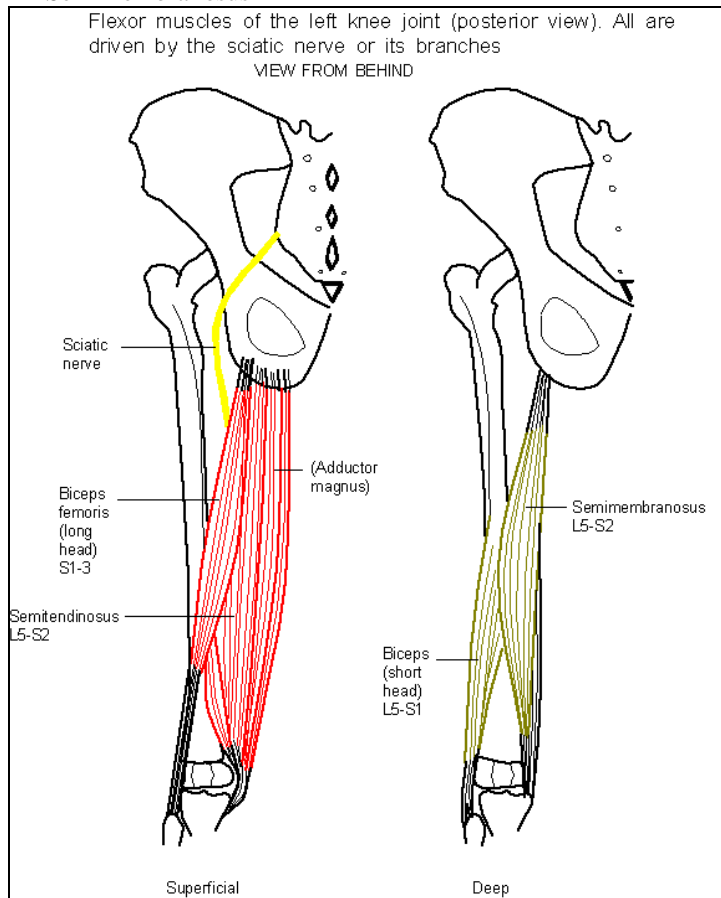Lateral meniscus

Posterior cruciate ligament

BACK

The knee movements are essentially extension and flexion. There are four knee extensors (hence quadriceps) comprise:

- Rectus femoris
- Vastus (= great) lateralis, intermedius and medius

The Knee extensor muscles (quadricpes)
All are supplied by L2-4 via the femoral nerve.

SARTORIUS AND PART OF RECTUS FEMORIS INFERIOR TO SARTORIUS HAVE BEEN REMOVED ON THIS SIDE

Sartorius can also laterally rotate the hip

Rectus femoris can also assist in hip flexion

Vastus lateralis

Vastus medialis

Gracilis

Vastus intermedius

(behind Vastus lateralis

The knee flexors, which also help extend the hip, comprise:

- Biceps femoris
- Semitendinosus
- Semimembranosus

Flexor muscles of the left knee joint (posterior view). All are driven by the sciatic nerve or its branches
VIEW FROM BEHIND

Popliteus (= relating to the poples = the hamstrings) is also a weak knee flexor which arises laterally and passes downwards and medially to insert on the tibia.

THE ANKLE JOINT

The ankle joint is synovial with a tough capsule and strong medial and lateral ligaments. The configuration of the joints, bones, muscles, ligaments and tendons ensures that movement at the tibia-talar joint is substantially limited to flexion and extension. The foot can be dorsiflexed, plantar flexed, inverted, everted, abducted and adducted.

The (left) ankle joint
View from behind
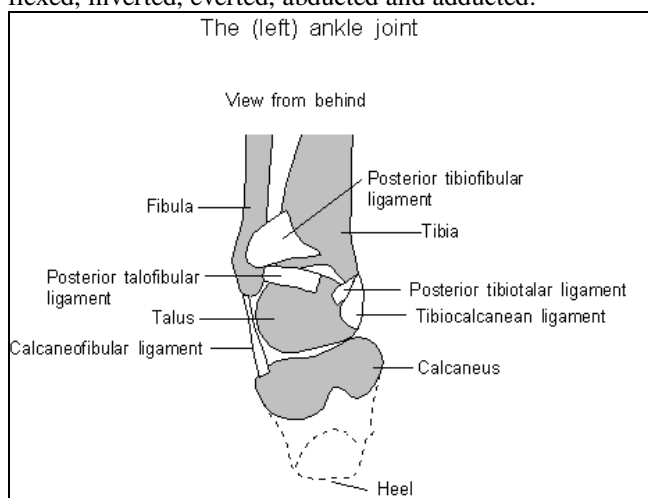
There are four dorsiflexor muscles
- Tibialis anterior (which can also invert the foot)
- Extensor digitorum longus
- Extensor hallucis longus (which can also extend the digits
- Peroneus (= relating to the fibula) tertius, which can also evert the foot

There are six plantar flexor muscles.
 Three are superficial:
- Gastrocnemius (= calf of the leg), which is also a weak knee flexor
- Plantaris (= related to the sole), which is also a weak knee flexor
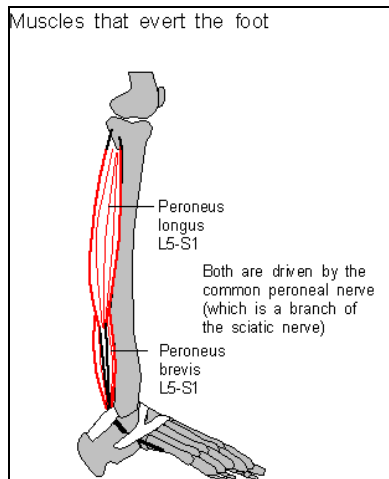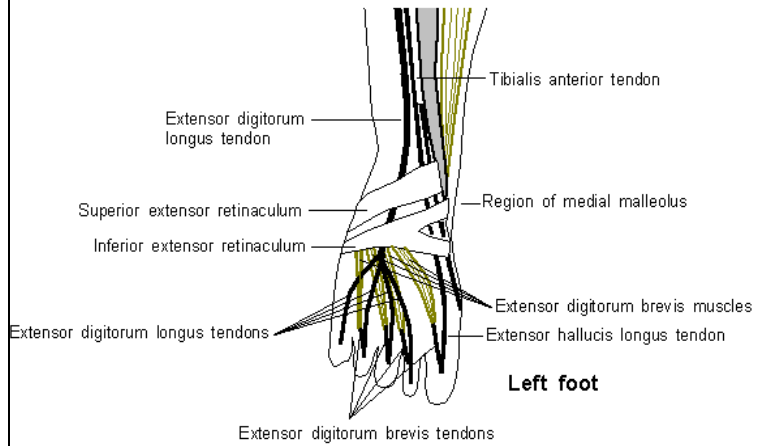- Soleus (= a sandal)

And three, which al insert into the bony structure of the foot, are deep:
- Tibialis posterior
- Flexor digitorum longus
- Flexor hallucis longus

Two muscles evert the foot, peroneus longus and peroneus brevis, and two muscles invert the foot
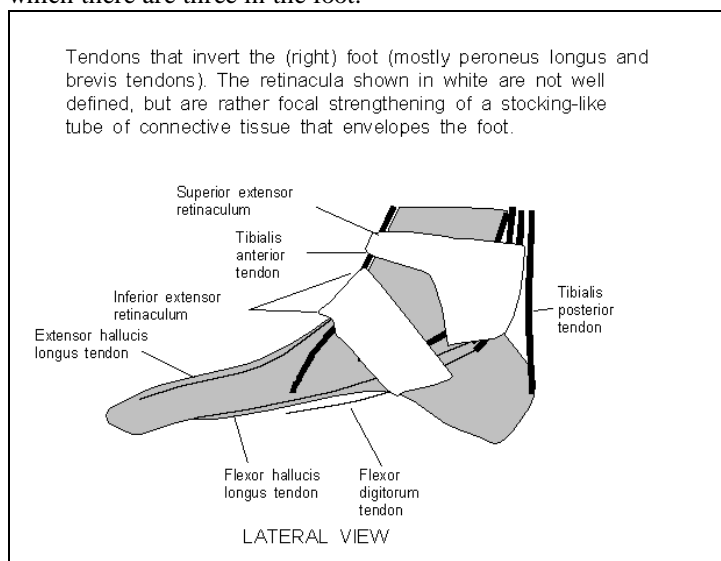tibialis anterior and tibialis posterior.
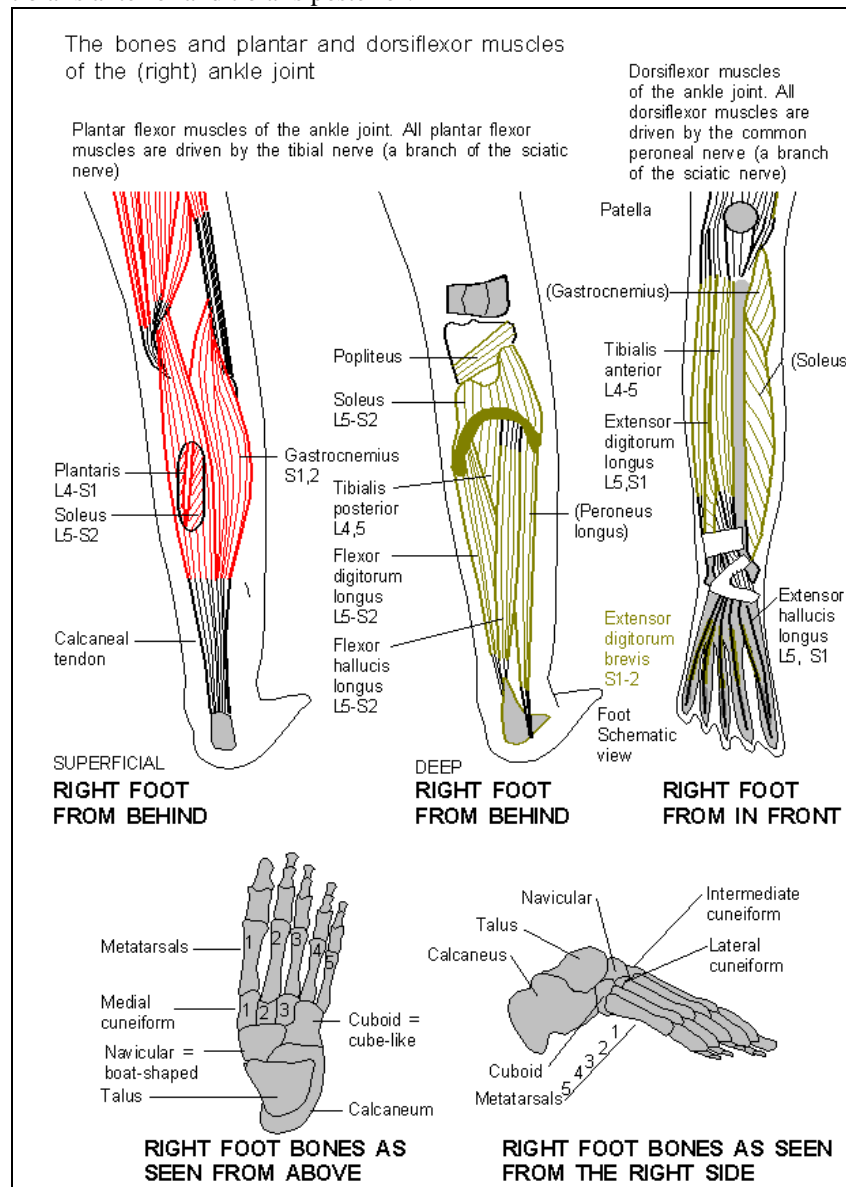
Extensor digitorum brevis: a simplified view (as in the hand the extrinsic muscle power is delivered by tendons and the intrinsic muscles are smaller than the extrinsic muscles).

Tibialis anterior tendon

Extensor digitorum longus tendon

Superior extensor retinaculum

Region of medial malleolus

Inferior extensor retinaculum

Extensor digitorum brevis muscles

Extensor digitorum longus tendons

Extensor hallucis longus tendon

Left foot

Extensor digitorum brevis tendons

Muscles that evert the foot

Peroneus longus L5-S1

Both are driven by the common peroneal nerve (which is a branch of the sciatic nerve)

Peroneus brevis L5-S1

RETINACULA

As in the upper limb bowstringing of tendons has to be prevented by retinacula (= to hold back) of which there are three in the foot.

Tendons that invert the (right) foot (mostly peroneus longus and brevis tendons). The retinacula shown in white are not well defined, but are rather focal strengthening of a stocking-like tube of connective tissue that envelopes the foot.

Superior extensor retinaculum

Tibialis anterior tendon

Tibialis posterior tendon

Inferior extensor retinaculum

Extensor hallucis longus tendon

Flexor hallucis longus tendon

Flexor digitorum tendon

LATERAL VIEW

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The tendons beneath the retinacula have synovial sheaths to assist tendon movement. The detailed anatomy and function of foot muscles is disproportionally complex and the following is a simplified account. There is only one muscle (but also tendons of some longus muscles) on the dorsum of the foot, extensor digitorum brevis.

There are no less than four muscle layers on the sole of the foot. These muscles, along with tendons and a multitude of ligaments connecting the bones of the foot, and the bony configuration, ensure the simultaneous stability and flexibility of the foot.